Repairing and maintenance of Township buildings/Transit Camp

400/220 KV Bahadurgarh S/s

Technical Specifications

1.0 GENERAL

1.1 All civil works shall be carried out as per design/drawings provided by the Employer/ Contractor and as per these specification provided by the Employer. In case design/drawings are prepared by the contractor then these shall be approved by the employer before execution. In case any item is not covered under specification then the same shall be carried out as per CPWD specification /applicable BIS Standards and Codes. Any item for which specification is not provided herein and is not covered under CPWD specification/ BIS Standards, the same shall be executed as per manufacturer guidelines with the approval of employer. All materials shall be of best quality conforming to relevant Indian Standards and Codes. In case of any conflict between Standards/ Code and Technical Specification, the order of precedence shall be as under:

1.1.1 Technical specification
1.1.2 CPWD specification.

The decision of engineer in charge in this regard shall be final and binding.

1.2 Wherever reference to CPWD/BIS/National Building Code/ Standard Field Quality Plan (SFQP) is made, it shall be to the latest edition/revision of the same, issued/uploaded up to 28 days prior to the actual date of bid opening for instant package.

1.3 The Contractor shall arrange all labour, tools, equipment, materials, temporary works, constructional plant & machinery, fuel supply, transportation and all other incidental items

not shown or specified but as may be required for complete performance of the Works in accordance with drawings, specifications and direction of Employer.

1.4 All materials including cement, reinforcement steel, structural steel etc. shall be arranged by the Contractor.

1.5 The Contractor shall execute the work as per the Field Quality Plan (FQP) which is available on POWERGRID website. All testing required shall be arranged by the Contractor at his own cost.

1.6 The bidder shall fully apprise himself of the prevailing conditions at the proposed site, Climatic conditions including monsoon patterns, local conditions and site specific parameters, soil parameters, availability of construction material and shall include for all such conditions and contingent measures in the bid, including those which may not have been specifically brought out in the specifications.

1.7 The material specification, workmanship and acceptance criteria shall be as per approved standard Field Quality Plan. In case certain item is not covered in FQP, it shall be constructed as per CPWD specification/ relevant BIS.

1.8 For Civil work items where base rate of raw material is mentioned in the BOQ description/ specification, the actual basic price of that raw material (*as approved by E-IC*) may vary. Then, approved rate of the item is generally governed as **Rate of item in the BOQ +/- (Plus/Minus)** (**difference in basic rate of raw material**) x **1.01** x **1.15**.

(Where Basic rate of material means Basic rate including all discounts, transportation till site and applicable taxes as applicable during purchase) and the same may be considered for the subject package also.

SUB HEAD : 5.0

REINFORCED CEMENT CONCRETE WORK

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LIST OF MANDATORY TESTS

Material	*Clause*	*Test*	*Field/ laboratory test*	*Test procedure*	*Min, quantity of material for carrying out the test*	*Frequency of testing*
1	2	3	4	5	6	7
Reinforced cement concrete (Nominal Mix)	5.4.1	(a) Slump test	Field/Lab	Appendix 'D' of Chapter 4	(i) 5 cum in case of column (ii) 20 cum for slabs, beams and connected columns (iii) 20 cum for other R.C.C. work for all other small items and where R.C.C. done in a day is less than 5 cum test may be carried out as required by Engineerin - Charge	(ii) Every 20 cum or part thereof (i) Every 5 cum of part thereof (iii) -Do-
	5.4.9.1	(b) Cube Test	Lab	Appendix 'A'	(i) 5 cum in case of column (ii) 20 cum for slabs, beams and connected Columns (iii) 20 cum for other R.C.C.work for all other small items and where R.C.C. done in a day is less than 5 cum test may be carried out as required by Engineerin-Charge	(i) Every 5 cum or part thereof (ii) Every 20cum or part thereof (iii) -Do

1	2	3	4	5	6	7
Reinforced Cement Concrete (Design Mix)	Coarse Aggregates				50 cum or part thereof & also on each change of source	
	Fine Aggregates				50 cum or part thereof & also on each change of source	
	Cement				50 MT or on each change of source	
	Fresh Concrete	(a) Slump test	Field	Appendix 'D' of Chapter 4	10 cum	50 cum for R.C.C. work including in all other small location. R.C.C.done in a day is less than 50 cum test may be carried out as required by Engineer-in-Charge
	Fresh Concrete	(b) Cube Test	Lab	Appendix 'A'	10 cum or part thereof	50 cum or 10 batches of 5-7 cum each for R.C.C. work in all location taken together. R.C.C. done in a day is less than 50 cum test may be carried out as required by Engineer-in-Charge
Reinforced Cement Concrete (Ready Mix)	Coarse Aggregates				50 cum or part thereof & also on each change of source	
	Fine Aggregates				50 cum or part thereof & also on each change of source	
	Cement				50 MT or on each change of source	
	Fresh Concrete	(a) Slump test	Field/Lab	Appendix 'D' of Chapter 4	10 cum	50 cum for R.C.C. work including in all other small location. R.C.C. done in a day is less than 50 cum test may be carried out as required by Engineer-in-Charge

1	2	3	4	5	6	7	
	Fresh Concrete	(b) Cube Test	Lab	Appendix 'A'	10 cum or part thereof	50 cum or 10 batches of 5-7 cum each for R.C.C. work in all location – taken together. R.C.C. done in a day is less than 50 cum test may be carried out as required by Engineerin-Charge	
Steel for Reinforced cement concrete	5.1.3	(A) Physical Test and chemical tests				(a) For consignment below 100 tonnes (i) under 10 mm dia, one Sample for each 25 tonnes or part thereof (ii) 10 mm to 16 mm dia one sample for each 35 tonnes or part thereof (iii) over 16 mm dia one sample for each 45 tonnes or part thereof	(b) For consignment over 100 tonnes (i) Under 10 mm dia, one sample For each 40 tonnes or part thereof (ii) 10 mm to 16 mm, one sample for each 45 (iii) over 16 mm dia, one sample for each 50 tonnes or part thereof

LIST OF BUREAU OF INDIAN STANDARDS CODES

Sl. No.	*I.S. No.*	*Subject*
1.	IS 226	Structural Steel
2.	IS 2285	Methods for chemical analysis of steel (Issues in various parts)
3.	IS 432 (Part I)	Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement part-I mild steel and medium tensile steel bars.
4.	IS 432 (Part II)	Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement – Part-II hard drawn steel wire.
5.	IS 456	Code of Practices for plain and Reinforced concrete.
6.	IS 516	Method of test for strength of concrete.
7.	IS 716	Specification for pentachlorophenol
8.	IS 1199	Method of sampling and analysis of concrete.
9.	IS 1200 (Part II)	Method of measurement of building and civil engineering work – concrete work
10.	IS 1200 (Part V)	Method of measurement of building and civil engineering work – concrete work (Part 5- Form work)
11.	IS 1566	Specification for hard drawn steel wire fabric for concrete requirement.
12.	IS 1599	Method for bend test
13.	IS 1343	Code of Practice for Prestressed Concrete
14.	IS 1387:1993	General requirements for the supply of metallurgical materials
15.	IS 14687	Guidelines for falsework for concrete structures
16.	IS 1608	Method for tensile testing of steel products
17.	IS 1786	Specification for high strength deformed steel and wires for concrete reinforcement.
18.	IS 1791	Specification for batch type concrete mixes
19.	IS 2502	Code of practice for bending and fixing of bars for concrete reinforcement.
20.	IS 2751	Recommended practice for welding of mild steel plain and deformed bars for reinforced construction.
21.	IS 4925	Batch plants specification for concrete batching and mixing plant
22.	IS 4926	Ready – Mixed Concrete
23.	IS 5522:2014	Specification for Indian Standard Stainless Steel sheet and strips for utensils
24.	IS 6523	Specification for precast reinforced concrete door, window frames
25.	IS 10262	Recommended guidelines for concrete mix design
26.	IS 13311 (Part I)	Indian standard for non-destructive testing of concrete. Method of test for ultrasonic pulse velocity
27.	IS 13311 (Part II)	Indian standard for non-destructive testing of concrete. Method of testing by rebound hammer.
28.	IS 14276:1995	Indian standard for Cement bonded particle boards
29.	IS 16172:2014	Specification for Reinforcement couplers for mechanical splices of bars in concrete

5.0 REINFORCED CEMENT CONCRETE WORK

5.0 GENERAL

Reinforced cement concrete work may be cast-in-situ or Precast as may be directed by Engineer-in-Charge according to the nature of work. Reinforced cement concrete work shall comprise of the following which may be paid separately or collectively as per the description of the item of work.

(a) Form work (Centering and Shuttering)

(b) Reinforcement

(c) Concreting: (1– Cast-in-situ), (2 – Precast)

5.1 MATERIALS

5.1.1 Water, cement, fine and coarse aggregate shall be as specified under respective clauses of chapter 03 mortars and chapter 04 concrete work as applicable.

5.1.2 Fly Ash admixed cement concrete (FACC) and fly ash Blended cements in Cement Concrete (PPCC) in RCC structures.

5.1.2.0 Fly ash Blended Cements conforming to IS 1489 (Part I) may be used in RCC structures as per guidelines given below :

5.1.2.1 ***General***

(i) IS 456- 2000 Code of Practice for Plain and Reinforced Concrete (as amended up to date) shall be followed in regard to Concrete Mix Proportion and its production as under :
   (a) The concrete mix design shall be done as “Design Mix Concrete” as prescribed in clause-9 of IS 456 mentioned above.
   (b) Concrete shall be manufactured in accordance with clause 10 of above mentioned IS 456 covering quality assurance measures both technical and organizational, which shall also necessarily require a qualified Concrete Technologist to be available during manufacture of concrete for certification of quality of concrete.

(ii) Minimum M -25 grade of concrete shall be used in all structural elements made with RCC both in load bearing and framed structure.

(iii) The mechanical properties such as modulus of elasticity, tensile strength, creep and shrinkage of fly ash mixed concrete or concrete using fly ash blended cements (PPCs) are not likely to be significantly different and their values are to be taken same as those used for concrete made with OPC.

(iv) To control higher rate of carbonation in early ages of concrete both in fly ash admixed as well as PPC based concrete, water/binder ratio shall be kept as low as possible, which shall be closely monitored during concrete manufacture.
   If necessitated due to low water/binder ratio, required workability shall be achieved by use of chloride free chemical admixtures conforming to IS 9103. The compatibility of chemical admixtures and super plasticizers with each set OPC, fly ash and /or PPC received from different sources shall be ensured by trials.

(v) In environment subjected to aggressive chloride or sulphate attach in particular, use of fly ash admixed or PPC based concrete is recommended. In cases, where structural concrete is exposed to excessive magnesium sulphate, fly ash substitution/content shall be limited to 18% by weight. Special type of cement with low C3A content may also be alternatively used. Durability criteria like minimum binder content and maximum water /binder ratio also need to be given due consideration in such environment.

(vi) Wet curing period shall be enhanced to a minimum of 10 days or its equivalent. In hot & arid regions, the minimum curing period shall be 14 days or its equivalent.

5.1.2.2 ***Use of Fly ash Admixed Cement Concrete (FACC) in RCC structures***

There shall be no bar on use of FACC in RCC structures subject to following additional conditions.

(i) Fly ash shall have its chemical characteristics and physical requirements etc. conforming to IS 3812 (part I & II) and shall be duly certified.

(ii) To ensure uniform blending of fly ash with cement in conformity with IS 456, a specific facility needs to be created at site with complete computerized automated process control to achieve design quality or with similar facility from Ready Mix Concrete (RMC) plants.

(iii) As per IS 1489 (Part-I) maximum 35% of OPC by mass is permitted to be substituted with fly ash conforming to IS 3812 (Part –I) and same is reiterated.

(iv) Separate storage for dry fly ash shall be provided. Storage bins or silos shall be weather proof and permit a free flow and efficient discharge of fly ash. The filter or dust control system provided in the bins or silos shall be of sufficient size to allow delivery of fly ash maintained at specified pressure to prevent undue emission of fly ash dust, which may interfere weighing accuracy.

5.1.2.3 ***Use of Fly Ash Blended Cements in Cement Concrete (PPCC) in RCC Structures***

(i) Subject to General Guidelines detailed out as above, PPC manufactured conforming to IS 1489 (Part-I) shall be treated at par with OPC for manufacture of Design Mix concrete for structural use in RCC.

(ii) Till the time, BIS makes it mandatory to print the %age of fly ash on each bag of cement, the certificate from the PPC manufacture indicating the same shall be insisted upon before allowing use of such cements in works.

(iii) While using PPC for structural concrete work, no further admixing of fly ash shall be permitted.

5.1.3 Steel for Reinforcement

5.1.3.1 The steel used for reinforcement shall be any of the following types:

(a) Mild steel and medium tensile bars conforming to IS 432 (Part I)

(b) High strength deformed steel bars conforming to IS 1786

(c) Hard drawn steel wire fabric conforming to IS 1566

(d) Structural steel conforming to Grade A of IS 2062

(e) Thermo-mechanically treated (TMT) Bars.

5.1.3.2 Elongation percent on gauge length is $5.65\sqrt{A}$ where A is the cross sectional areas of the test piece.

5.1.3.3 Mild steel is not recommended for the use in structures located in earthquake zone subjected to severe damage and for structures subjected to dynamic loading (other than wind loading) such as railway and highway bridges.

5.1.3.4 Welding of reinforcement bars covered in this specification shall be done in accordance with the requirements of IS 2751.

Nominal mass/weight : The tolerance on mass/ weight for round and square bars shall be the percentage given in Table 5.1 of the mass/ weight calculated on the basis that the masses of the bar/ wire of nominal diameter and of density 7.85 kg/ cm^3 or 0.00785 kg/mm^3.

TABLE 5.1
Tolerance on Nominal Mass

Nominal size in mm	*Tolerance on the Nominal Mass per cent*		
	Batch	*Individual sample +*	*Individual sample for coil (x)*
(a) Upto and including 10	±7	-8	±8
(b) Over 10, upto and including 16	±5	-6	±6
Over 16	±3	-4	±4

\+ for individual sample plus tolerance is not specified
(x) for coil batch tolerance is not applicable
Tolerance shall be determined in accordance with method given in IS 1786.

5.1.3.5 High strength deformed bars & wires shall conform to IS 1786. The physical properties for all sizes of steel bars are mentioned below in Table 5.2.

TABLE 5.2

Sl. No	*Property*	*Fe 415*	*Fe 415 D*	*Fe 500 D*	*Fe 550 D*
(i)	0.2 Per cent Proof stress/ yield stress, Min, N/mm^2	415.0	415.0	500.0	550.0
(ii)	Elongation, per cent, Min. on gauge length 5.65 √A, where A is the corss-sectional area of the test piece.	14.5	18.0	16.0	14.5
(iii)	Tensile strength, Min	10 Per cent more than the actual 0.2 per cent proof stress/ yield stress but not less than 485.0 N/mm^2	12 Per cent more than the actual 0.2 percent proof stress/yield stress but not less than 500.0 N/mm^2	10 Per cent more than the actual 0.2 per cent proof stress/ yield stress but not less than 565.0 N/mm^2	8 Per cent more than the actual 0.2 per cent proof stress/yield stress but not less than 600.0 N/mm^2
(iv)	Total elongation at maximum force, percent, Min on gauge length 5.65 √A, where A is the cross-sectional area of the test piece.	-	5	5	5

Tests: Selection and preparation of Test sample. All the tests pieces shall be selected by the Engineer-in-Charge or his authorized representative either-

(a) From cutting of bars
Or
(b) If he so desires, from any bar after it has been cut to the required or specified size and the test piece taken from and any part of it.

In neither case, the test pieces shall be detached from the bar or coil except in the presence of the Engineer-in-Charge or his authorized representative.

The test pieces obtained in accordance with as above shall be full sections of the bars as rolled and subsequently cold worked and shall be subjected to physical tests without any further modifications. No deduction in size by machining or otherwise shall be permissible. No test piece shall be enacted or otherwise subject to heat treatment. Any straightening which a test piece may require shall be done cold.

Tensile Test: 0.2% proof stress and percentage elongation –
This shall be done as per IS 1608, read in conjunction with IS 226.

RE- test: This shall be done as per IS 1786.

Rebend test: This shall be done as per IS 1786.

5.1.3.6 Chemical composition of reinforcement bars shall be as per Table 5.3 as follows:-

TABLE 5.3

Constituent	*Maximum Per cent*			
	Fe 415	*Fe 415 D*	*Fe 500 D*	*Fe 550 D*
Carbon	0.30	0.25	0.25	0.25
Sulphur	0.060	0.045	0.040	0.040
Phosphorus	0.060	0.045	0.040	0.040
Sulphur and Phosphorus	0.110	0.085	0.075	0.075

5.1.3.7 Thermo Mechanically treated reinforcement bars:

(a) There is no BIS code for TMT bars. The available code BIS 1786 pertains to HSD Bars. Therefore there should be no stipulation that TMT bars should conform to relevant BIS code.

(b) The TMT bars are being produced under valid licence from either of the firms namely Tempcore, Thermex Evcon Turbo & Turbo Quench. These firms have acquired patents and are giving licences to various producers to produce TMT Bars.

(c) The TMT bars shall conform to IS 1786 pertaining to Fe 415 D or Fe 500 D or Fe grade of steel as specified.

(d) In design and construction of reinforced concrete building in seismic zone III and above, steel reinforcement of Grade Fe 415 D shall be used. However, high strength deformed steel bars, produced by thermo mechanical treatment process of grade Fe 415, Fe 500 and Fe 550 having elongation more than 14.5. % and conform to other requirements of Fe 415 D, Fe 500 D and Fe 550 D respectively of IS 1786 may also be used for reinforcement. In future, latest provision of IS 456 and IS 13920 or any other relevant code as modified from time to time shall be applicable.

5.1.4 Stacking and Storage

Steel for reinforcement shall be stored in such a way as to prevent distorting and corrosion. Care shall be taken to protect the reinforcement from exposure to saline atmosphere during storage, fabrication and use. It may be achieved by treating the surface of reinforcement with cement wash or by suitable methods. Bars of different classifications, sizes and lengths shall be stored separately to facilitate issue in such sizes and lengths to cause minimum wastage in cutting from standard length.

5.1.5 Identification

Care shall also be taken to properly identify these bars at site. The staff shall be specially trained for looking for identification marks on these bars given by the manufacturers which are generally given colour code. It will be advisable to see that only one type/grade of bars are brought to site and used in the project after conducting tests for each lot.

5.2 FORM WORK (CENTRING & SHUTTERING)

5.2.1 Form Work

Form work shall include all temporary or permanent forms or moulds required for forming the concrete which is cast-in-situ, together with all temporary construction required for their support.

5.2.2 Design & Tolerance in Construction

Form work shall be designed and constructed to the shapes, lines and dimensions shown on the drawings with the tolerance given below.

(a)	Deviation from specified dimension of cross section of columns and beams	**+10 mm** **-5 mm**
(b)	Deviation from dimensions of footings	
	(i) Dimension in Plan	(+ 50 mm (**-10 mm**
	(ii) Eccentricity in plan	0.02 times the width of the footing in the direction of deviation but not more than 50 mm.
	(iii) Thickness	**+50mm** **Or** **± 0.05 times the specified thickness** **Whichever is less**

(**Note**- These tolerance apply to concrete dimensions only, and not to positioning of vertical steel or dowels).

5.2.3 General Requirement

It shall be strong enough to withstand the dead and live loads and forces caused by ramming and vibrations of concrete and other incidental loads, imposed upon it during and after casting of concrete. It shall be made sufficiently rigid by using adequate number of ties and braces, screw jacks or hard board wedges where required shall be provided to make up any settlement in the form work either before or during the placing of concrete.

Form shall be so constructed as to be removable in sections in the desired sequence, without damaging the surface of concrete or disturbing other sections, care shall be taken to see that no piece is keyed into the concrete.

5.2.3.1 ***Material for Form Work***

(a) *Propping and Centering* : All propping and centering should be either of steel tubes with extension pieces or built up sections of rolled steel.

5.2.3.2 (a) ***Centering/Staging :*** Staging should be as designed with required extension pieces as approved by Engineer-in-Charge to ensure proper slopes, as per design for slabs/ beams etc. and as per levels as shown in drawing. All the staging to be either of Tubular steel structure with adequate bracings as approved or made of built up structural sections made form rolled structural steel sections.

(b) In case of structures with two or more floors, the weight of concrete, centering and shuttering of any upper floor being cast shall be suitably supported on one floor below the top most floor already cast.

(c) Form work and concreting of upper floor shall not be done until concrete of lower floor has set at least for 14 days.

5.2.3.3 ***Shuttering:*** Shuttering used shall be of sufficient stiffness to avoid excessive deflection and joints shall be tightly butted to avoid leakage of slurry. If required, rubberized lining of material as approved by the Engineer-in-Charge shall be provided in the joints. Steel shuttering used or concreting should be sufficiently stiffened. The steel shuttering should also be properly repaired before use and properly cleaned to avoid stains, honey combing, seepage of slurry through joints etc.

(a) *Runner Joists:* RSJ, MS Channel or any other suitable section of the required size shall be used as runners.

(b) Assembly of beam head over props. Beam head is an adopter that fits snugly on the head plates of props to provide wider support under beam bottoms.

(c) Only steel shuttering shall be used, except for unavoidable portions and very small works for which 12 mm thick water proofing ply of approved quality may be used.

5.2.3.4 Form work shall be properly designed for self weight, weight of reinforcement, weight of fresh concrete, and in addition, the various live loads likely to be imposed during the construction process (such as workmen, materials and equipment). In case the height of centering exceeds 3.50 metres, the prop may be provided in multi-stages. A typical detail of multistage shuttering is given in Fig. 5.9.

5.2.3.5 ***Camber:*** Suitable camber shall be provided in horizontal members of structure, especially in cantilever spans to counteract the effect of deflection. The form work shall be so assembled as to provide for camber. The camber for beams and slabs shall be 4 mm per metre (1 to 250) or as directed by the Engineer-in- Charge, so as to offset the subsequent deflection, For cantilevers the camber at free end shall be 1/50th of the projected length or as directed by the Engineer-in-Charge.

5.2.3.5.1 Typical arrangement of form work for 'beams, columns and walls' are shown in Figures 5.1 to 5.8 and form secured by wall ties is shown in Fig. 5.3.

5.2.3.6 ***Walls :*** The form faces have to be kept at fixed distance apart and an arrangement of wall ties with spacer tubes or bolts is considered best. A typical wall form with the components identified is given in Fig. 5.1, 5.2 & 5.3. The two shutters of the wall are to be kept in place by appropriate ties, braces and studs, some of the accessories used for wall form are shown in Fig. 5.3.

5.2.3.7 ***Removal of Form work (Stripping Time) :*** In normal circumstance and where various types of cements are used, forms, may generally be removed after the expiry of the following periods:

Type of Form work	*Minimum period Before Striking Form work for OPC 33 grade*	*Minimum period Before Striking Form work for OPC 43 grade*	*Minimum period Before Striking Form work for PPC*
(a) Vertical form work to columns, walls, beams	16-24 h	16-24 h	24-36 h

Type of Form work	*Minimum period Before Striking Form work for OPC 33 grade*	*Minimum period Before Striking Form work for OPC 43 grade*	*Minimum period Before Striking Form work for PPC*
(b) Soffit form work to slabs (Props to be refixed immediately after removal of formwork)	3 days	3 days	4 days
(c) Soffit form work to beams (Props to be refixed immediately after removal of formwork	7 days	7 days	10 days
(d) Props to slabs: (1) Spanning upto 4.5m (2) Spanning over 4.5m	 7 days 14 days	 7 days 14 days	 10 days 20 days
(e) Props to beams and arches: (1) Spanning upto 6m (2) Spanning over 6m	 14 days 21 days	 14 days 21 days	 20 days 30 days

Note 1: For other types of cement, the stripping time recommended for ordinary Portland cement may be suitably modified. Generally If Portland Pozzolana or low heat cement or OPC with direct addition of fly ash has been used for concrete, the stripping time will be 10/7 of the period stated for OPC with 43 grade cement above.

Note 2: The number of props left under, their sizes and disposition shall be such as to be able to safely carry the full dead load of the slabs, beam or arch as the case may be together with any live load likely to occur during curing or further construction.

Note 3: For rapid hardening cement, 3/7 of above periods for OPC 33 grade will be sufficient in all cases except for vertical side of slabs, beams and columns which should be retained for at least 24 hours.

Note 4: In case of cantilever slabs and beams, the centering shall remain till structures for counter acting or bearing down have been erected and have attained sufficient strength.

Note 5: Proper precautions should be taken to allow for the decrease in the rate of hardening that occurs with all types of cement in cold weather and accordingly stripping time shall be increased.

Note 6: Work damaged through premature or careless removal of forms shall be reconstructed within 24 hrs.

5.2.4 Surface Treatment

5.2.4.1 ***Oiling the Surface*** **:** Shuttering gives much longer service life if the surfaces are coated with suitable mould oil which acts both as a parting agent and also gives surface protections.

A typical mould oil is heavy mineral oil or purified cylinder oil containing not less than 5% pentachlorophenol conforming to IS 716 well mixed to a viscosity of 70-80 centipoises.

After 3-4 uses and also in cases when shuttering has been stored for a long time, it should be recoated with mould oil before the next use.

The second categories of shuttering oils / leavening agents are Polymer based water soluble Compounds. They are available as concentrates and when used diluted with water in the ratio of 1:20 or as per manufacturer specifications. The diluted solution is applied by brush applications on the shuttering both of steel as well as ply wood. The solution is applied after every use.

5.2.4.2 The design of form work shall conform to sound Engineering practices and relevant IS codes.

5.2.5 Inspection of Form Work

The completed form work shall be inspected and approved by the Engineer-in-Charge before the reinforcement bars are placed in position.

Proper form work should be adopted for concreting so as to avoid honey combing, blow holes, grout loss, stains or discoloration of concrete etc. Proper and accurate alignment and profile of finished concrete surface will be ensured by proper designing and erection of form work which will be approved by Engineer-in-Charge.

Shuttering surface before concreting should be free from any defect/ deposits and full cleaned so as to give perfectly straight smooth concrete surface. Shuttering surface should be therefore checked for any damage to its surface and excessive roughness before use.

5.2.5.1 ***Erection of Form Work (Centering and shuttering):*** Following points shall be borne in mind while checking during erection.

(a) Any member which is to remain in position after the general dismantling is done, should be clearly marked.

(b) Material used should be checked to ensure that, wrong items/ rejects are not used.

(c) If there are any excavations nearby which may influence the safety of form works, corrective and strengthening action must be taken.

(d) (i) The bearing soil must be sound and well prepared and the sole plates shall bear well on the ground.
(ii) Sole plates shall be properly seated on their bearing pads or sleepers.
(iii) The bearing plates of steel props shall not be distorted.
(iv) The steel parts on the bearing members shall have adequate bearing areas.

(e) Safety measures to prevent impact of traffic, scour due to water etc. should be taken. Adequate precautionary measures shall be taken to prevent accidental impacts etc.

(f) Bracing, struts and ties shall be installed along with the progress of form work to ensure strength and stability of form work at intermediate stage. Steel sections (especially deep sections) shall be adequately restrained against tilting, over turning and form work should be restrained against horizontal loads. All the securing devices and bracing shall be tightened.

(g) The stacked materials shall be placed as catered for, in the design.

(h) When adjustable steel props are used. They should:
1. be undamaged and not visibly bent.
2. have the steel pins provided by the manufacturers for use.
3. be restrained laterally near each end.
4. have means for centralizing beams placed in the forkheads.

(i) Screw adjustment of adjustable props shall not be over extended.

(j) Double wedges shall be provided for adjustment of the form to the required position wherever any settlement/ elastic shorting of props occurs. Wedges should be used only at the bottom end of single prop. Wedges should not be too steep and one of the pair should be tightened/ clamped down after adjustment to prevent shifting.

(k) No member shall be eccentric upon vertical member.

(l) The number of nuts and bolts shall be adequate.

(m) All provisions of the design and/or drawings shall be complied with.

(n) Cantilever supports shall be adequate.

(o) Props shall be directly under one another in multistage constructions as far as possible.

(p) Guy ropes or stays shall be tensioned properly.

(q) There shall be adequate provision for the movements and operation of vibrators and other construction plant and equipment.

(r) Required camber shall be provided over long spans.

(s) Supports shall be adequate, and in plumb within the specified tolerances.

5.2.5.2 Guidelines for Multistage Certering: The proper handling the situation of multistage centering in buildings or where height of casting of concrete is higher than normal height of 3.5 M or where higher loadings are coming during casting of concrete or large span structures and in situations of casting of some special structures like Domes, Vaults etc.

In all situations, centering/scaffolding/staging for casting of these structures should be properly designed by a qualified and experienced person/agency having past experience in design of false work (centering) for concrete structures and should be proof checked by similar experienced person/ agency and it should be properly approved and issued to contractor by Engineer-In-Charge. The provisions of clause 7 of IS:14687 may be referred for design of false work (centering).

A method statement for erection and dismantling of the centering/scaffolding/staging and process of concreting shall be prepared by contractor and submitted to Engineer-in-Charge for approval and the work shall be commenced only after approval of method statement by Engineer-in-Charge. The provisions of clause 9 of IS:14687 may be referred for erection of false work (centering), safety precautions and other site operations, pertaining to false work (centering).

Experienced form watcher shall be engaged during erection, concreting and dismantling for early detection of any movement or instability in the system. The field engineers shall ensure that CPWD specifications and provisions of BIS codes are strictly followed.

A detailed programme of field safety inspection of centering/scaffolding/form work of such structures during different stages should be chalked out and strictly followed.
Provision of safety net, fall arresting system including other safety gears, for workers, working over these structures shall be made in contract and should be followed strictly.

5.2.6 MEASUREMENTS

5.2.6.1 ***General*** **:** The form work shall include the following:

(a) Splayed edges, notching, allowance for overlaps and passing at angles, sheathing battens, strutting, bolting, nailing, wedging, easing, striking and removal.

(b) All supports, struts, braces, wedges as well as mud sills, piles or other suitable arrangements to support the form work.

(c) Bolts, wire, ties, clamps, spreaders, nails or any other items to hold the sheathing together.

(d) Working scaffolds, ladders, gangways, and similar items.

(e) Filleting to form stop chamfered edges of splayed external angles not exceeding 20mm wide to beams, columns and the like.

(f) Where required, the temporary openings provided in the forms for pouring concrete, inserting vibrators, and cleaning holes for removing rubbish from the interior of the sheathing before pouring concrete.

(g) Dressing with oil to prevent adhesion and

(h) Raking or circular cutting

5.2.6.2 ***Classification of Measurements:*** Where it is stipulated that the form work shall be paid for separately, measurements shall be taken of the area of shuttering in contact with the concrete surface. Dimensions of the form work shall be measured correct to a cm. The measurements shall be taken separately for the following.

(a) Foundations, footings, bases of columns etc. and for mass concrete

(b) Walls (any thickness) including attached pilasters, buttresses, plinth and string courses etc.

(c) Suspended floors, roofs, landings, shelves and their supports and balconies.

(d) Lintels, beams, plinth beams, girders, bressummers and cantilevers.

(e) Columns, pillars, piers, abutments posts and struts.

(f) Stairs (excluding landings) except spiral staircase.

(g) Spiral staircases (including landings).

(h) Arches, Domes, vaults, shells roofs, arch ribs, curvilinear shaped folded plates

(i) Extra for arches, domes, vaults exceeding 6 m span other than curvilinear shaped

(j) Chimneys and shafts.

(k) Well steining.

(l) Vertical and horizontal fins individually or forming box, louvers and bands.facias and eaves board

(m) Waffle or ribbed slabs.

(n) Edges of slabs and breaks in floors and walls (to be measured in running metres where below 200 mm in width or thickness).

(o) Cornices and mouldings.

(p) Small surfaces, such as cantilevers ends, brackets and ends of steps, caps and boxes to pilasters and columns and the like.

(q) Chullah hoods, weather shades, chajjas, corbels etc. including edges and

(r) Elevated water reservoirs.

5.2.6.3 Centering, and shuttering where exceeding 3.5 metre height in one floor shall be measured and paid for separately.

5.2.6.4 Where it is not specifically stated in the description of the item that form work shall be paid for separately, the rate of the RCC item shall be deemed to include the cost of form work.

5.2.6.5 No deductions from the shuttering due to the openings/ obstructions shall be made if the area of each openings/ obstructions does not exceed 0.4 square metre. Nothing extra shall be paid for forming such openings.

5.2.6.6 Form work of elements measured under categories of arches, arch ribs, domes, spiral staircases, well steining, shell roofs, curvilinear folded plates & curvilinear eaves board, circular shafts & chimneys shall not qualify for extra rate for circular work.

5.2.6.7 Extra for circular work shall be admissible for surfaces circular or curvilinear in plan or in elevation beyond the straight edge of supporting beam in respective mode of measurement. However, there may be many different types of such structures. In such cases, extra payment shall be made judiciously after deducting areas where shuttering for circular form work is not involved.

5.2.7 Rate

The rate of the form work includes the cost of labour and materials required for all the operations described above.

5.3 REINFORCEMENTS

5.3.1 General Requirements

Steel conforming to para 5.1.3 for reinforcement shall be clear and free from loose mill scales, dust, loose rust, coats of paints, oil or other coating which may destroy or reduce bond. It shall be stored in such a way as to avoid distortion and to prevent deterioration and corrosion. Prior to assembly of reinforcement on no account any oily substance shall be used for removing the rust.

5.3.1.1 ***Assembly of Reinforcement :*** Bars shall be bent correctly and accurately to the size and shape as shown in the detailed drawing or as directed by Engineer- in-Charge. Preferably bars of full length shall be used. Necessary cutting and straightening is also included. Overlapping of bars, where necessary shall be done as directed by the Engineer-in-Charge. The overlapping bars shall not touch each other and these shall be kept apart with concrete between them by 25mm or $1^{1}/_{4}$ times the maximum size of the coarse aggregate whichever is greater. But where this is not possible, the overlapping bars shall be bound together at intervals not exceeding twice the dia. of such bars with two strands annealed steel wire of 0.90 mm to 1.6 mm twisted tight. The overlaps/ splices shall be staggered as per directions of the Engineer-in-Charge. But in no case the overlapping shall be provided in more than 50% of cross sectional area at one section.

5.3.1.2 ***Bonds and Hooks Forming End Anchorages:*** Reinforcement shall be bent and fixed in accordance with procedure specified in IS 2502, code of practice of bending and fixing of bars for concrete reinforcement. The details of bends and hooks are shown below for guidance.

(a) U-Type Hook

In case of mild steel plain bars standard U type hook shall be provided by bending ends of rod into semicircular hooks having clear diameter equal to four times the diameter of the bar.

Note: In case of work in seismic zone, the size of hooks at the end of the rod shall be eight times the diameter of bar or as given in the structural drawings.

(b) Bends

Bend forming anchorage to a M.S. plain bar shall be bent with and internal radius equal to two times the diameter of the bar with a minimum length beyond the bend equal to four times the diameter of the bar.

5.3.1.3 ***Anchoring Bars in Tension :*** Deformed bars may be used without end anchorages provided, development length equipment is satisfied. Hooks should normally be provided for plain bars in tension. Development length of bars will be determined as per IS: 456.

5.3.1.4 ***Anchoring Bars in Compression :*** The anchorage length of straight bar in compression shall be equal to the 'Development length' of bars in compression as specified in IS: 456. The projected length of hooks, bend and straight lengths beyond bend, if provided for a bar in compression, shall be considered for development length.

5.3.1.5 ***Binders, stirrups, links etc. :*** In case of binders, stirrups, links etc. the straight portion beyond the curve at the end shall be not less than eight times **the** nominal size of bar.

5.3.2 Welding of Bars

Wherever facility for electric **arc** welding **or gas pressure welding** is available, welding of bars shall be done in lieu of overlap. The location and type of welding shall be got approved by the Engineer-in-Charge. Welding shall be as per IS 2751 and 9417.

5.3.3 Placing in Position

5.3.3.1 Fabricated reinforcement bars shall be placed in position as shown in the drawings or as directed by the Engineer -in -charge. The bars crossing one another shall be tied together at every intersection with two strands of annealed steel wire 0.9 to 1.6 mm thickness twisted tight to make the skeleton of the steel work rigid so that the reinforcement does not get displaced during deposition of concrete.

Tack welding in crossing bars shall also be permitted in lieu of binding with steel wire if approved by Engineer-in-Charge.

5.3.3.2 The bars shall be kept in correct position by the following methods:

(a) In case of beam and slab construction pre-cast cover blocks in cement mortar 1:2 (1 cement : 2 coarse sand) about 4x4 cm section and of thickness equal to the specified cover shall be placed between the bars and shuttering, so as to secure and maintain the requisite cover of concrete over reinforcements.

(b) In case of cantilevered and doubly reinforced beams of slabs, the vertical distance between the horizontal bars shall be maintained by introducing chairs, spacers or support bars of steel at 1.0 mere or at shorter spacing to avoid sagging.

(c) In case of columns and walls, the vertical bars shall be kept in position by means of timber templates with slots accurately cut in them: or with clock of cement mortar 1:2 (1 cement: 2 coarse sand) of required size suitable tied to the reinforcement to ensure that they are in correct position during concreting.

(d) In case of other R.C.C. structure such as arches, domes, shells, storage tanks etc. a combination of cover blocks, spacers and templates shall be used as directed by Engineer-in-Charge.

5.3.3.3 ***Tolerance on Placing of Reinforcement*****:** Unless otherwise specified by the Engineer-in-Charge, reinforcement shall be placed within the following tolerances:

	Tolerance in spacing
(a) For effective depth, 200 mm or less	+10 mm
(b) For effective depth, more than 200 mm	+ 15 mm

5.3.3.4 ***Bending at Construction Joints*** **:** Where reinforcement bars are bent aside at construction joints and afterwards bent back into their original position care should be taken to ensure that at no time the radius of the bend is less than 4 bar diameters for plain mild steel or 6 bar diameter for deformed bars. Care shall also be taken when bending back bars to ensure that the concrete around the bar is not damaged.

5.3.3.5 ***Cover :*** The minimum nominal cover to meet durability requirements shall be as under:-

Exposure	*Nominal Concrete cover in mm not less than*
Mild	20
Moderate	30
Severe	45
Very severe	50
Extreme	75

Notes :

1. For main reinforcement upto 12 mm diameter bar for mild exposure the nominal cover may be reduced by 5 mm.
2. Unless specified otherwise, actual concrete cover should not deviate from the required nominal cover by + 10 mm.
3. For exposure condition 'severe' and 'very severe' reduction of 5 mm may be made, where concrete grade is M35 and above.
4. Nominal cover to meet specified period of fire resistance shall not be less than as given in Table 16A of IS 456.

5.3.4 Measurement

Reinforcement including authorized spacer bars and lappages shall be measured in length of different diametre, as actually (not more than as specified in the drawings.) used in the work nearest to a centimetre and their weight calculated on the basis of standard weight given in Table 5.4 below. In case actual unit weight of the bars is less than standard unit weight, but within variation, in such cases weight of reinforcement shall be calculated on the basis of actual unit weight. Wastage and unauthorized overlaps shall not be paid for. Annealed steel wire required for binding or tack welding shall not be measured, its cost being included in the rate of reinforcement.

Where tack welding is used in lieu of binding, such welds shall not be measured. Chairs separators etc. shall be provided as directed by the Engineer-in-Charge and measured separately and paid for.

TABLE 5.4
Cross Sections Area and Mass of Steel Bar

Nominal Size mm	*Cross sectional Area Sq.mm*	*Mass per metre Run Kg.*
6	28.3	0.222
8	50.3	0.395
10	78.6	0.617
12	113.1	0.888
16	201.2	1.58
20	314.3	2.47
25	491.1	3.85
28	615.8	4.83
32	804.6	6.31
36	1018.3	7.99
40	1257.2	9.86

Note: These are as per clause 6.2 of IS 1786.

5.3.5 Rate

The rate for reinforcement shall include the cost of labour and materials required for all operations described above such as cleaning of reinforcement bars, straightening, cutting, hooking bending,

binding, placing in position etc. as required or directed including tack welding on crossing of bars in lieu of binding with wires.

5.3A STEEL FOR REINFORCEMENT READY TO USE "CUT & BEND"

5.3A.1 Cut and bend rebars are customised reinforced steel bars required at construction sites. These shall be made from specialized machinery ensuring exact precision, ready to use pre-cut and pre-bent as per approval drawings. The steel used for reinforcement shall be the following types.

(a) Thermo-mechanically treated (TMT) Bars.

5.3A.2 Elongation percent on gauge length is 5.65A, where A is the cross sectional area of the test piece.

5.3A.3 Welding of reinforcement bars covered in this specification shall be done in accordance with the requirement of IS 2751.

Nominal mass/weight:- The tolerance on mass/weight for round and square bars shall be the percentage given in Table 5.4A of the mass/weight calculated on the basis that the masses of the bar/wire of nominal diameter and of density 7.85 Kg/cm^3 or 0.00785 kg/mm^3.

TABLE 5.4A
Tolerance on Nominal Mass

Nominal size in mm	Tolerance on the Nominal Mass per cent		
	Batch	Individual sample+	Individual sample for coil (x)
(a) Upto and including 10	$\pm$7	-8	$\pm$8
(b) Over 10, upto and including 16	$\pm$5	-6	$\pm$6
(c) Over 16	$\pm$3	-4	$\pm$4

\+ for individual sample plus tolerance is not specified
(x) for coil batch tolerance is not applicable
Tolerance shall be determined in accordance with method given in IS 1786.

5.3A.4 High strength deformed bars & wires shall conform to IS 1786. The physical properties for all sizes of steel bars are mentioned below in Table 5.4B.

TABLE 5.4B

Sl. No.	Property	Fe 500 D	Fe 550 D
(i)	0.2 Per cent Proof stress/yield stress, Min, N/mm^2	500.0	550.0
(ii)	Elongation per cent, Min. on gauge length 5.65 $\sqrt{A}$, where A is the cross-sectional area of the test piece.	16.0	14.5
(iii)	Tensile strength, Min	10 Per cent more than the actual 0.2 per cent proof stress/yield stress but not less than 565.0 N/mm^2.	8 Per cent more than the actual 0.2 per cent proof stress/yield stress but not less than 600.0 N/mm^2.
(iv)	Total elongation at maximum force, percent, Min on gauge length 5.65 $\sqrt{A}$, where A is the cross-sectional area of the test piece.	5	5

Tests:-Selection and preparation of Test sample. All the tests piece shall be selected by the Engineer-in-charge or his authorized representative either-

(a) From cutting of bars
Or

(b) If he so desires, from any bar after it has been cut to the required or specified size and the test piece taken from and any part of it.

In neither case, the test pieces shall be detached from the bar or coil except in the presence of the Engineer-in-charge or his authorized representative.

The test piece obtained in accordance with as above shall be full sections of the bars as rolled and subsequently cold worked and shall be subjected to physical tests without any further modifications. No deduction in size by machining or otherwise shall be permissible. No test piece shall be enacted or otherwise subject to heat treatment. Any straightening which a test piece may require shall be done cold.

Tensile Test: 0.2% proof stress and percentage elongation-
This shall be done as per IS 1608, read in conjunction with IS 226.

RE-test:- This shall be done as per IS 1786.

Rebend test:- This shall be done as per IS 1786.

5.3A.5 Chemical composition of reinforcement bars shall be as per Table 5.4C as follows:-

TABLE 5.4C

Constituent	Maximum Per cent	
	Fe 500 D	Fe 550 D
Carbon	0.25	0.25
Sulphur	0.040	0.040
Phosphorus	0.040	0.040
Sulphur and Phosphorus	0.075	0.075

5.3A.6 Thermo Mechanically treated reinforcement bars:

(a) There is no BIS code for TMT bars. The available code BIS 1786 pertains to HSD Bars. Therefore there should be no stipulation that TMT bars should conform to relevant BIS code.

(b) The TMT bars are being produced under valid licence from either of the firms namely Tempcore, Thermex Evcon Turbo & Turbo Quench. These firms have acquired patents and are giving licences to various producers to produce TMT Bars.

(c) The TMT bars shall conform to IS 1786 pertaining to Fe 500 D or Fe grade of steel as specified.

(d) In design and construction of reinforcement concrete building in seismic zone III and above, steel reinforcement of Grade Fe 415 D shall be used. However, high strength deformed steel bars, produced by thermomechanical treatment process of grade Fe 500 and Fe 550 having elongation more than 14.5% and conform to other requirements of Fe 500 D and Fe 550 D respectively of IS 1786 may also be used for reinforcement. In future, latest provision of IS 456 and IS 13920 or any other relevant code as modified from time to time shall be applicable.

5.3A.7 Assembly of Rebars

5.3A.7.1 The rebars shall be bend correctly and precisely to the size and shape as shown in the detailed drawing or as directed by Engineer-in-charge. Overlapping of bars, where necessary shall be done as directed by the Engineer-in-charge. The overlapping bars shall not touch each other and these shall be kept apart with concrete between them by 25 mm or 1¼ times the maximum size of the coarse aggregate whichever is greater. But where this is not possible, the overlapping bars shall be bound together at intervals not exceeding twice the dia. of such bars with two strands annealed steel wire of 0.90 mm to 1.6 mm twisted light. The overlaps/splices shall be staggered as per direction of the Engineer-in-charge. But in no case the overlapping shall be provided in more than 50% of cross sectional area at one section.

5.3A.7.2 Bonds and Hooks Forming End Anchorages:-Reinforcement shall be bent and fixed in accordance with procedure specified in IS 2502, code of practice of bending and fixing of bars for concrete reinforcement.

5.3A.7.3 Anchorages Bars in Tension:-Deformed bars may be used without end anchorages Development length of bars will be determined as per IS: 456.

5.3A.7.4 Anchorages Bars in Compression:-The anchorages length of straight bar in compression shall be equal to the 'Development length' of bars in compression as specified in IS: 456. The projected length of bend and straight length beyond bend, if provided for a bar in compression, shall be considered for development length.

5.3A.7.5 Binders, stirrups, link etc:-In case of binders, stirrups, link etc. the straight portion beyond the curve at the end shall be not less than eight times the nominal size of bar.

5.3A.8 Welding of Bars.

Wherever facility for electric arc welding or gas pressure welding is available, welding of bars shall be done in lieu of overlap. The location and type of welding shall be got approved by the Engineer-in-charge. Welding shall be as per IS 2751 and 9417.

5.3A.9 Placing in Position

5.3A.9.1 Fabricated reinforcement bars shall be placed in position as shown in the drawings or as directed by the Engineer-in-charge. The bars crossing one another shall be tied together at every intersection with two strands of annealed steel wire 0.9 to 1.6 mm thickness twisted tight to make the skeleton of the steel work rigid so that the reinforcement does not get displaced during deposition of concrete.

Tack welding in crossing bars shall also be permitted in lieu of binding with steel wire if approved by Engineer-in-charge.

5.3A.9.2 The bars shall be kept in correct position by the following methods:

(a) In case of beam and slab construction pre-cast cover blocks in cement mortar 1:2 (1cement : 2 coarse sand) about 4 x 4 cm section and of thickness equal to the specified cover shall be placed between the bars and shuttering, so as to secure and maintain the requisite cover of concrete over reinforcements.

(b) In case of cantilevered and doubly reinforced beams of slabs, the vertical distance between the horizontal bars shall be maintained by introducing chairs, spacers or support bars of steel at 1.0 metre or at shorter spacing to avoid sagging.

(c) In case of columns and walls, the vertical bars shall be kept in position by means of timber templates with slots accurately cut in them or with block of cement mortar 1:2 (1 cement : 2 coarse sand) of required size suitable tied to the reinforcement to ensure that they are in correct position during concreting.

(d) In case of other R.C.C. structure such as arches, domes, shells, storage tank etc. a combination of cover blocks, spacers and templates shall be used as directed by Engineer-in-charge.

5.3A.9.3 Tolerance on Placing of Reinforcement:-Unless otherwise specified by the Engineer-in-charge, reinforcement shall be placed within the following tolerances.

	Tolerance in spacing
(a) For effective depth, 200 mm or less	+ 10 mm
(b) For effective depth, more than 200 mm	+ 15 mm

5.3A.9.4 Bending at Construction Joints:-Where reinforcement bars are bent aside at construction joints and afterwards bent back into their original position, care should be taken to ensure that at no time the radius of the bend is less than 6 bars diameter. Care should also be taken when bending back bars to ensure that the concrete around the bar is not damaged.

5.3A.9.5 Cover:-The minimum nominal cover to meet durability requirements shall be as under:-

Exposure	Nominal Concrete cover in mm not less than
Mild	20
Moderate	30
Severe	45
Very severe	50
Extreme	75

Note : 1. For main reinforcement upto 12 mm diameter bar for mild exposure the nominal cover may be reduced by 5 mm.

2. Unless specified otherwise, actual concrete cover should not deviate from the required nominal cover by + 10 mm.

3. For exposure condition ‘severe’ and ‘very severe’ reduction of 5 mm may be made, where concrete grade is M 35 and above.

4. Nominal cover to meet specified period of fire resistance shall not be less than as given in Table 16A of IS 456.

5.3A.10 Measurement

The Measurement shall be as specified under para 5.3.4

5.3A.11 Rate

The Measurement shall be as specified under para 5.3.5

5.3B REINFORCEMENT COUPLERS

5.3B.1 General requirement of material

Reinforcement coupler shall have adequate strength, length and internal threads as per manufacturer's design to be able to meet the performance requirement as per IS Code. All reinforcement coupler shall be finished smooth and shall be free from burrs, cracks and other manufacturing defects. The threads shall be clearly formed and shall be free from imperfections. The nominal sizes of reinforcement couplers based on their internal diameter shall correspond to the size of bars covered under IS Code 1786. Each coupler should be identifiable by marks/ brands which indicate name of manufacture or their brand name, class designation, nominal size and grade of reinforcement for which it is intended and BIS standard mark.

5.3B.2 Performance Requirement: All reinforcement couplers shall meet the performance requirements as per IS Code 16172:2014 clause 9.2, 9.3, 9.4 and 9.5.1. Class H couplers in addition to above shall also meet requirement of clause 9.5.2 of IS Code 16172:2014.
The static tensile test shall constitute acceptance test.

5.3B.3 Sampling and criteria for conformity: Sampling and criteria for conformity shall be as per Annexure 'F' of IS Code 16172:2014

5.3B.4 Installation procedure/ instructions: The manufacturer/ supplier shall provide written installation instructions. The installation instructions shall be clear and understandable. The described installation procedure of reinforcement coupler shall be repeatable and able to achieve its performance under different job site circumstances.

5.3B.5 Measurement : The reinforcement couplers shall be measured in numbers.

5.3B.6 Rate : The rate shall be inclusive of all materials &labour involved in fixing parallel threaded couplers to reinforcement bars.

5.4 CONCRETING

5.4.0 The concrete shall be as specified under chapter 4 concrete work. The proportion by volume or by the weight of ingredients shall be as specified.

5.4.1 Consistency

The concrete which will flow sluggishly into the forms and around the reinforcement without any segregation of coarse aggregate from the mortar shall be used. The consistency shall depend on whether the concrete is vibrated on or hand tamped, it shall be determined by slump test as prescribed in sub-head "concrete" under workability – requirement.

5.4.2 Placing of Concrete

5.4.2.1 Concreting shall be commenced only after Engineer-in-Charge has inspected the centering, shuttering and reinforcement as placed and passed the same. Shuttering shall be clean and free from all shavings, saw dust, pieces of wood, or other foreign material and surfaces shall be treated as prescribed in 5.2.4.

5.4.2.2 In case of concreting of slab and beams, wooden plank or cat walks of chequerred MS plated or bamboo chalies or any other suitable material supported directly on the centering by means of wooden blocks or lugs shall be provided to convey the concrete to the place of deposition without disturbing the reinforcement in any way. Labour shall not be allowed to walk over the reinforcement.

5.4.2.3 In case of columns and wall, it is desirable to place concrete without construction joints. The progress of concreting in the vertical direction, shall be restricted to one metre per hour.

5.4.2.4 The concrete shall be deposited in its final position in a manner to preclude segregation of ingredients. In deep trenches and footings concrete shall be placed through chutes or as directed by the Engineer-in-Charge. In case of columns and walls, the shuttering shall be so adjusted that the vertical drop of concrete is not more than 1.5 metres at a time.

5.4.2.5 During cold weather, concreting shall not be done when the temperature falls below 4.5^{0}C. The concrete placed shall be protected against frost by suitable covering. Concrete damaged by frost shall be removed and work redone.

5.4.2.6 During hot weather precaution shall be taken to see that the temperature of wet concrete does not exceed 38ºC. No concrete shall be laid within half an hour of the closing time of the day, unless permitted by the Engineer-in-Charge.

5.4.2.7 It is necessary that the time between mixing and placing of concrete shall not exceed 30 minutes so that the initial setting process is not interfered with.

5.4.3 Compaction

It shall be as specified in sub-head of Concrete Work of this specification.

5.4.3.1 Concrete shall be compacted into dense mass immediately after placing by means of mechanical vibrators designed for continuous operations complying with IS 2505, IS 2506, IS 2514 and IS 4656. The Engineer- in- Charge may however relax this condition at his discretion for certain items depending on the thickness of the members and feasibility of vibrating the same and permit hand compaction instead. Hand compaction shall be done with the help of tamping rods so that concrete is thoroughly compacted and completely worked around the reinforcement, embedded fixtures, and into corners of the form. The layers of concrete shall be so placed that the bottom layer does not finally set before the top layer is placed. The vibrators shall maintain the whole of concrete under treatment in an adequate state of agitation; such that de-aeration and effective compaction is attained at a rate commensurate with the supply of concrete from the mixers. The vibration shall continue during the whole period occupied by placing of concrete, the vibrators being adjusted so that the centre of vibrations approximates to the centre of the mass being compacted at the time of placing.

5.4.3.2 Concrete shall be judged to be properly compacted, when the mortar fills the spaces between the coarse aggregate and begins to cream up to form an even surface. When this condition has been attained, the vibrator shall be stopped in case of vibrating tables and external vibrators. Needle vibrators shall be withdrawn slowly so as to prevent formation of loose pockets in case of internal vibration. In case both internal and external vibrators are being used, the internal vibrator shall be first withdrawn slowly after which the external vibrators shall be stopped so that no loose pocket is left in the body of the concrete. The specific instructions of the makers of the particular type of vibrator used shall be strictly complied with. Shaking of reinforcement for the purpose of compaction should be avoided. Compaction shall be completed before the initial setting starts, i.e. with 30 minutes of addition of water to the dry mixture.

5.4.3.3 In case of roof slabs the top surface shall be finished even and smooth with wooden trowel, before the concrete begins to set. Sprinkling of dry cement while finishing shall not be resorted to.

5.4.4 Construction joints

5. 4.4.1 Joints are a common source of weakness and, therefore, it is desirable to avoid them. If this is not possible, their number shall be minimized. Concreting shall be carried out continuously up to construction joints, the position and arrangement of which shall be indicated in Fig 5.26 or as directed by Engineer-in-Charge.

5.4.4.2 In case of columns the joints shall be horizontal and 10 to 15 cm below the bottom of the beam running into the column head. The portion of the column between the stepping off level and the top of the slab shall be concreted with the beam.

5.4.4.3 When stopping the concrete on a vertical plane in slabs and beams, and approved stop board (see Fig. 26C) shall be placed with necessary slots for reinforcement bars or any other obstruction to pass the bars freely without bending. The construction joints shall be keyed by providing a triangular or trapezoidal fillet nailed on the stop board. Inclined or feather joints shall not be permitted. Any concrete flowing through the joints of stop board shall be removed soon after the initial set. When concrete is stopped on a horizontal plane, the surface shall be roughened and cleaned after the initial set.

5.4.4.4 When the work has to be resumed, the joint shall be thoroughly cleaned with wire brush and loose particles removed. A coat of neat cement slurry at the rate of 2.75 kg of cement per square metre shall then be applied on the roughened surface before fresh concrete is laid.

5.4.5 Expansion Joints

Expansion joints shall be provided as shown in the structural drawings or as indicated in Fig. 5.10 to 5.25 or as directed by Engineer-in-Charge, for the purpose of general guidance. However it is recommended that structures exceeding 45 m in length shall be divided by one or more expansion joints. The filling of these joints with bitumen filler, bitumen felt or any such material and provision of copper plate, etc. shall be paid for separately in running metre. The measurement shall be taken two places of decimal stating the depth and width of joint.

5.4.6 Curing

After the concrete has begun to harden i.e. about 1 to 2 hours after its laying, it shall be protected from quick drying by covering with moist gunny bags, sand, canvass Hessian or any other material approved by the Engineer-in-Charge. After 24 hours of laying of concrete, the surface shall be cured by ponding with water for a minimum period of 7 days from the date of placing of concrete in case of OPC and at least 10 days where mineral admixtures or blended cements are used. The period of curing shall not be less than 10 days for concrete exposed to dry and hot weather condition.

5.4.7 Rectification of Surface defects of Minor nature

Immediately on removal of forms, the R.C.C. work shall be examined by the Engineer-in-Charge, before any defects are made good.

(a) The work that has sagged or contains honey combing to an extent detrimental to structural safety or architectural concept shall be rejected as given in para 5.4.9.4 for visual inspection test.

(b) Surface defects of minor nature may be accepted. On acceptance of such a work by the Engineer-in-Charge, the same shall be rectified as follows:

1. Surface defects which require repair when forms are removed, usually consist of bulged due to movement of forms, ridges at form joints, honey-combed areas, damage resulting from the stripping of forms and bolt holes, bulges and ridges are removed by careful chipping or tooling and the surface is then rubbed with a grinding stone. Honey-combed and other defective areas must be chipped out, the edges being cut as straight as possible and perpendicularly to the surface, or preferably slightly under cut to provide a key at the edge of the patch.

2. Shallow patches are first treated with a coat of thin grout composed of one part of cement and one part of fine sand and then filled with mortar similar to that used in the concrete. The mortar is placed in layers not more than 10mm thick and each layer is given a scratch finish to secure bond with the succeeding layer. The last layer is finished to match the surrounding concrete by floating, rubbing or tooling on formed surfaces by pressing the form material against the patch while the mortar is still plastic.

3. Large and deep patches require filling up with concrete held in place by forms. Such patches are reinforced and carefully dowelled to the hardened concrete.

4. Holes left by bolts are filled with mortar carefully packed into places in small amounts. The mortar is mixed as dry as possible, with just enough water so that it will be tightly compacted when forced into place.

5. Tiered holes extending right through the concrete may be filled with mortar with a pressure gun similar to the gun used for greasing motor cars.

6. Normally, patches appear darker than the surrounding concrete, possibly owing to the presence on their surface of less cement laitance. Where uniform surface colour is important, this defect shall be remedied by adding 10 to 20 percent of white Portland cement to the patching mortar, the exact quantity being determined by trial.

7. The same amount of care to cure the materials in the patches should be taken as with the whole structure. Curing must be started as soon as possible, after the patch is finished to prevent early drying. Damp Hessian may be used but in some locations it may be difficult to hold it in place. A membrane curing compound in these cases will be most convenient.

(c) **Whenever required**, The exposed surface of R.C.C. work shall be plastered with cement mortar 1:3 (1 cement : 3 fine sand) of thickness not exceeding 6 mm to give smooth and even surface true to line and form. Any RCC surface which remains permanently exposed to view in the completed structure, shall be considered exposed surfaced for the purpose of this specification.

(d) The surface which is to receive plaster or where it is to be joined with brick masonry wall, shall be properly roughened immediately after the shuttering is removed, taking care to remove the laitance completely without disturbing the concrete. The roughening shall be done by hacking. Before the surface is plastered, it shall be cleaned and wetted so as to give bond between concrete and plaster.

RCC work shall be done carefully so that the thickness of plaster required for finishing the surface is not more than 6 mm.

(e) The surface of RCC slab on which the cement concrete or mosaic floor is to be laid shall be roughened with brushes while the concrete is green. This shall be done without disturbing the concrete.

5.4.8 Strength of Concrete

The compressive strength on the work tests for different mixed shall be as given in Table 5.5 below:-

TABLE 5.5

Concrete Mix (Nominal Mix on Volume basis)	*Compressive Strength in (Kg/ sq cm)*	
	7 days'	*28 days'*
1:1:2	210	315

1:1.5:3	175	265
1:2:4	140	210

5.4.9 Testing of Concrete

5.4.9.0 Regular mandatory tests on the workability of the fresh concrete shall be done to achieve the specified compressive strength of concrete. These will be of two types

(a) Mandatory Lab, Test
(b) Mandatory Field Test

Results of Mandatory Field Test will prevail over mandatory Lab. Test.

5.4.9.1 ***Cube Test for Compressive Strength of Concrete - Mandatory Lab Test :*** Mandatory tests shall be carried out as prescribed in Appendix A of Chapter 5.

5.4.9.2 ***Additional Test*** *:* Additional test, if required, shall be carried out as prescribed in Appendix B of Chapter 5.

5.4.9.3 ***Slump Test :*** This test shall be carried out as prescribed in sub-head 4 of concrete.

5.4.9.4 ***Visual Inspection Test :*** The concrete will be inspected after removal of the form work as described in para 5.4.7.2 The question of carrying out mandatory test or other tests described in Appendix A and B (para 5.4.9.1 and 5.4.9.2) will arise only after satisfactory report of visual inspection.

The concrete is liable to be rejected if:

(i) It is porous or honeycombed as per para 5.4.7.2 (a).
(ii) Its placing has been interrupted without providing a proper construction joint.
(iii) The reinforcement has been displaced beyond tolerance specified or construction tolerances have not been met.

However, the hardened concrete may be accepted after carrying out suitable remedial measures to the satisfaction of the Engineer-in-Charge at the risk and cost of the contractor.

5.4.10 Standard of Acceptance – for Nominal Mix

5.4.10.1 ***Mandatory Lab. Test :*** For concrete sampled and tested as prescribed in Appendix A of Chapter 5, the following requirement shall apply.

5.4.10.2 Out of six sample cubes, three cubes shall be tested at 7 days and remaining three cubes at 28 days.

5.4.10.3 ***7 days' Tests***

Sampling: The average of the strength of three specimen shall be accepted as the compressive strength of the concrete provided the variation in strength of individual specimen is not more than $\pm$ 15% of the average. Difference between the maximum and minimum strength should not exceed 30% of average strength of three specimens. If the difference between maximum and minimum strength exceeds 30% of the average strength, then 28 days' test shall have to be carried out.

Strength: If the actual average strength of sample accepted in para 'sampling' above is equal to or higher than specified strength upto $\pm$15% then strength of the concrete shall be considered in order.

In case the actual average strength of sample accepted in the above para is lower than the specified or higher by more than 15% then 28 days' test shall have to be carried out to determine the compressive strength of concrete cubes.

5.4.10.4 ***28 days' Test***

(a) The average of the strength of three specimen be accepted as the compressive strength of the concrete provided the strength of any individual cube shall neither be less than 70% nor higher than 130% of the specified strength.

(b) If the actual average strength of accepted sample exceeds specified strength by more than 30% the Engineer-in-Charge, if he so desires, may further investigate the matter. However, if the strength of any individual cube exceeds more than 30% of specified strength, it will be restricted to 130% only for computation of strength.

(c) If the actual average strength of accepted sample is equal to or higher than specified strength upto 30% then strength of the concrete shall be considered in order and the concrete shall be accepted at full rates.

(d) If the actual average strength of accepted sample is less than specified strength but not less than 70% of the specified strength, the concrete may be accepted at reduced rate at the discretion of Engineer-in-Charge (see para 5.4.13.2).

(e) If the actual average strength of accepted sample is less than 70% of specified strength, the Engineer-in-Charge shall reject the defective portion of work represented by sample and nothing shall be paid for the rejected work. Remedial measures necessary to retain the structure shall be taken at the risk and cost of contractor. If, however the Engineer-in-Charge so desires, he may order additional tests (See Appendix B of Chapter 5) to be carried out to ascertain if the structure can be retained. All the charges in connection with these additional tests shall be borne by the contractor.

5.4.10.5 ***Acceptance Criteria of Field Test (Additional Test – Not Mandatory)***

(A) Preparation of Standard Test Cubes for calibration of Rebound Hammer at site

(a) In the beginning the standard test cubes of the specified mix shall be prepared by field units before undertaking any concrete work in each project.

(b) At least 18 standard cubes necessary for formation of one specimen of specified mix, shall be cast by site staff well in advance. From these 18 cubes any 3 cubes may be selected at random to be tested for crushing strength of 7 days. The crushing strength obtained should satisfy the specified strength for the mix as per specification or agreement. If the strength is satisfactory then the remaining cube will form the standard samples for calibration of rebound hammer. In case of failure, the site staff should totally reject the samples and remove them also and then make another set of samples by fresh mixing or alternatively, out of the remaining 15 cubes, 3 cubes will be tested on 28 days. If the 28 days' tests are found satisfactory then remaining 12 cubes will form the standard sample for calibration at 28 days' strength otherwise all samples shall be rejected and whole procedure repeated to form a fresh specimen. All the results shall be recorded in a register.

(c) No concreting will be allowed unless the standard specimen cubes are obtained.

The criteria for acceptance and calibration of hammer will be 28 days' strength. The 7 days' strength is only to facilitate the work to start.

(d) No work (for the concrete cast between 8th and 28th day) shall be allowed to be paid unless 28 days' cube strength is obtained. For the concrete cast between 8th and 28th day, the decision to make the payment may be taken by the Engineer-in-charge on the basis of existing criteria. Concrete work will be rejected if 28 days' strength falls short as per acceptance criteria. No further work will be allowed till the acceptable standard cubes are obtained.

(e) *Frequency*: it will be once in each quarter or as per the direction and discretion of Engineer-in-Charge. Whenever the acceptance criteria is changed or concrete mix or type of cement is changed or Engineer-in-Charge feels it necessary for recorded reasons with the approval of the authority according to technical sanction, fresh specimen shall be prepared.

(B) Calibration of Hammer

(a) Simultaneously, same three cubes to be tested on 28 days as referred in para A (b) above shall be used to correlate the compressive strength of their concrete with rebound number as per procedure described in para 5.2 of the IS 13311 (Part 2) "Indian standard for non-destructive testing of concrete Method of test by rebound hammer which is given below in para B (b). The average of values of the rebound number (minimum readings) obtained in respect of same three cubes passing on 28 days' work test shall form the datum reference for remaining cubes for the strength of cubes.

(b) The concrete cubes specimens are held in a compression testing machine under a fixed load, measurements of rebound hammer taken and then compressive strength determined as per IS 516. The fixed load required is of the order of 7 N/mm^2 when the impact energy of the hammer is about 2.2 NM.

If the specimen are wet cured, they should be removed from wet storage & kept in the laboratory atmosphere for about 24 hours before testing.

Only the vertical faces of the cubes as cast should be tested for rebound number. At least nine readings should be taken on each of the three vertical faces accessible in the compression testing machine when using rebound hammers. The points of impact in the specimen must not be nearer than 20 mm from the edge & should not be less than 20 mm from each other. The same points must not be impacted more than once.

(c) The rebound number of hammer will be determined on each of the remaining (18-3-3=12) cubes. Whenever the rebound number of hammer of any individual cube varies by more than +25% form the datum readings referred to in para B (a) above, that cube will be excluded and will not be considered for standard specimen cubes for calibration. It must be ensured that at least 8 cubes out of 12 that is 66.67% are within the permissible range of variation of rebound number i.e. +25% or otherwise whole procedure shall have to be repeated and fresh specimen prepared.

These 8 cubes will form one standard sample in the beginning before commencement of work and shall be kept carefully for the visiting officers who will calibrate their hammers on these cubes.

(d) This calibration will be done by field staff with their hammer and then chart of calibration giving the details of the average readings, date & month of casting, mix of the concrete etc. shall be prepared and signed by Engineer-in-Charge and will be duly preserved for future reference as and when required.

(C) Preservation of Cubes at site

Standard sample cubes cast shall be carefully preserved at site under the safe custody of AE or his representative for making them available together with the charts, to the officers of QCTA/CTE or any other senior departmental officer, during their inspection of the work. They will calibrate their hammer on these cubes if required.

(D) Testing at Site

(D-1) Testing Equipments

(D-2) Testing will be done generally by non-destructive methods like rebound hammers etc. Each field Division/ Sub Division/ Unit will purchase rebound hammers and keep them in working order at work site. The testing will be done only by hammers which are duly calibrated.

(D-3) The relative strength of actual field work will be tested with reference to strength of these standard cubes and calibration charts of a hammer for determining the rebound number on the field work. The hammer will be used as per manufacturer's guidelines at various locations chosen at random. The number of location/reading on each wall, beam or column etc. shall not be less than 12. All the readings should be within the +25% range of values prescribed in calibration chart normally. However, reading indicating good strength will be when it is at per with calibrated value or between 100% & 125% and very good if more than 125% any value between 100% & 75% of calibrated value shall be considered satisfactory. Values from 75% to 50% shall be considered for payment at rates reduced on prorate basis. The concrete indicating rebound number less than 50% of calibrated value shall be rejected and not paid for.

(E) Acceptance of Field Tests and Strength

If the relative strength of actual field work is found satisfactory considering the calibration charts with reference to the standard cube test kept at site, the representative work will be considered satisfactory. If the work is considered below satisfactory, the same will be dealt as stated in para D-3 above.

(F) 7 days' Strength in Rare Cases only

Normally cube crushing strength on 28 days' test shall form the basis of acceptance. However in rare cases of time bound projects/ urgent repairs 7 days' cube test strength criteria may be adopted on similar lines using 7 days' standard test cubes and calibration graphs/ curves/ charts for 7 days' in lieu of 28 days' and testing work done at 7 days'.

(G) Precautions

(G-1) The testing shall be done generally as per guidelines of manufacture of the apparatus and strictly in accordance with the procedure laid down in clause 6 of IS 13311 (Part 2): Indian Standard for Non-Destructive Testing of Concrete - Method of Test by Rebound Hammer.

(G-2) The rebound hammers are influenced by number of factor like type of cement aggregate, surface conditions, moisture content, age of concrete & extent of calibration of concrete etc. hence care shall be taken to compare the cement, aggregate etc. and tested under the similar surface conditions having more or less same moisture content and age. However effect of age can be ignored for concrete between 3 days & 3 months old.

5.4.11 Measurements

5.4.11.1 Dimensions shall be measured nearest to a cm except for the thickness of slab which shall be measured correct to 0.5 cm. The areas shall be worked out nearest to 0.01 Sq. mt. The cubical contents shall be worked out to nearest 0.01 cubic metre.

5.4.11.2 Reinforced cement concrete whether cast-in-situ or pre cast shall be classified and measured separately as follows.

(a) Raft, footing, bases of columns and mass concrete etc. all work up to plinth level, column up to plinth level, plinth beams.

(b) Wall (any thickness) including attached pilasters, buttresses plinth and string course, fillets, column, pillars, piers, abutments, post and struts etc.

(c) Suspended floors, roofs, landings and balconies.

(d) Shelves

(e) Chajjas

(f) Lintel, beams and bressummers.

(g) Columns, pillars, piers, abutments, posts and struts.

(h) Stair-cases including waist or waist less slab but excluding landing except in (i) below.

(i) Spiral stair-case (including landing).

(j) Arches, arch ribs, domes and vaults.

(k) Chimneys and shafts.

(l) Well steining.

(m) Vertical and horizontal fins individually or forming box, louvers and facias.

(n) Kerbs, steps and the like.

(o) String courses, bands, coping, bed plates, anchor blocks, plain window sills and the like.

(p) Mouldings as in cornices, window sills etc.

(q) Shell, dome and folded plates.

(r) Extra for shuttering in circular work in plan.

5.4.11.3 Work under the following categories shall be measured separately.

(a) Rafts, footings, bases of columns etc. and mass concrete.

(b) All other items upto floor two level.

(c) From floor two level to floor three level and so on.

(d) R.C.C. above roof level shall be measured along with R.C.C. Work in floor just below.

5.4.11.4 No deduction shall be made for the following:

(a) Ends of dis-similar materials (e.g. Joists, beams, post, girders, rafter, purlins, trusses, corbels steps etc.) upto 500 sq cm in cross-section.

(b) Opening upto 0.1. sqm.

Note: In calculating area of openings upto 0.1 sqm the size of opening shall include the thickness of any separate lintels or sills. No extra labour for forming such openings or voids shall be paid for.

(c) The volume occupied by reinforcement.

(d) The volume occupied by water pipes, conduits etc. not exceeding 25 sq cm each in cross sectional area. Nothing extra shall be paid for leaving and finishing such cavities and holes.

5.4.11.5 Measurement shall be taken before any rendering is done in concrete members. Measurement will not include rendering. The measurement of R.C.C. work between various units shall be regulated as below:

(a) Slabs shall be taken as running continuously through except when slab is monolithic with the beam. In that case it will be from the face to face of the beam.

(b) Beams shall be measured from face to face of columns and shall be including haunches, if any, between columns and beam. The depth of the beam shall be from the bottom of slab to the bottom of beam if beam and slab are not monolithic. In case of monolithic construction where slabs are integrally connected with beam, the depth of beam shall be from the top of the slab to the bottom of beam.

(c) The columns measurements shall be taken through.

(d) Chajjas along with its bearing on wall shall be measured in cubic metre nearest to two places of decimal. When chajjas is combined with lintel, slab or beam, the projecting portion shall be measured as chajjas, built in bearing shall be measured as per item of lintel, slab or beam in which chajja bears.

(e) Where the band and lintels are of the same height and the band serves as lintel the portion of the band to be measured as lintel shall be for clear length of opening plus twice the over all depth of band.

5.4.12 Tolerances

Subject to the condition that structural safety is not impaired and architectural concept does not hamper, the tolerances in dimensions of R.C.C. members shall be as specified in the drawings by the designer. Whenever these are not specified, the permissible tolerance shall be decided by the Engineer-in-Charge after consultations with the Designer, if necessary.

When tolerances in dimensions are permitted, following procedure for measurement shall apply.

(a) If the actual dimension of R.C.C. members do not exceed or decrease the design dimensions of the members plus or minus tolerance limit specified above, the design dimensions shall be taken for the purpose of measurement.

(b) If the actual dimensions exceed the design dimensions by more than the tolerance limit, the design dimensions only shall be measured for the purpose of payment.

(c) If the actual dimensions decrease more than the tolerance limit specified, the actual dimensions of the RCC members shall be taken for the purpose of measurement and payment.

(d) For acceptance of RCC members whose dimensions are not exactly as per design dimensions, the decision of Engineer-in-Charge shall be final. For the purpose of payment, however, the clarification as given in para a, b & c above shall apply.

5.4.13 Rate

5.4.13.1 The rate included the cost of materials and labour involved in all the operations described above except for the cost of centering and shuttering, **finishing & reinforcement**.

5.4.13.2 On the basis of mandatory lab tests, in case of actual average compressive strength being less than specified strength but upto 70% of specified strength, the rate payable shall be in the same proportion as actual average compressive strength bears to specified compressive strength.

Example:

1. Average compressive strength in 80% of specified strength. Rate payable shall be 80% of agreement rate.
2. In case average compressive strength is less than 70% of the specified strength, the work represented by the sample shall be rejected.
3. However, on the basis of mandatory field tests, where they prevail, the rates of the work represented by samples showing actual compressive strength less than specified strength shall be worked out as per para 5.4.10.5 (D-3) above. In addition, Engineer-in-charge may order for additional tests (see Appendix 'B' of chapter 5) to be carried out at the cost of contractor to ascertain if the portion of structure where in concrete represented by the samples had been used, can be retained on the basis of these tests. Engineer-in-Charge may take further remedial measured as necessary to retain the structure at the risk and cost of the contractor.

5.4.13.3 Where throating or plaster drip or moulding is not required to be provided in RCC chajjas, deduction for not providing throating or plaster drip or moulding shall be made from the item of R.C.C. in chajjas. The measurement for deduction item shall be made in running metres correct to a cm of the edge of chajja.

5.4.13.4 No extra payment for richer mix which projects into any member from another member during concreting of junctions of beams and columns etc. will be made except to the extent structurally considered necessary and when so indicated in the structural drawings. The payment for work done under items of different mixed shall be limited strictly to what is indicated in the structural drawings.

5.5 ENCASING ROLLED STEEL SECTIONS

5.5.1 General Requirements

Before concrete work is started, the Engineer-in-Charge shall check that all rolled steel sections to be encased, have been erected truly in position. The sections shall be unpainted and shall be wire brushed to remove the loose rust/ scales etc. Where so specified, ungalvanised metal, having mesh or perforations large enough to permit the free passage of 12.5 mm nominal size aggregate through them shall be wrapped round the section to be encased and paid for separately.

5.5.2 Wrapping

5.5.2.1 In case of columns, the wrapping shall be arranged as illustrated in Fig. 5.27 to pass through the centre of the concrete covering. The wrapping of the entire length of the columns be carried out in stages and no stage shall cover more than 1.5 metre of height of columns. Successive wrappings shall be carried out only after the immediate adjacent wrapping has been encased in concrete. The surface and edges of the flanges of the steel columns shall have a concrete cover of not less than 50mm. The wrappings of the successive stages shall be tied together.

5.5.2.2 In the case of beams and grillages, the wire mesh or expanded metal shall be wrapped round the lower flange of the beam as illustrated in Fig. 5.28 and the wrapping shall be suspended by wire hangers 5 mm diameter placed at about 1.2 metres centres. The surfaces and edges of the steel sections shall have a concrete cover of not less than 50mm. The wrapping shall pass through the centre of the concrete covering at the edges and soffits of the flanges.

5.5.3 Form Work shall be as prescribed in 5.2.

5.5.4 Concreting

Concrete shall consist of a mix of 1:2:4 (1 cement : 2 coarse and : 4 graded stone aggregate of 12.5 mm nominal size) unless a richer mix is specified. The mix shall be poured solidly around the steel sections and around the wrapping by vibrating the concrete into position. Consistency of concrete, Placing of concrete and its compaction, curing, finishing and strength of concrete shall be as described in 5.4.

5.5.5 Measurements

The length shall be measured correct to one cm and other dimensions correct of 0.5 cm. The cement concrete shall be measured as per gross dimensions of the encasing exclusive of the thickness of plaster. No deduction shall be made for the volume of steel sections, expanded metal, mesh or any other reinforcement used therein. However, in case of boxed stanchions or girders, the boxed portion only shall be deducted.

Fabric reinforcement such as expanded metal shall be measured separately in square metres stating the mesh and size of strands.

The description shall include the bending of the fabric as necessary, Racking or circular cutting and waste shall be included in the description.

5.5.6 Rate

The rate shall include the cost of materials and labour required for all the operations described above except the cost of fabric reinforcement. The cost of providing and erecting steel section and wire hangers shall be paid for separately.

5.6 PRECAST REINFORCED CONCRETE

5.6.1 General Requirements

Precast reinforced concrete units such as columns, fencing posts, door and window frames, lintels, chajjas, copings, sills , shelves, slabs, louvers etc. shall be of grade of mix as specified and cast in forms or moulds. The forms/ moulds shall be of fiber glass or of steel sections for better finish. Provision shall be made in the forms and moulds to accommodate fixing devices such as nibs, clips, hooks, bolts and forming of notches and holes. The contractor may precast the units on cement or steel platform which shall be adequately oiled provided the surface finish is of the same standard as obtained in form. Each unit shall be cast in one operation.

5.6.2 Concrete used for precasting the units should be well proportioned, mixed, placed and thoroughly compacted by vibrations or tamping to give a dense concrete free from voids and honey combing.

5.6.3 Precast articles shall have a dense surface finish showing no coarse aggregate and shall have not cracks or crevices likely to assist in disintegration of concrete or rusting of steel or other defects that would interfere with the proper placing of the units. All angle of the precast units with the exception of the angles resulting from the splayed or chamfered faces shall be true right angles. The arises shall be clean and sharp except those specified or shown to be rounded. The wearing surface shall be true to the lines. On being fractured, the interior of the units should present a clean homogeneous appearance.

5.6.4 The longitudinal reinforcement shall have a minimum cover of 12 mm or twice the diameter of the main bar, whichever is more, unless otherwise directed in respect of all items except fencing posts or electric posts where the minimum cover shall be 25 mm.

5.6.5 Curing

After having been cast in the mould or form the concrete shall be adequately protected during setting in the first stages of hardening from shocks and from harmful effects of frost, sunshine, drying winds and cold. The concrete shall be cured at least for 7 days from the date of casting.

5.6.6 The precast articles shall be matured for 28 days before erection or being built in so that the concrete shall have sufficient strength to prevent damage to units when first handled.

5.6.7 Marking

Precast units shall be clearly marked to indicate the top of member and its location and orientation in the structure.

5.6.8 Precast units shall be stored, transported and placed in position in such as manner that they will not be overstressed or damaged.

5.6A PRECAST DOOR AND WINDOW FRAMES

5.6A.1 MATERIALS

5.6A.1.1 Factory Made Precast Reinforced Concrete Door and Window Frame- The frame shall be manufactured from M 40 grade reinforced cement concrete of specified thickness confirming to IS:4021. The ingredients of RCC for the manufacture of precast reinforced concrete door and window frames shall comply with the requirements given in Table 1 of IS:6523.

5.6A.1.2 Aggregates - The aggregates shall consist of well-graded mixture of clean coarse and fine aggregates. The nominal maximum size of coarse aggregates shall not exceed 10 mm.

5.6A.1.3 Concrete - The mix proportion of the concrete shall be determined by the manufacturer and shall be such as to produce a dense concrete not weaker than grade M 40.

5.6A.1.4 Reinforcement - Steel reinforcement shall be minimum of 3 nos. 6 mm dia M.S. bars tied with 3 mm dia mild steel wire placed @ 200 mm c/c. The reinforcement bars and wires shall confirm to IS432 (Part-I & II).

Reinforcement shall be clean and free from loose millscale, loose rust, mud, oil, grease or any other coating which may reduce the bond between the concrete and steel.

5.6A.1.5 Cement Concrete Block – Cement Concrete Block of minimum size 15 cm x 10 cm x 10 cm, shall be of nominal mix concrete 1:3:6 and hold fast shall be embedded in the Block.

5.6A.1.6 High Strength Polymer Block–High Strength Polymer Block for securing hinges, tower bolts, sliding bolts shall be confirming to IS3395.

5.6A.1.7 Mild Steel Galvanised Sleeves& Bolts -Mild Steel Galvanised Sleeves& Boltsshall be confirming to IS806, IS 1363 and IS 4736.

5.6A.1.8 Hinges– Bright finished or black enamelled mild Steel butthinges shall be confirming to IS1341.

5.6A.2 MANUFACTURE

5.6A.2.1 Construction and Finish

5.6A.2.1.1 Each frame shall be made of concrete proportioned, mixed, placed and compacted by vibration/pressing to give a dense concrete free from voids and honeycombing.

Compaction by vibration may be done using a vibrating table or a shutter vibrator. A good finish may generally be obtained by using smooth surface moulds and proper vibration of concrete. Any small surface defects shall be rectified by rubbing with Carborundum stone before erection of the frame. Plastering or touching shall not be done under any circumstances.

5.6A.2.1.2 Each member of the frame shall have a dense surface finish showing no coarse aggregate and shall have no crevices likely to assist in the disintegration of concrete or rusting of steel by the action of natural agencies.

5.6A.2.1.3 The specification of M 40 grade concrete shall be according to Sub Head:5.0of CPWD Specification 2019 Vol-I.

5.6A.2.1.4 The RCC door/window frames shall be cast in rubber / PUmoulds / shuttering having proper shape and dimension with smooth finish.

5.6A.2.1.5 Rubber / PU moulds/ shuttering for RCC door/window frames are casted suitably on the vibrating table having good quality vibration facility to achieve adequate compaction and smooth finish without blow holes or crisis.

5.6A.2.1.6 Curing shall be done as per Section 4.2.10 of CPWD Specification 2019 Vol.-1.

5.6A.2.2 Positioning of Reinforcement - The vertical as well as the horizontal members of the frame shall be reinforced with longitudinal bars. The longitudinal reinforcement for each of the vertical or horizontal member shall be in one piece. The longitudinal bar shall be firmly held by means of at least 3 mm dia steel ties spaced at not more than 200 mm centre to centre.

5.6A.2.2.1 Cover - The longitudinal reinforcement shall have a minimum clear cover of 12 mm or twice the diameter of the main bar, whichever is more.

5.6A.2.2.2 Casting-The entire frame may be cast complete in one piece.

5.6A.3 Hinges – Bright finished or black enamelled mild steel butt hinges of minimum size 100 mm shall be used. For door frames 80 cm wide and under, three hinges shall be rigidly fixed to one jamb and for door frames above 80 cm wide, four hinges shall rigidly fixed to one jamb, if it is single shutter, where the height of door shutter exceeds 2.15 metres, one additional hinge shall be provided for every 0.5 m or part thereof the additional height. In all cases the hinges shall be so fixed that the distance from the inside of the head rebate to the top of the upper hinge is 20 cm and the distance from the bottom of the door frame to the bottom of the bottom hinge is also kept about 200 mm. The middle hinges shall be at equal distances from lower and upper hinges or as agreed to between the purchaser and the supplier. Hinges shall be made of steel 2.5mm thick with zinc coated removable pin of 6 mm diameter. The space between the two leaves of the hinge when closed shall be 3 mm and the leaf that is not fixed to the frame shall have four counter sunk holes to take cross recessed head screws.

5.6A.4 Other Hardware fixing- RCC frames shall be provided with high strength polymer blocks at the appropriate locations for fixing hinges of adequate sizeon the vertical members. The Hinge blocks shall be of minimum size 120 mm x 25 mm x 25 mm with the provision to pass one longitudinal reinforcement bar through the Hinge block, to ensure proper anchoring with the concrete. Screw holding capacity of Hinge blocks should not be less than 200 kg per screw. Blocks shall not get cracked on hammering a nail or screw and should be soft enough to drill a hole to drive a screw easily. Such blocks shall also be provided at appropriate locations for fixing latches, tower bolts, mortise locks and cylindrical locks, etc.Specially designed M.S. galvanized sleeves shall also be provided for accommodating 6 mm dia fully threaded bolts for fixing holdfasts on vertical members.

5.6A.5 Finishing- The surface of door frame shall be thoroughly cleaned, free of rust, mill scale, dirt, oil etc. After pre-treatment two coats of paints as directed by the Engineer-in-charge shall be applied to the exposed surface.

5.6A.6 Fixing-Frames shall be fixed up right in plumb and plane. To avoid sag or bow in width during fixing orduring construction phase, temporary struts across the width preventing sides bulging inwards may be provided. Wall shall be built solid on each side and grouted at each course to ensure solid contact with frame leaving no voids behind the frame. Three lugs shall be provided on each jamb with spacing not more than 75 cm. The temporary struts should not be removed till the masonry behind the frame is set.Fixing door, window or clerestory window chowkhats in existing opening shall be done as per section 14.2 of CPWD Specification 2019 Vol-II.

5.6A.7 Measurements -The length shall be measured in running metre correct to a cm along the centre line of the frames.

5.6A.8 Rate -The rate shall include the cost of labour and material involved in all the operation described above.

5.7 PRECAST CEMENT CONCRETE JALI

5.7.0 The jali shall be of cement concrete 1:2:4 (1 cement 2 coarse sand:4 stone aggregate 6 mm nominal size) reinforced with 1.6 mm thick mild steel wire, unless otherwise specified.

5.7.1 Fixing

The jali shall be set in position true to plumb and level before the joints sills and soffits of the openings are plastered. It shall then be properly grouted with cement mortar 1:3 (1 cement :3 coarse sand) and rechecked for levels. Finally the jambs, sills and soffits shall be plastered embedding the jali uniformly on all sides.

5.7.2 Measurements

The jali shall be measured for its gross superficial area. The length and breadth shall be measured correct to a cm. The thickness shall not be less than that specified.

5.7.3 Rate

The rate shall be inclusive of materials and labour involved in all the operations described above except plastering of jambs, sills and soffits, which will be paid for under relevant items of plastering.

5.7A EXPANSION JOINT COVERING WITH CEMENT BONDED PARTICLE BOARD

5.7A.1 Materials :

Species of wood which do not hinder the process of setting of cement shall be used. Suitable additives such as sodium silicate conforming to IS 381:1995 and aluminum sulphate conforming

IS260:2001 shall be used to prevent inhibitive effect of setting & cement when other services are used. Also cement conforming to IS 8112:2013 shall be used.

Tolerance in thickness

(i) Un-sanded boards
6mm to 12mm: $\pm$ 1mm

(ii) Sanded boards
(For all thickness) : $\pm$ 0.3mm

5.7A.2 Physical Requirements :

5.7A.2.1 Workability: The boards shall not crack or split when drilled, sawed or nailed perpendicular to surface. For nailing perpendicular to surface a pre-bore of 0.8 times the diameter of the nail shall be made. Other requirements shall be as stated in Table 1 (i.e. requirement of physical and mechanical properties of cement bonded particle boards) of IS 14276: 1995.

5.7A.2.2 Sampling and Inspection: In any consignment, all the boards of the same dimensions and manufactured under similar condition of product shall be grouped together to constitute a lot. The number of boards to be selected from a lot , method of selection ,test specimen and number of specimen shall be in accordance withIS Code : 14276 : 1995

5.7A.2.3 Criteria for conformity: A lot shall be considered as conforming to the requirement of the specification if the sample and test specimen pass the requirements prescribed in clause 10 of IS Code 14276:1995. In case of failure, double the number of samples shall be taken from the lot for testing. The lot shall be considered to have passed if all these samples conform to the requirement as specified in clause 10 of IS Code:14276: 1995.

5.7A.3 Measurement : The length of sheet shall be measured correct to a cm.

5.7A.4 Rate : The rate shall be inclusive of all materials and labour involved in fixing cement bonded wood particle board over expansion joints.

5.7B EXPANSION JOINT COVERING WITH STAINLESS STEEL GRADE 304

5.7B.1 Material:

General requirement to the supply of material shall conform to IS 1387:1993

Stainless steel sheets and strips shall be free from harmful defects such as scale, rust, blisters, laminations, cracked edges and seams.

5.7B.2 Chemical composition: It shall be as given in table 1 of IS 5522 : 2014 with permissible variations between specified analysis and check analysis as per table 2 of IS 5522 : 2014 when the analysis of steel carried out according to IS :228 and its relevant parts.

5.7B.3 Tolerances: The tolerances for thickness shall be as per clause 10.1 of IS 1387 : 1993

5.7B.4 Mechanical properties: The mechanical properties of the material shall be as per Table-3 of IS 1387 : 1993

5.7B.5 Frequency of sampling: One test shall be made on each coil and for every 100 sheets for each size of the same cast.

5.7B.6 Measurement : The length of sheet shall be measured, correct to a cm.

5.7B.7 Rate : The rate shall be inclusive of all material and labour involved in fixing stainless steel plate over expansion joints.

5.8 DESIGN MIX

5.8.0 Definition

Design mix concrete is that concrete in which the design of mix i.e. the determination of proportions of cement, aggregate & water is arrived as to have target mean strength for specified grade of concrete. The minimum mix of M25 shall be used in all structural elements in both load bearing & RCC framed construction.

5.8.1 Mix Design and Proportioning

5.8.1.1 Mix proportions shall be designed to ensure that the workability of fresh concrete is suitable for conditions of handling and placing, so that after compaction it surrounds all reinforcement and completely fills the formwork. When concrete is hardened, it shall have the stipulated strength, durability and impermeability.

5.8.1.2 Determination of the proportions by weight of cement, aggregates and water shall be based on design of the mix.

5.8.1.3 As a trial the manufacturer of concrete may prepare a preliminary mix according to provisions of SP: 23. Reference may also be made to ACI 211.1-77 for guidance.

5.8.1.4 Mix design shall be tried and the mix proportions checked on the basis of tests conducted at a recognized laboratory approved by the Engineer-in-Charge.

5.8.1.5 All concrete proportions for various grades of concrete shall be designed separately and the mix proportions established keeping in view the workability for various structural elements, methods of placing and compacting.

5.8.1.6 Before using an admixture in concrete, its performance shall be evaluated by comparing the properties of concrete with the admixture and concrete without any admixture. Chloride content of admixture should be declared by the manufacturer of admixture and shall be within limits stipulated by IS:9103.

5.8.2 Standard Deviation

5.8.2.1 Standard deviation calculations of test results based on tests conducted on the same mix design for a particular grade designation shall be done in accordance with IS 456.

5.8.3 Acceptance Criteria for Design Mix

5.8.3.1 ***Compressive Strength :*** The concrete shall be deemed to comply with the strength requirements when both the following condition are met:

(a) The mean strength determined from any group of four consecutive test results complies with the appropriate limits in col 2 of Table 5.6.

(b) Any individual test result complies with the appropriate limits in col. 3 of Table 5.6.

5.8.3.2 ***Flexural Strength :*** When both the following conditions are met, the concrete complies with the specified flexural strength.

(a) The mean strength determined from any group of four consecutive test results exceeds the specified characteristic strength by at least 0.3 N/mm^2.

(b) The strength determined from any test result is not less than the specified characteristic strength/ 0.3 N/mm^2.

5.8.3.3 ***Quantity of Concrete Represented by Strength Test Results :*** The quantity of concrete represented by a group of four consecutive test results shall include the batches from which the first and last samples were taken together with all intervening batches.

For the individual test result requirements given in col 3 of Table 5.6 or in item (b) of 5.8.3.2. Only the particular batch from which the sample was taken shall be at risk.

Where the mean rate of sampling is not specified the maximum quantity of concrete that four consecutive test results represent shall be limited to 60 m^3.

5.8.3.4 If the concrete is deemed not to comply pursuant to 5.8.3 the structural adequacy of the parts affected shall be investigated and any consequential action as needed shall be taken.

5.8.3.5 Concrete of each grade shall be assessed separately.

5.8.3.6 Concrete is liable to be rejected if it is porous or honey-combed, its placing has been interrupted without providing a proper construction joint, the reinforcement has been displaced beyond the tolerances specified, or construction tolerances have not been met. However, the hardened concrete may be accepted after carrying out suitable remedial measured to the satisfaction of the Engineer-in-Charge.

5.8.4 Cement Content of Concrete

5.8.4.1 For all grades of concrete manufactured/produced, minimum cement content in the concrete shall be 330 kg per cubic metre of concrete. Also, irrespective of the grade of concrete the maximum cement content shall not be more than 500 kg per cubic metre of concrete. These limitations shall apply for all types of cements of all strengths.

5.8.4.2 Actual cement content in each grade of concrete for various conditions of variable shall be established by design mixes within the limits specified in para 5.8.4.1 above.

5.8.5 Water Cement Ratio and Slump

5.8.5.1 In proportioning a particular mix, the manufacturer/ producer/ contractor shall give due consideration to the moisture content in the aggregates, and the mix shall be so designed as to restrict the maximum free water cement ratio to less than 0.5.

5.8.5.2 Due consideration shall be given to the workability of the concrete thus produced. Slump shall be controlled on the basis of placement in different situations. For normal methods of placing concrete, maximum slump shall be restricted to 100 mm when measured in accordance with IS 1199.

TABLE 5.6
Characteristic Compressive Strength Compliance Requirement
(Clause 5.8.3.1 and 5.8.3.3)

Specified Grade	*Mean of the Group of 4 Non- Overlapping Consecutive Test Results in N/mm³*	*Individual Test Results in N/mm³*
(1)	*(2)*	*(3)*
M15 and above	$\geq f_{ck}$ + 0.825 x established standard deviation (rounded off to nearest 0.5 N/mm^2) or f_{ck} + 3 N/mm^2 whichever is greater	≥ f_{ck}-3 N/mm^2

NOTE –

1. In the absence of established value of standard deviation, the values given in Table may be assumed, and attempt should be made to obtain results of 30 samples as early as possible to establish the value of standard deviation.

2. **For concrete of quantity up to 30 m^3 (where the number of samples to be taken is less than four as per frequency of sampling given in 5.11.5(d), the mean of test results of all such samples shall be f_{ck} + 4 N/mm^2, minimum**

5.8.6 Approval of Design Mix

5.8.6.1 The producer/ manufacturer/ contractor of concrete shall submit details of each trial mix of each grade of concrete designed for various workability conditions to the Engineer-in-Charge for his comments and approval. Concrete of any particular design mix and grade shall be produced/ manufactured for works only on obtaining written approval of the Engineer-in-Charge.

5.8.6.2 For any change in quality/ quantity in the ingredients of a particular concrete, for which mix has been designed earlier and approved by the Engineer-in-Charge, the mix has to be redesigned and approval obtained again.

5.8A R.C.C FOR PIERS, ABUTMENTS, POTAL FRAMES, PIER CAPS AND BEARING PEDESTALS AND SEISMIC ARRESTERS

5.8A.1 GENERAL

Reinforced cement concrete work shall be cast-in-situ as directed by Engineer-in-Charge according to the nature of work. Reinforced cement concrete work shall comprise of the following which may be paid collectively or separately as per the description of the item of work.

(a) Reinforcement
(b) Self compacting design mix concrete of minimum grade M50/M60by using admixure Retarder / Plasticizer and micro silica as per design mix.

5.8A.2 MATERIALS

5.8A.2.1 Water, cement, fine and coarse aggregate shall be as specified under respective clauses of chapter 03 of mortars, chapter 04 of concrete work and chapter 20 of Pile Work as applicable.

5.8A.2.2 General

(i) IS 456- 2000 Code of Practice for Plain and Reinforced Concrete (as amended up to date) shall be followed in regard to Concrete Mix Proportion and its production as under:
  (a) The concrete mix design shall be done as “Design Mix Concrete” as prescribed in clause-9 of IS 456 mentioned above.
  (b) Concrete shall be manufactured in accordance with clause 10 of above mentioned IS 456 covering quality assurance measures both technical and organizational, which shall also necessarily require a qualified Concrete Technologist to be available during manufacture of concrete for certification of quality of concrete.

(ii) Self-compacting concrete of grade M-50/M-60 shall be used in all structural elements.
If necessitated due to low water/binder ratio, required workability shall be achieved by use of chloride free chemical admixtures conforming to IS 9103. The compatibility of chemical admixtures and super plasticizers with OPC, received from different sources shall be ensured by trials.

(v) In cases, where structural concrete is exposed to excessive magnesium sulphate, flyash substitution/content shall be limited to 18% by weight. Special type of cement with low C3A content may also be alternatively used. Durability criteria like minimum binder content and maximum water /binder ratio also need to be given due consideration in such environment.

(vi) Curing as per provision in IS 456:2000 (with amendment). Wet curing period shall be enhanced to a minimum of 10 days or its equivalent. In hot & arid regions, the minimum curing period shall be 14 days or its equivalent.

5.8A.3 Steel for reinforcement

Steel shall be thermo mechanically treated bar Fe-500D as per IS1786-2008 (with amendments) or more as per as per clause 5.1.3 of CPWD Specification Vol.I, 2019 with upto date correction slips.

5.8A.3.1 Cover

Cover as per IS456:2000 (with amendment) and clause 5.3.3.5 of CPWD Specification Vol.I, 2019.

5.8A.4 Concreting

Self-compacting concrete of grade M-50/M-60 for construction of piers, abutments, portal frames, pier caps and bearing pedestals and seismic arresters over pier/ abutment caps at all locations with specified grade using Ordinary Portland Cement (conforming to strength requirement of IS:8112).

5.8A.4.1 Strength of concrete

As per IS 456:2000 with amendments.

5.8A.5 Self Compacting Concrete

Self-compacting concrete shall be able to flow under its own weight and completely fill the formwork, even in the presence of dense reinforcement, without the need of any vibration, whilst maintaining homogeny.

5.8A.5.1 Guiding Technical specification for Self compacting concrete.

The specification, performance and conformity requirements for structural concrete are given in IS 456-2000 Annex - J. Test methods. The filling ability and stability of self-compacting concrete in the fresh state shall be defined by four key characteristics like flow ability viscosity, passing ability & Segregation resistance. Each characteristic shall be addressed by one or more test methods:

Grade	*M30 & above*
Cementitious content	*400 – 600kg / m3*
Admixtures	*PCE based & Viscosity Modifiers or as per design mix*
Flow	*550 – 850 mm*
T 50 time	*Time of 2-5 seconds*
V-Funnel	*Time Max 25 seconds*
L – Box ratio	*0.8 – 1.0*
Compressive Strength	*As per Specification of IS 456.*

Characteristic	**Preferred test method(s)**
Flow ability	Slump-flow test
Viscosity (assessed by rate of flow)	T500 Slump-flow test or V-funnel test
Passing ability	L-box test

5.8A.5.1.1 Slump - flow

Slump-flow value describes the flow ability of a fresh mix in unconfined conditions. It is a sensitive test that will normally be specified for all SCC, as the primary check that the fresh concrete consistence meets the specification. Visual observations during the test and/or measurement of the T_{500} time can give additional information on the segregation resistance and uniformity of each delivery.

The following are typical slump-flow classes for a range of applications:

SF1 (550 - 650 mm) is appropriate for:

- Unreinforced or slightly reinforced concrete structures that are cast from the top with free displacement from the delivery point (e.g. housing slabs)
- Casting by a pump injection system (e.g. tunnel linings)
- Sections that are small enough to prevent long horizontal flow (e.g. piles and some deep foundations).

SF2 (660 - 750 mm) is suitable for many normal applications (e.g. walls, columns)

SF3 (760 – 850 mm) is typically produced with a small maximum size of aggregates (less than 16 mm) and is used for vertical applications in very congested structures, structures with complex shapes, or for filling under formwork. SF3 will often give better surface finish than SF 2 for normal vertical applications but segregation resistance is more difficult to control.

Target values higher than 850 mm may be specified in some special cases but great care should be taken regarding segregation and the maximum size of aggregate should normally be lower than 12 mm.

Class	Slump – Flow in mm	Conformity criteria
SF 1	550 to 650	>520 & <700
SF 2	660 to 750	>640 & <800
SF 3	760 to 850	>740 & <900



Picture above shows Slump flow test

5.8A.5.1.2 Viscosity

Viscosity can be assessed by the T_{500} time during the slump-flow test or assessed by the V-funnel flow time. The time value obtained does not measure the viscosity of SCC but is related to it by describing the rate of flow. Concrete with a low viscosity will have a very quick initial flow and then stop. Concrete with a high viscosity may continue to creep forward over an extended time.

Viscosity (low or high) should be specified only in special cases such as those given below. It can be useful during mix development and it may be helpful to measure and record the T_{500} time while doing the slump-flow test as a way of confirming uniformity of the SCC from batch to batch.

VS1/VF1 has good filling ability even with congested reinforcement. It is capable of self-levelling and generally has the best surface finish. However, it is more likely to suffer from bleeding and segregation.

VS2/VF2 has no upper class limit but with increasing flow time it is more likely to exhibit thixotropic effects, which may be helpful in limiting the formwork pressure (see Clause 10.5) or improving segregation resistance. Negative effects may be experienced regarding surface finish (blow holes) and sensitivity to stoppages or delays between successive lifts.

Class	V-Funnel Time in Seconds	Conformity criteria
VF 1	≤ 9	± 3
VF 2	10 to 25	± 3



5.8A.5.1.3 Passing ability

Passing ability describes the capacity of the fresh mix to flow through confined spaces and narrow openings such as areas of congested reinforcement without segregation, loss of uniformity or causing blocking. In defining the passing ability, it is necessary to consider the geometry and density of the reinforcement, the flowability/filling ability and the maximum aggregate size.

The defining dimension is the smallest gap (confinement gap) through which SCC has to continuously flow to fill the formwork. This gap is usually but not always related to the reinforcement spacing. Unless the reinforcement is very congested, the space between reinforcement and formwork cover is not normally taken into account as SCC can surround the bars and does not need to continuously flow through these spaces.

Examples of passing ability specifications are given below:

PA 1 structures with a gap of 80 mm to 100 mm, (e.g. housing, vertical structures)
PA 2 structures with a gap of 60 mm to 80 mm, (e.g. civil engineering structures)

For thin slabs where the gap is greater than 80 mm and other structures where the gap is greater than 100 mm no specified passing ability is required.
For complex structures with a gap less than 60 mm, specific mock-up trials may be necessary.

Class	Passing Ability	Conformity criteria
PA 1	≥ 0.8 with 2 bars	≥ 0.75
PA 2	≥ 0.8 with 3 bars	≥ 0.75



5.8A.5.1.4 Segregation resistance

Segregation resistance is fundamental for SCC in-situ homogeneity and quality. SCC can suffer from segregation during placing and also after placing but before stiffening. Segregation which occurs after placing will be most detrimental in tall elements but even in thin slabs, it can lead to surface defects such as cracking or a weak surface.

In the absence of relevant experience, the following general guidance on segregation resistance classes is given:

Segregation resistance becomes an important parameter with higher slump-flow classes and/or the lower viscosity class, or if placing conditions promote segregation. If none of these apply, it is usually not necessary to specify a segregation resistance class.

SR1 is generally applicable for thin slabs and for vertical applications with a flow distance of less than 5 metres and a confinement gap greater than 80 mm.

SR2 is preferred in vertical applications if the flow distance is more than 5 metres with a confinement gap greater than 80 mm in order to take care of segregation during flow.

SR2 may also be used for tall vertical applications with a confinement gap of less than 80 mm if the flow distance is less than 5 metres but if the flow is more than 5 metres a target SR value of less than 10% is recommended.

SR2 or a target value may be specified if the strength and quality of the top surface is particularly critical.

5.8A.6 Laying of RMC concrete

All Ready Mixed Designed concrete from plant shall be laid with the help of concrete pump of adequate capacity for which nothing extra shall be paid over and above the quoted rates in relevant items. However, small quantity can be allowed without pump with prior written approval of Engineer-in-charge as per site requirement.

NOTE :- In case cement content as per the approved design mix is more or less than the cement contents for cubic metre of concrete specified in the nomenclature of the item, financial adjustment by way of extra payment or such recovery for more or less cement content shall be effected at the rate provided in BOQ with applicable quoted percentage.

5.8A.7 Specifications for pier, abutment, pier/abutment cap. (IRC 78-2014)

(i) Thickness of the wall of hollow concrete pier should not be 300mm.

(ii) Pier shall be designed to withstand the load enforced from the superstructure and the load enforces on the pier itself, apart from the effect of itself weight in general, pier may be solid, hollow or framed structure.

(iii) In case of pier consisting of 2 or more columns, the horizontal forces at the bearing be distributed on columns as required by appropriate analysis.

(iv) The lateral reinforcement of the walls of hollow circular RCC pier shall not be less than 0.3% of the sectional area of the walls of pier. This lateral reinforcement shall be distributed 60% on outer face and 40% in inner face.

5.8A.7.1 Abutments

(i) The abutment will carry superstructure from one side, it should be designed/dimensioned to retain earth from the approach embankment.

(ii) The embankment to should be design to be withstand earth pressure in normal condition in addition to load enforces transferred from superstructure. In addition, any load acting on the embankment, including self-weight is to be considered.

(iii) All abutments and abutment columns shall be designed for a live load surcharge equivalent to 1.2m height of earth fill. The effective width of the columns need not be increased as in clause 710.4.3 for surcharge effect when spill through abutment is adopted.

(iv) Abutment should also be designed for water current forces during 'scour all round' condition.

(v) The Weight of earth filling material on heel may be considered. In case of toe, the weight may be considered if the bed is protected.

(vi) In case of abutments having counterfort, the minimum thickness of the front wall should not be less than 200mm and the thickness of the counterfort should not be less than 250mm.

(vii) In case of box type abutments, weep holes shall be provided similar to hollow piers as per clause 710.2.9.

5.8A.7.2 Pier and abutment cap.

The width of the abutment and pier cap shall be sufficient to accommodate:

(i) The bearing living an offset 150mm beyond them.

(ii) The blast wall

(iii) The space for jacks to lift the super structure for repair/replacement of bearing, etc.

(iv) The equipment for pre-restrain operation where necessary, over and above space for end block in cast in situ cases.

(v) The drainage arrangement for water on the cap.

(vi) Seismic arrestor if provided.

(vii) To accommodate inspection ladders.

5.8A.7.2.1 The thickness of cap over the hollow pier or column type of abutment should not be less than 250mm but in case of solid plain or reinforced concrete pier and abutment, the thickness can be reduced to 200mm.

5.8A.7.2.2 Pier/abutment caps should be suitably designed and reinforced to take care of concentrated point loads dispersing in pier/abutment. Caps cantilevering out from the supports or resting on two or more columns shall be designed to cater for the lifting of superstructure on jacks for repair/ replacement of bearings. The locations of jacks shall be predetermined and permanently marked on the caps.

5.8A.7.2.3 In case of bearing are placed centrally over the columns and the width of bearing/pedestal is located within half the depth of cap from any external face of column, the load from bearing will be considered to have been directly transferred to columns and the cap been need not be designed for flexure.

5.8A.7.2.4 Reinforcement in pier and abutment cap where the bearing satisfied the square root formula stated in clause 307.1 of IRC 21, the pier cap shall be reinforced with total minimum of 1% steel assuming a cap thickness of 225mm. the total steel shall be distributed equally and provided both at top and bottom in two directions. The reinforcement in the direction of length of the pier shall extend from and end to end of the pier cap while the reinforcement at right angle shall extend for the full width of the pier cap and be in form of stirrups. In addition, two layers of mass reinforcement one at 20mm from top and the other at 100mm centers in both directions shall be provided directly under the bearing.

5.8A.8 Measurement

Quantity of concrete in cum of pier, abutment, pier caps, bearing pedestal and seismic arrestor over pier/abutment cap shall be measured. “Excess/less cement used for design mix including the extra cement required under water concreting is payable/recoverable separately”.

5.8A.9 Rate

The rate include cost of steel, centering and shuttering etc. complete including testing of material etc. for casting pier and pier cap in one/two stage, necessary tools, plants, machinery and all related operations as required to complete the work as per drawing and specification with all leads, lifts and depth true to level and position but excluding the cost of providing reinforcement. Reinforcement shall be measured and paid separately.

5.8B R.C.C. DIRPHRAGM WALL

5.8B.1 GENERAL

Reinforced cement concrete work shall be cast-in-situ as directed by Engineer-in-Charge according to the nature of work. Reinforced cement concrete work shall comprise of the following which may be paid collectively as per the description of the item of work. Form work shall be paid separately.

(a) Reinforcement
(b) Self compacting design mix concrete of minimum grade M30 with suitable Retarder / Plasticizer: (Cast-in-situ) with tremie controlled pipe
(c) Bentonite slurry
(d) Concrete mix 1:2:4 for guide walls.

5.8B.2 MATERIALS

5.8B.2.1 Water, cement, fine and coarse aggregate shall be as specified under respective clauses of chapter 03 of mortars, chapter 04 of concretework and chapter 20 of Pile Work as applicable.

5.8B.2.2 Fly Ash admixed cement concrete (FACC) and fly ash blended cements in Cement Concrete (PPCC) in RCC structures.

5.8B.2.2.1 Fly ash Blended Cements conforming to IS 1489 (Part I) may be used in RCC structures as per guidelines given below:

5.8B.2.2.2 General

(i) IS 456- 2000 Code of Practice for Plain and Reinforced Concrete (as amended up to date) shall be followed in regard to Concrete Mix Proportion and its production as under:

  (a) The concrete mix design shall be done as “Design Mix Concrete” as prescribed in clause-9of IS 456 mentioned above.

  (b) Concrete shall be manufactured in accordance with clause 10 of above mentioned IS 456covering quality assurance measures both technical and organizational, which shall alsonecessarily require a qualified Concrete Technologist to be available during manufacture ofconcrete for certification of quality of concrete.

(ii) Minimum M-30 grade of concrete shall be used in all structural elements.

(iii) The mechanical properties such as modulus of elasticity, tensile strength, creep and shrinkage offly ash mixed concrete or concrete using fly ash blended cements (PPCs) are not likely to besignificantly different and their values are to be taken same as those used for concrete made with OPC.

(iv) To control higher rate of carbonation in early ages of concrete both in fly ash admixed as well as PPC based concrete, water/binder ratio shall be kept as low as possible, which shall be closelymonitored during concrete manufacture.

  If necessitated due to low water/binder ratio, required workability shall be achieved by use ofchloride free chemical admixtures conforming to IS 9103. The compatibility of

chemicaladmixtures and super plasticizers with each set OPC, fly ash and /or PPC received from differentsources shall be ensured by trials.

(v) In environment subjected to aggressive chloride or sulphate attack in particular, use of fly ashadmixed or PPC based concrete is recommended. In cases, where structural concrete isexposed to excessive magnesium sulphate, flyash substitution/content shall be limited to 18% byweight. Special type of cement with low C3A content may also be alternatively used. Durabilitycriteria like minimum binder content and maximum water /binder ratio also need to be given dueconsideration in such environment.

(vi) Curing as per provision in IS 456:2000 (with amendment). Wet curing period shall be enhanced to a minimum of 10 days or its equivalent. In hot & aridregions, the minimum curing period shall be 14 days or its equivalent.

5.8B.3 Steel for reinforcement

Steel shall be thermo mechanically treated bar Fe-500D as perIS1786-2008 (with amendments) or more as per as per clause 5.1.3 of CPWD Specification Vol.I, 2019 with upto date correction slips.

5.8B.3.1 Cover

Cover as per IS456:2000 (with amendment) and clause 5.3.3.5 of CPWD Specification Vol.I, 2019

5.8B.4 Concreting

Constructing cast-in situ RCC diaphragm wall by providing and laying machine batched, machine mixed, self-compacting, ready mix reinforced cement concrete, tremie controlled.

5.8B.4.1 Strength of concrete

As per IS 456:2000 with amendments.

5.8B.5 SELF COMPACTING CONCRETE

Self-compacting concrete shall be able to flow under its own weight and completely fill the formwork, even in the presence of dense reinforcement, without the need of any vibration, whilst maintaining homogeny.

5.8B.5.1 Guiding Technical specification for Self compacting concrete.

The specification, performance and conformity requirements for structural concrete are given in IS 456-2000 Annex - J. Test methods. The filling ability and stability of self-compacting concrete in the fresh state shall be defined by four key characteristics like flow ability viscosity, passing ability &Segregation resistance. Each characteristic shall be addressed by one or more test methods:

Grade	M30 & above
Cementitious content	400 – 600kg / m^3
Admixtures	PCE based & Viscosity Modifiers or as per design mix
Flow	550 – 850 mm
T 50 time	Time of 2-5 seconds
V-Funnel	Time Max 25 seconds
L – Box ratio	0.8 – 1.0
Compressive Strength	As per Specification of IS 456.

Characteristic	**Preferred test method(s)**
Flow ability	Slump-flow test
Viscosity (assessed by rate of flow)	T500 Slump-flow test or V-funnel test
Passing ability	L-box test

5.8B.5.2 Slump-flow

Slump-flow value describes the flow ability of a fresh mix in unconfined conditions. It is a sensitive test that will normally be specified for all SCC, as the primary check that the fresh concrete consistence meets the specification. Visual observations during the test and/or measurement of the T_{500} time can give additional information on the segregation resistance and uniformity of each delivery.

The following are typical slump-flow classes for a range of applications:

SF1 (550 - 650 mm) is appropriate for:

- Unreinforced or slightly reinforced concrete structures that are cast from the top with free displacement from the delivery point (e.g. housing slabs)
- Casting by a pump injection system (e.g. tunnel linings)
- Sections that are small enough to prevent long horizontal flow (e.g. piles and some deep foundations).

SF2 (660 - 750 mm) is suitable for many normal applications (e.g. walls, columns)

SF3 (760 – 850 mm) is typically produced with a small maximum size of aggregates (less than 16 mm) and is used for vertical applications in very congested structures, structures with complex shapes, or for filling under formwork. SF3 will often give better surface finish than SF 2 for normal vertical applications but segregation resistance is more difficult to control.

Target values higher than 850 mm may be specified in some special cases but great care should be taken regarding segregation and the maximum size of aggregate should normally be lower than 12 mm.

Class	Slump – Flow in mm	Conformity criteria
SF 1	550 to 650	>520 & <700
SF 2	660 to 750	>640 & <800
SF 3	760 to 850	>740 & <900



5.8B.5.3 Viscosity

Viscosity can be assessed by the T_{500} time during the slump-flow test or assessed by the V-funnel flow time. The time value obtained does not measure the viscosity of SCC but is related to it by describing the rate of flow. Concrete with a low viscosity will have a very quick initial flow and then stop. Concrete with a high viscosity may continue to creep forward over an extended time.

Viscosity (low or high) should be specified only in special cases such as those given below. It can be useful during mix development and it may be helpful to measure and record the T_{500} time while doing the slump-flow test as a way of confirming uniformity of the SCC from batch to batch.

VS1/VF1 has good filling ability even with congested reinforcement. It is capable of self-levelling and generally has the best surface finish. However, it is more likely to suffer from bleeding and segregation.

VS2/VF2 has no upper class limit but with increasing flow time it is more likely to exhibit thixotropic effects, which may be helpful in limiting the formwork pressure (see Clause 10.5) or improving segregation resistance. Negative effects may be experienced regarding surface finish (blow holes) and sensitivity to stoppages or delays between successive lifts.

Class	V-Funnel Time in Seconds	Conformity criteria
VF 1	≤ 9	± 3
VF 2	10 to 25	± 3



5.8B.5.4 Passing ability

Passing ability describes the capacity of the fresh mix to flow through confined spaces and narrow openings such as areas of congested reinforcement without segregation, loss of uniformity or causing blocking. In defining the passing ability, it is necessary to consider the geometry and density of the reinforcement, the flowability/filling ability and the maximum aggregate size.

The defining dimension is the smallest gap (confinement gap) through which SCC has to continuously flow to fill the formwork. This gap is usually but not always related to the reinforcement spacing. Unless the reinforcement is very congested, the space between reinforcement and formwork cover is not normally taken into account as SCC can surround the bars and does not need to continuously flow through these spaces.

Examples of passing ability specifications are given below:

PA 1 structures with a gap of 80 mm to 100 mm, (e.g. housing, vertical structures)
PA 2 structures with a gap of 60 mm to 80 mm, (e.g. civil engineering structures)

For thin slabs where the gap is greater than 80 mm and other structures where the gap is greater than 100 mm no specified passing ability is required.

For complex structures with a gap less than 60 mm, specific mock-up trials may be necessary.

Class	Passing Ability	Conformity criteria
PA 1	≥ 0.8 with 2 bars	≥ 0.75
PA 2	≥ 0.8 with 3 bars	≥ 0.75



5.8B.5.5 Segregation resistance

Segregation resistance is fundamental for SCC in-situ homogeneity and quality. SCC can suffer from segregation during placing and also after placing but before stiffening. Segregation which occurs after placing will be most detrimental in tall elements but even in thin slabs, it can lead to surface defects such as cracking or a weak surface.

In the absence of relevant experience, the following general guidance on segregation resistance classes is given:

Segregation resistance becomes an important parameter with higher slump-flow classes and/or the lower viscosity class, or if placing conditions promote segregation. If none of these apply, it is usually not necessary to specify a segregation resistance class.

SR1 is generally applicable for thin slabs and for vertical applications with a flow distance of less than 5 metres and a confinement gap greater than 80 mm.

SR2 is preferred in vertical applications if the flow distance is more than 5 metres with a confinement gap greater than 80 mm in order to take care of segregation during flow.

SR2 may also be used for tall vertical applications with a confinement gap of less than 80 mm if the flow distance is less than 5 metres but if the flow is more than 5 metres a target SR value of less than 10% is recommended.

SR2 or a target value may be specified if the strength and quality of the top surface is particularly critical.

5.8B.5.6 Laying of RMC concrete

All Ready Mixed Designed concrete from plant shall be laid with the help of concrete pump of adequate capacity for which nothing extra shall be paid over and above the quoted rates in relevant items. However, small quantity can be allowed without pump with prior written approval of Engineer-in-charge as per site requirement.

NOTE :- In case cement content as per the approved design mix is more or less than the cement contents for cubic metre of concrete specified in the nomenclature of the item, financial adjustment by way of extra payment or such recovery for more or less cement content shall be effected at the rate provided in BOQ with applicable quoted percentage.

5.8B.6 Specifications for diaphragm wall

(i) Cast-in-situ RCC diaphragm wall shall be as per IS14344:1996.

(ii) Rigid type of diaphragm wall or plastic concrete diaphragm wall shall be constructed by resorting to either successive panel method or alternate panel method. For cement bentonite slurry trench diaphragm wall, alternate panel method of construction is suitable in view of the time that is require to achieve hardness of the mix put in the trench.

5.8B.6.1 Tolerance:

(i) Guide walls:
Finished faces of the guide wall toward the trench shall be vertical. There shall be no rigid or abrupt change of the guide wall and variation from a straight line or a specified profile shall not exceed 25mm in 3 meter.

(ii) Diaphragm wall:
Verticality
Face of the wall and ends of panel shall be vertical within a tolerance of 1:80.
In positioning of reinforcement longitudinal tolerance of cage head at top of the guide wall measured along the trench, shall be 75mm and vertical tolerance at caged head in relation to top of guide wall shall be 50mm.

(iii) Testing
Testing of material to be used for the work shall be done in a laboratory to confirm their usability as per applicable IS Standard.

Mix for rigid concrete, plastic concrete and cement bentonite slurry shall be design in a laboratory and testing shall be done to ascertain various parameters like compressive and tensile strength, permeability, modulus of elasticity, erodibility, PH value, etc. to be confirm that the mix design satisfies the design parameter.

Sample of mix at the time of placing shall be collected and kept in air tight sealed molds of specified size till due dates of various tests. Important test to be perform are as under: -

(a) Compressive strength: Test shall be carried out at 7, 28 and 90 days.

(b) Triaxial compressive strength test shall be carried out on filling material like plastic concrete, cement, bentonite etc. to determine stress strain characteristic, modulus of elasticity and shear parameters, test shall be carried out at 7, 28 and 90 days in consolidated undrained conditions.

(c) Permeability test on sample shall be conducted after 28 days in membrane permeameter.

5.8B.6.2 Instrumentation:

(i) Placement of instruments simultaneously with casting of panel is difficult, as there is a possibility of damaging the instruments, wires etc., or losing their sensitivity due to vibrations generated during placement of concrete. It is, therefore, preferable to install the instrument outside the completed diaphragm wall to measure in-situ performance.

5.8B.6.2.1 Deformation of the structure

For the purpose of measuring deformation behavior of the diaphragm, inclinometers at various location shall be installed close to the diaphragm wall.

5.8B.6.2.2 Settlement gauge

Settlement gauged may be installed at selected locations to measured vertical displacement. Gauges shall not have an error of more than 1mm.

5.8B.6.2.3 Piezometric levels:

To judge the efficiency in water tightness of the diaphragm wall, residual discharge collected downstream of the cut off wall is the essential measurement. This can be determined by a double network of Piezometers placed on either side of the wall and well protected by filters. Chemical and physical analysis water may be useful to pinpointed its source. Observations frequency shall not be more than 15 days.

5.8B.6.2.4 Permeability

100mm diameter tubes extending to random depths, shall be placed at the center of the thickness of the diaphragm panel at randomly chosen locations. After a period of 28 days bore holes may be drilled into the diaphragm below the tubes and permeability test by pumping in method carried out. The in-situ permeability of the diaphragm shall be compared with the specified limit as per requirement.

5.8B.7 Records

Following records shall be maintained in a manner approved by the Engineer-in-charge.

(i) Name of Project/work.

(ii) Panel No. & reference drawing no.

(iii) Date of commencement and completion of excavation

(iv) Date of concreting of panel

(v) Length of panel

(vi) Thickness of panel

(vii) Top of guide wall level

(viii) Depth of guide wall

(ix) Top level of wall as cast, in relation to top of guide wall at the edges and at the center.

(x) Depth of panel from base of top of guide wall

(xi) Strata encountered

(xii) Volume of panel and volume of concrete used, slump, water cement ratio.

(xiii) Cube taken and their result.

(xiv) Details of reinforcement (cage type)

(xv) Detail of any obstructions/ peculiar conditions encountered and time spent and measures taken in overcoming them.

(xvi) Type and proportion of any additives used and reason for use.

5.8B.8 Measurement

Actual area of diaphragm wall correct to two places of decimal, from design bottom level to the design cut off level (including portion incurred in the rock upto the design bottom level) only shall be measured for payment. "Excess/less cement used for design mix including the extra cement required under water concreting is payable/recoverable separately".

5.8B.9 Rate

The rate include cost of all inputs of labour, material and T&P, cost of handling, lifting and placing in position the reinforcement cage in the trench, including cost of reinforcement bar, welding, etc. involved in the work and all other incidental expenditure for completing the work as directed by the Engineer-in-charge shall include the cost of labour and material involved in all the operation describedabove.

5.9 READY MIXED CONCRETE (as per IS 4926)

5.9.1 Materials

5.9.1.1 ***Selection and Approval of Materials*** **:** Materials used should satisfy the requirements for the safety, structural performance durability and appearance of the finished structure, taking full account of the environment to which it will be subjected. The selection and use of materials shall be in accordance with IS 456. Materials used shall conform to the relevant Indian Standards applicable. Where materials are used which are not covered by the provisions of the relevant Indian Standard, there should be satisfactory data on their suitability and assurance of quality control. Records and details of performance of such materials should be maintained. Account should be taken of possible interactions and compatibility between IS 4926 and materials used. Also, prior permission of the purchaser shall be obtained before use of such materials.

5.9.1.2 ***Cement*** : Cement used for concrete shall be in accordance with the requirements of IS 456.

5.9.1.3 ***Mineral Admixtures :*** Use of mineral admixtures shall be permitted in accordance with the provisions of IS 456.

5.9.1.4 ***Aggregates :*** Aggregates used for concrete shall be in accordance with the requirement of IS 456. Unless otherwise agreed testing frequencies for aggregates in plant shall be as given IS 4926.

5.9.1.5 ***Chemical Admixtures***

(i) Use of chemical admixtures shall be permitted in accordance, with the provisions of IS 456 and IS 9103.

(ii) It shall be the responsibility of the producer to establish compatibility and suitability of any admixture with the other ingredients of the mix and the determine the dosage required to give the desired effect.

(iii) Admixtures should be stored in a manner that prevents degradation of the product and consumed within the time period indicated by the admixture supplier. Any vessel containing an admixture in the plant or taken to site by the producer shall be clearly marked as to its content.

(iv) When offering or delivering a mix to a purchaser it should be indicated if such a mix contains an admixture or combination of admixtures or not. The admixtures may be identified generically and should be declared on the delivery ticket.

(v) The amount of admixture added to mix shall be recorded in the production record. In special circumstances, if necessary, additional dose of admixture may be added at project site to regain the workability of concrete with the mutual agreement between the producer and the purchaser.

5.9.1.6 ***Water :*** Water used shall be in accordance with the requirement of IS 456. Unless otherwise agreed, the testing frequencies for water shall be as given in Annex A.

The use of re-cycled water is encouraged as long as concrete of satisfactory performance can be produced and steps are taken to monitor the build up of chlorides in any recirculated water and that any subsequent adjustments to the mix design are made to ensure that any overall limit on chloride contents is satisfied. The addition of any recycled water shall be monitored and controlled to meet these requirements.

The total amount of water added to the mix shall be recorded in the production record. The water content of concrete shall be regulated by controlling its workability or by measuring and adjusting the moisture contents of its constituent materials. The producer's production staff and truck -mixer, drivers shall be made aware of the appropriate responses to variations in concrete consistency of a particular mix caused by normal variations in aggregate moisture content or grading.

5.9.2 General Requirements

5.9.2.1 ***Basis of Supply :*** Ready-mixed concrete shall be supplied having the quality and the quantity in accordance with the requirement agreed with the purchaser or his agent. Notwithstanding this, the concrete supplied shall generally comply with requirements of IS 456.

All concrete will be supplied and invoiced in terms of cubic metres (full or part) of compacted fresh concrete. All proportioning is to be carried out by mass except water and admixture, which may be measured by volume.

5. 9.2.2 ***Transport of Concrete :*** Ready-mixed concrete shall be transported from the mixer to the point of placing as rapidly as practicable by methods that will maintain the required workability and will prevent segregation, loss of any constituents or ingress of foreign matter or water. The concrete shall be placed as soon as possible after delivery, as close as is practicable to its final position to avoid re- handling or moving the concrete horizontally by vibration. If required by the purchaser the producer can utilize admixtures to slow down the rate of workability loss, however this does not remove the need for the purchaser to place the concrete as rapidly as possible. The

purchaser should plan his arrangements so as to enable a full load of concrete to be discharged within 30 minutes of arrival on site.

Concrete shall be transported in a truck-mixer unless the purchaser agrees to the use of non-agitating vehicles. When non-agitating vehicles are used, the mixed concrete shall be protected from gain or loss of water.

5.9.2.3 ***Time in Transport :*** The general requirement is that concrete shall be discharged from the truck-mixer within 2 h of the time of loading. However, a longer period may be permitted if retarding admixtures are used or in cool humid weather or when chilled concrete is produced. The time of loading shall start from adding the mixing water to the dry mix of cement and aggregate or of adding the cement to the wet aggregate whichever is applicable.

Ready-mixed concrete plant shall have test facilities at its premises to carry out routine tests as per the requirement of the standard.

5.9.3 Sampling and Testing of Ready-Mixed Concrete

5.9.3.1 ***Point and Time of Sampling*** **:** For the assessment of compliance of ready-mixed concrete, the point and time of sampling shall be at discharge from the producer's delivery vehicle or from the mixer to the site or when delivered into the purchaser's vehicle. It is critical that the sampling procedure and equipment used enables as representative a sample as possible to be taken of the quantity of concrete delivered (see Annex A).

The sampling may be carried out jointly by the purchaser and the supplier with its frequency mutually agreed upon. However, it will not absolve the supplier of his responsibility from supplying in concrete as per the requirement given in this standard or otherwise agreed to where so permitted in the standard.

5.9.3.2 ***Workability :*** The test for acceptance is to be performed upon the producer's delivery vehicle discharge on site or upon discharge into the purchaser's vehicle. If discharge from the producers' vehicle is delayed on site due to lack of preparedness on behalf of the purchaser then the responsibility passes to the purchaser after a delay of more than 30 min.

The workability shall be within the following limits on the specified value as appropriate:

Slump ± 25 mm or 1/3 of the specified value, whichever is less.

Compacting factor : ± 0.03, where the specified value is 0.90 or greater,
± 0.04, where the specified value is less than 0.90 but more than 0.80,
± 0.05, where the specified value is 0.80 or less.

Flow table test may be specified for concrete, for very high workability (see IS 9103) Acceptance criteria for spread (flow) are to be established between the supplier and the purchaser.

5.9.3.3 ***Specified Strength***

(i) Compliance shall be assessed against the requirements of IS 456 or other agreed Indian Standard. The purchaser may perform his sampling and testing or may enter into an arrangement with the producer to provide his testing requirements.

(ii) Unless otherwise agreed between the parties involved, the minimum testing frequency to be applied by the producer in the absence of a recognized ready- mixed concrete industry method of production control should be one sample for every 50 m^3 of production or every 50 batches, whichever is the greater frequency. Three test specimens shall be made up for each sample for testing at 28 days (see also IS 456).

In order to get a relatively quicker idea of the quality of concrete, optional test on beams for modulus of rupture at 72 ± 2 h or at 7 days or compressive strength test at 7 days may be carried out in addition to 28 days compressive strength test. For this purpose the value should be arrived at based on actual testing. In all cases 28 days compressive strength shall alone be the criteria for acceptance or rejection of the concrete.

(iii) The purchaser shall inform the producer if his requirements for sampling and testing are higher than one sample every 50 m^3 or 50 batches, whichever is the greater frequency.

5.9.3.4 ***Additional Compliance Criteria*** *:* Any additional compliance criteria shall be declared to the producer by the purchaser prior to supply and shall be mutually agreed upon in terms of definition, tolerance frequency of assessment, method of test and significance result.

5.9.3.5 ***Non-Compliance :*** The action to be taken in case of non-compliance shall be declared and mutually agreed upon.

5.9.4 Information to be Supplied by the Purchaser

5.9.4.1 The purchaser shall provide to the producer the details of the concrete mix or mixes required by him and all pertinent information on the use of the concrete and the specified requirements. Prior to supply taking place, it is recommended that a meeting is held between the purchaser and the producer. Its objective to clarify operational matters such as notice to be given prior to delivery, delivery rate, the name of the purchasers authorized representative who will coordinate deliveries, any requirements for additional services such as pumping, on site testing or training, etc.

5.9.4.2 ***Designed Mixes :*** Where the purchaser specifies a designed mix to be supplied it is essential that all relevant information is conveyed to the producer. In order to assist in this, the format given in Annex B may be completed and forwarded to the producer at the time of enquiry.

5.9.4.3 ***Prescribed Mixes :*** The concrete mix shall be specified by its constituent materials and the properties or quantities of those constituents to produce a concrete with the required performance. The assessment of the mix proportions shall form an essential part of the compliance requirements. The purchaser shall provide the producer with all pertinent information on the use of the concrete and the specified requirements. In order to assist in this, the format given in Annex B may be followed with suitable modifications as applicable to prescribed mixes.

5.9.5 Information to be Supplied by the Producer

When requested, the producer shall provide the purchaser with the following information before any concretes is supplied:

(a) Nature and source of each constituent material,

(b) Source of supply of cement,

(c) Proposed proportions or quantity of each constituent/ m^3 of fresh concrete.

(d) Generic type(s) of the main active constituent(s) in the admixture;

(e) Whether or not the admixture contains chlorides and if so, the chloride content of the admixture expressed as a percentage of chloride ion by mass of admixture;

(f) Where more than one admixture is used, confirmation of their compatibility and

(g) Initial and final setting time of concrete when admixture is used at adopted dosage (tested as per IS 8142).

5.9.6 Production and Delivery

5.9.6.1 *Materials Storage and Handling*

(i) *Cement :* Separate storage for Different types and grades of cement shall be provided. Containers may be used to store cement of different types provided these are emptied before loading new cement. Bins or silos shall be weatherproof and permit free flow and efficient discharge of the cement. Each silo or compartment of a silo shall be completely separate and fitted with a filter or alternative method of dust control. Each filter or dust control system shall be of sufficient size to allow delivery of cement to be maintained at a specified pressure, and shall be properly maintained and prevent undue emission of cement dust and prevent interference with weighing accuracy by build up of pressure. Cement shall be stored and stacked in bags and shall be kept free from the possibility of any dampness or moisture coming in contact with them and where cement can be stored and retrieved without undue damage to the bags. The bags are to be protected from becoming damp either from the ground or the weather. The cement is to be used in the order it is delivered (see also IS 4082).
In case, the cement remains in storage for more than 3 months, the cement shall be retested before use and shall be rejected, if it fails to conform to any of the requirements given in the relevant Indian Standard.

(ii) *Dry Pulverized Fuel Ash and Other Mineral Admixtures :* Suitable separate arrangement for storage of pulverized fuel ash, silica fume, metakeolin, rice husk ash, ground granulated blast furnace slag such as for cement, shall be provided, in the plants utilizing these materials.

(iii) *Aggregates (Coarse and Fine) :* Stockpiles shall be free draining and arranged to avoid contamination and to prevent intermingling with adjustment material. Handling procedures for loading and unloading aggregates shall be such as to reduce segregation to a minimum. Provision shall be made for separate storage for each nominal size and type of aggregate and the method of loading of storage bins shall be such as to prevent intermingling of different sizes and types. Fine aggregates shall be stacked in a place where loss due to the effect of wind is minimum (see also IS 4082 and IS 456).

(iv) *Water :* An adequate supply shall be provided and when stored on the plant such storage facilities shall be designed to minimize the risk of contamination.

(v) *Chemical Admixtures :* Tanks or drums containing liquid admixtures shall be clearly labeled for identification purposes and stored in such a way to avoid damage, contamination or the effects of prolonged exposure to sunlight (if applicable). Agitation shall be provided for liquid admixture, which are not stable solutions.

5.9.6.2 *Batching Plants and Batching Equipment :* Hoppers for weighing cement, mineral admixtures, aggregates and water and chemical admixture (if measured by mass) shall consist of suitable container freely suspended from a scale or other suitable load-measuring device and equipped with a suitable discharging mechanism. The method of control of the loading mechanism shall be such that, as the quantity required in the weighing hopper is approached the material may be added at controllable rate and shut off precisely within the weighing tolerances specified in Annex C. The weighing hoppers for cement, mineral admixtures aggregate shall be capable of receiving their rated load, without the weighed material coming into contact with the loading mechanism. Where the rated capacity of a batching plant mixing cycle is less than 2.0 m^3, additional precautions shall be taken to ensure that the correct number of batches are loaded into the truck mixer. The weighing hoppers shall be constructed so as to discharge efficiently and prevent the build up of materials. A tare adjustment, up to 10 percent of the nominal capacity of the weigh scale, shall be provided on the weighing mechanism so that the scale can be adjusted to zero at least once each day. Dust seals shall be provided on cement hoppers between the loading mechanism and the weigh hopper, and shall be fitted so as to prevent the emission of cement dust and not affect weighing accuracy. The hopper shall be vented to permit escape of air without emission of cement dust.

Vibrator or other attachment, where fitted, shall not affect the accuracy of weighing. There shall be sufficient protection to cement and aggregate weigh hoppers and weighing mechanisms to prevent interference with weighing accuracy by weather conditions or external build-up of materials.

Where chemical admixture dispensers are used, they shall be capable of measurement within the tolerance in annex C and calibrated container or weigh scales shall be provided to check the accuracy of measurement at least once a month.

Where a continuous mixer with ribbon loading is used the batching procedure specified by the manufacture of the plant shall be followed.

Each control on the batching console and weigh-dial or display shall be clearly labeled with its function and where concerned with the batching of materials, the materials type.

When more than one type or grade of cement is being used, the weighing device and discharge screw or other parts of the transfer system shall be empty before changing from on type of cement to another.

When more than one type or grade of cement is being used, the weighing devised and discharge screw or other parts of the transfer system shall be empty before changing from on type of cement to another.

When pulverized fuel ash and other mineral admixtures are batched through the cement weigh system, the weighing device and discharge screw or other parts of the transfer system shall be empty when the weighing system has returned to zero reading or completed the batch.

Where a back weigh system is utilized to weigh materials a system shall be in place so as to prevent materials being loaded during the process of weighing.

5.9.6.3 ***Measurement of Materials :*** Cement and mineral admixture materials shall be measured by mass in a hopper or compartment separate from those used for other materials and on a scale of appropriate sensitivity, measurement being taken from a zero reading. Aggregates shall be measured by mass, allowance being made for the free moisture content of the aggregates. The added water shall be measured by volume or by mass. Any liquid chemical admixture (or paste) shall be measured by volume or by mass and any solid admixture by mass. When weighing materials any build up in the hopper during the day must be tared out or allowed for in the batch weights. After measurement all materials shall be discharged into the mixer without loss.

The accuracy of the measuring equipment shall be within $\pm$ 2 percent of the quantity of cement and mineral admixtures being measured and within $\pm$ 3 percent of the quantity of aggregate, chemical admixture and water being measured. The plant operator shall be provided with a clear display of the quantities of materials to be batched for each mix and batch size with information identifying the display to be selected for each designed and prescribed mix to be produced. Analogue scale displays for the weighing of cement, mineral admixtures, aggregates and water shall be readily discernable from the operating position. For digital readouts the numerals shall be readily discernable from the operating position .

Fully automatic production systems shall be fitted with control equipment to allow the correct operation of the plant to be monitored during weighing and batching. Automatic control systems on batching plants shall not commence batching until all hoppers have been emptied and /or tared and the scales zeroed unless such systems are designed to take account of build up in their programming.

All scales shall be tested and calibrated as per Annex C.

5.9.6.4 *Mixing*

(i) *Washing Out Water :* Before loading concrete materials or mixed concrete into either a stationary mixer or truck mixer any water retained in the mixing drum for washing out purposes shall be completely discharged.

(ii) *Stationary or Central Mixers :* Stationary mixers shall not be loaded in excess of the manufacturer's rated capacity. The mixing time shall be measured from the time all the materials required for the batch, including water, are in the drum of the mixer. The mixing time shall not be less than that recommended by the manufacturer. Where a continuous mixing plant is used, the complete mixing time shall be sufficient to ensure that the concrete is of the required uniformity.

(iii) *Truck Mixers :* When a truck mixer is used for the partial or complete mixing of concrete, mixing shall be considered to commence from the moment when all the materials required for the batch, including water, are in the rotating drum of the mixer.

Truck or agitators shall not be loaded in excess of the manufacturer's rated capacity. In order to produce a satisfactory mix, and where there is no data available to establish different period and speed of revolutions, mixing shall continue for not less than 60 revolutions of the truck mixer drum at a rate of not less than 7 revolutions/min. All completely truck mixed concrete shall be visually inspected for uniformity prior to leaving the plant.

When a truck mixer or agitator is used for transporting concrete which has been mixed before leaving the plant, the concrete shall be agitated during transit and remixed at the site for at least 2 min so that the concrete is of the required uniformity.

Where water is added to the concrete in the truck mixer through the truck mixer water meter and when such water is being accounted for in the total water within the mix, it shall be ensured that the truck mixer water meter is in operational condition and properly calibrated. Where a water meter is not available, water must be measured in a suitable container before being added to the truck mixer.

(iv) *Condition of Mixers :* Stationary and truck mixers shall be maintained in an efficient and clean condition with no appreciable build up of hardened concrete or cement in the mixing drum, on the mixing blades, or on the loading hopper or discharge chutes.

5.9.6.5 *Delivery Ticket :* Immediately before discharging the concrete at the point of delivery, the producer or his representative shall provide the purchaser with a preprinted delivery ticket for each delivery of concrete on which is printed, stamped or written the minimum information detailed invoicing as per Annex D.

5.9.7 Quality Control

Quality control of ready-mixed concrete may be divided into three components, forward control, immediate control and retrospective control.

5.9.7.1 *Forward control :* Forward control and consequent corrective action are essential aspects of quality control. Forward control includes the following.

(i) Control of purchased material Quality

(ii) Control of Materials storage

(iii) Mix design and mix design modification

(iv) *Transfer and Weighing Equipment :* The producer shall be able to demonstrate that a documented calibration procedure is in place. The use of elector-mechanical weighing and metering systems, that is, load cells, flow meters, magmeters, etc, is preferable over purely mechanical system, that is, knife edge and lever systems.

(v) Plant mixers where present and truck mixers used shall be in an operational condition.

5.9.7.2 ***Immediate Control :*** Immediate control is concerned with instant action to control the quality of the concrete being produced or that of deliveries closely following. It includes the production control and product control.

(i) *Production Control :* The production of concrete at each plant shall be systematically controlled. This is to ensure that all the concrete supplied shall be in accordance with these requirements and with the specifications that has formed the basis of the agreement between the producer and purchaser.

Each load of mixed concrete shall be inspected before dispatch and prior to discharge.

The workability of the concrete shall be controlled on a continuous basis during production and any corrective action necessary taken.
For each load, written, printed or graphical records shall be made of the mass of the materials batched, the estimated slump, the total amount of water added to the load, the delivery ticket number for that load, and the time the concrete was loaded into the truck.

Regular routine inspections shall be carried out on the condition of plant and equipment including delivery vehicles.

(ii) *Product Control :* Concrete mixes shall be randomly sampled and tested for workability and where appropriate, plastic density, temperature and air content. Where significant variations from target values are detected, corrective action shall be taken.

It is important to maintain the water cement ratio constant at its correct value. The amount of added water shall be adjusted to compensate for any observed variations in the moisture contents in the aggregates. Suitable adjustments should also be made in masses of the aggregates due to this variation (see IS 456). Any change in water content due to change in aggregate grading shall be taken care of by forward control by suitable modifications to mix design.

5.9.7.3 ***Retrospective Control :*** Retrospective control is concerned with those factors that influence the control of production. Retrospective control may cover any property of materials or concrete, such as aggregate grading, slump, or air content, but is particularly associated with 28-day cube strength because by its very nature it is not property which can be measured ahead of, or at the time of, manufacture.

5.9.7.4 ***Mix Performance :*** The producer shall be responsible for ensuring that suitable control procedures are in place ensure the following.

(i) *Design Mixes :* A quality control system shall be operated to control the strength of design mixes to the levels required as per IS 456 and shall be based on random tests of mixes which form the major proportion of production. The system shall include continuous analysis of results from cube tests to compare actual with target values together with procedures for modifying mix proportions to correct for observed differences. Compressive strength testing shall be carried out using a machine that meets the requirements of IS 14858.

(ii) *Prescribed Mixes :* Periodic and systematic checks shall be made to ensure that the cementitious material contents of prescribed mixes comply with their mix descriptions.

5.9.7.5 ***Stock Control of Materials :*** The producer shall operate a materials stock control procedure to enable verification of total quantities used and to confirm that only approved materials have been received.

5.9.7.6 ***Complaints :*** The producer shall have a procedure in place to enable the diagnosis and correction of faults identified from complaints.

5.9.8 Order Processing

A competent person to interpret the specified requirements and relate these to mix design criteria shall systematically review specification and orders supplied by the purchaser. These shall be formally recorded together with any modification to the specification resulting from subsequent agreed documentation to ensure that the plant operator is given the correct instructions for batching and mixing. When mixes or materials are offered as alternatives to requested mixes or where there is no specification supplied by the purchaser, orders whether received verbally or in writing, shall be agreed with the purchaser and the fact recorded. Alternatives to the mix description or compliance requirements in the purchaser's specification shall be clearly identified in the quotation.

5.9.9 Records

Records shall be maintained by the producer to provide confirmation of the quality and quantity and quantity of concrete produced. The records shall be retained for the purposes of these requirements for a period of at least one year. They shall cover the following aspect:

(a) Production and delivery:
  (i) Batching instruction
  (ii) Batching Records,
  (iii) Delivery tickets, and
  (iv) Equipment calibration and plant maintenance.

(b) Materials and production control:
  (i) Concrete production and materials purchase, usage and stocks, and
  (ii) Certificates or test results for materials.

(c) Production quality Contol: Control test results.

5.10 PLACING CONCRETE BY PUMPING

5.10.1 General

Concrete conveyed by pressure through either rigid pipes or flexible hoses and discharged directly into the desired area is termed as pumped concrete.

Method of applying pressure to concrete is by pumps. Pumps to be used shall be either of the two types as mentioned below:-

(A) Piston type pumps
(B) Squeeze pressure type pumps.

Compressed air pressure pumps shall not be used in the works.

5.10.2 Pumping Equipments

5.10.2.1 ***Piston Pumps*** : Piston pump to be used in the works shall consist of a receiving hopper for mixed concrete, an inlet valve, an outlet valve, and the pump shall be a twin-piston pump.

The two pistons shall be so arranged that one piston retracts when the other is moving forward and pushing concrete into the pipe line to maintain a reasonably steady flow of concrete. Single piston pumps shall not be acceptable.

Inlet and outlet valve shall be any one of the following types:-

- Rotating plug type
- Sliding plate type
- Guided plunger type
- Swing type
- Flapper type

- Or any combination of the above.

The pistons shall be mechanically driven using a crank or chain or hydraulically driven using oil or water.

The receiving hopper shall have a minimum capacity of 1.0 cum and the hopper shall be fitted with remixing rotating blades capable of maintaining consistency and uniformity of concrete.

The primary power for pumps may be supplied by gasoline, diesel, or electric motors.

The primary power unit and the pump unit may be truck, trailer or skid mounted.

5.10.2.2 ***Squeeze Pressure Pumps :*** Squeeze pressure pumps shall consist of a receiving hopper fitted with re-mixing blades. Re-mixing blades shall be such that these can push the concrete into the flexible hose connected at the bottom of the hopper.

The flexible hose shall pass through a metal drum around the inside periphery of the drum and come out through the top part of the drum.

The drum shall be maintained under a very high degree of a vacuum during operation. The drum shall be so fitted with hydraulically operation metal rollers., which when rotating, create a squeeze pressure on the flexible hose carrying concrete and forces the concrete out into the pipe line.

5.10.2.3 ***Effective Range and Discharge of Pumps :*** Effective range of pumps to be used in the work shall be decided after studying the site conditions. However, the minimum horizontal range shall not be less than 150 metres and minimum vertical range shall not be less than 50 metres.

Selection of pumps bases on discharge capacity shall be decided after studying the requirements for the project. Discharge capacity shall be worked out by the contractors and approval obtained from the Engineer-in-Charge. As a guide line figure the contractor may assume a discharge capacity of 15 cubic metre/hour/pump.

5.10.2.4 ***Pipe Lines :*** All concrete carrying pipe lines shall generally be rigid pipe lines. Flexible pipe lines may only be used at bend curves in lines or at discharge ends if required. Placements of flexible units shall be done judiciously and connected to the pipe lines only when it meets the approval of the Engineer-in-Charge.

(i) ***Rigid Line/ Hard Line/ Slick line :*** Such lines shall be made either of steel or plastic. Aluminum alloy pipes shall not be used.

Minimum pipeline diameter shall be 100 millimeters and shall have normal maximum length of 3 metre in each section connected through couplers.

(ii) ***Flexible Pipe Line*** *:* Flexible lines shall be made out of rubber or spiral wound flexible metal or plastic. The pipe shall again be such that they are in sections of 3 metre length each and connected through couplers. These pipes shall be such that they are interchangeable with rigid lines. While installing flexible units, care shall be taken that there are no links in the pipeline, which is a normal tendency with these pipes having diameter 100 mm and above.

5.10.2.5 ***Couplers :*** Couplers to be used for connecting pipe line sections (either hard or flexible) shall have adequate strength to withstand stresses due to handling, misalignments, poor support to pipe lines etc.

For horizontal runs of pipes and for vertical run upto 30 metre height the couplers shall be rated for a minimum pressure of 35 kg/ cm square. Couplers used for rising runs between 30 metre and 50 metre heights shall have a minimum pressure rating of 50 kg/cm square. Couplers shall be designed to allow for replacement of any pipe section without displacing other sections. These

shall provide for the full internal cross section. These shall provide for the full internal cross section with no constructions or service. Which may disrupt the smooth flow of concrete. For pipelines of size 150mm and above, double togged type coupler with a thick rubber gasket and secondary wedge-take-up is recommended. Types of couplers that may be used shall be any of the following:-

- Grooved end coupler
- One piece extended lever swing type couplers
- And full flow oil line type couplers.

5.10.2.6 ***Other Accessories :*** Other accessories which shall be catered for, are as under:-

(a) Back up pump of rigid and flexible pipes of varying lengths of similar rating/specifications

(b) Curved sections of rigid pipes

(c) Swivel joints and rotary distributors

(d) Pin and gate valves to prevent back flow in pipe lines

(e) Switch valves to direct the flow into another pipe line

(f) Connection devices to fill forms from the bottom up

(g) Splints, rollers, and other devices for protection of conduit over rock concrete Reinforcing steel and form and to provide lifting and lashing points in the pipe line.

(h) Transitions for connecting different sizes of pipe sections

(i) Air vents for downward pumping.

(j) Clean out equipment.

For concreting of columns, walls and scattered small placement, recommendation is made for special cranes or power controlled booms carrying pipe lines with a pendant type concrete delivery hose.

5.10.2.7 Lubricating of Pipe Line

Before pumping concrete into the pipeline, the line shall be lubricated with a properly designed mortar/grout lubricant. This shall be ensured by starting the pumping operation with a properly designed mortar, or with a batch of regular concrete with the coarse aggregate omitted. The quantity of mortar required as lubricant is dependent on the smoothness and cleanliness of the pipelines. As a guide line, for a 100 mm diameter pipe line of 100 metre length, 0.08 cum to 0.10 cum of mortar should normally be adequate, but this shall not be taken as specified, and the contractor shall establish his requirements.

The quantity of mortar that comes out of the delivery end of the pipeline shall not be used in place of the concrete work. However, with the approval of Engineer-in -Charge, this mortar may be used as bedding mortar against construction joints. The rest of the mortar shall be wasted.

Lubrication shall be maintained as long as the pumping of concrete continues.

5.11 GUIDELINES FOR FIELD PRACTICE

5.11.1 *General Precautions*

(i) Proper planning of concrete supply, pump locations, line layout, placing sequence and the entire pumping operation will result in savings of time and expense.

(ii) The pump shall be placed as near the placement area as practicable. The surrounding area of the pump shall be free of obstructions to allow for movement of concrete delivery trucks. The surface must be strong enough to withstand the loaded trucks operating on it. If the surface is a suspended slab, the truck route shall be adequately supported in consultation with the Engineer-in-Charge.

(iii) Pipe lines from the pump to the placing area shall be laid with minimum number of bend. For large placement areas, alternate lines shall be installed for rapid connection when required. A flexible pipe at the discharge end will permit placing over a large area directly without re-handling of pipelines. The pipeline shall be firmly supported.

(iv) If more than one size of pipe must be used, the smaller diameter pipe shall be placed at the pump end and the larger diameter at the discharge end.

(v) When pumping downwards, an air release valve shall be provided at the middle of the top bend to prevent vacuum or air buildup. Similarly, while pumping upwards, a no-return valve shall be provided near the pump to prevent the reverse flow of concrete.

(vi) It is essential that direct radio/telecommunication be maintained between the pump operator and the concrete placing crew. Good communication between the pump operator and the batching-plant is also essential. The placing rate shall be estimated by the pump operator so that concrete can be ordered at an appropriate delivery rate.

(vii) The pump shall be started for a check run and operated without concrete to ensure that all moving parts are in operation properly. Before placing concrete, the pump shall be run with some grout/mortar for lubricating the line.

(viii) When concrete is received in the hopper, the pump shall be run slowly until the lines are completely full and the concrete is steadily moving. A continuous pumping must be ensured, because, if the pump is stopped, concrete in the line may be difficult to move again.

(ix) When a delay occurs because of concrete delivery or some form repair works or for any other reason, the pump shall be slowed down to maintain some movement of concrete in the pipe line. For longer delays, concrete in the receiving hopper shall be made to last as long as possible by moving the concrete in the lines occasionally with intermittent strokes of the pump. It is sometimes essential to run a return line back to the pump so that concrete can be re-circulated during long delays.

(x) If after a long delay, concrete cannot be moved in the line, it may be necessary to clean out the entire line. However, quite often only a small section of pipe line may be plugged and requires cleaning. The pump operator who know such details as the length of line, age of concrete in the line etc., should be depended upon to aid in deciding the appropriate section to be cleaned.

(xi) When the form is nearly full, and there is enough concrete in the line to complete the placement, the pump shall be stopped and a “go devil” inserted at the appropriate time so that concrete ahead of the go-devil shall be forced completion of the work. The go-devil shall be forced through the pipeline to clean it out. Use of water pressure is a safer method. The go-devil shall be stopped at the discharge end to ensure that water does not spill on the placement area, if air pressure is used, extreme care shall be taken and the pressure must be carefully regulated. A trap shall be installed at the end of the line to prevent the go-devil being ejected as a dangerous projectile. An air release valve shall also be installed in the line to prevent air pressure build up.

(xii) It is essential to clean the line after concrete placing operation is complete. Cleaning shall be done in the reverse direction from the form work end to the pump-end where the concrete in the
line can be dumped in bucket. After removal of all concrete, all pipe lines and other equipments shall be cleaned thoroughly and made ready for the next use.

5.11.2 Submittals

Along with their bid the contractors shall be required to submit the following information regarding the equipments proposed to be used by them:-

(i) Type, number, capacity, range, mounting, nature of primary power used and the operating weight of pump and mounting.

(ii) Manufacturer's specifications for pipe lines giving pressure ratings, sizes and material for straight and curved sections.

(iv) Manufacturer's certificates.

5.11.3 Sampling and Testing (Materials)

5.11.3.1 *Aggregates*

(i) Supplier of aggregates shall furnish the following information before the material is delivered to site:-
- Precise location of source from where the material is to be supplied.
- Trade group of principal rock type as per table 5.7 below :
- Presence or reactive minerals

TABLE 5.7

Trade group name of Aggregates to be used for concrete	: Granite, Gabbro, : Dolerite, Rhyolite, Basalt, Quartzite, Gneiss.

(ii) The supplier shall also furnish reports on test results giving the following information for approval to Engineer-in-Charge before delivery of material at site:-
Specific gravity Bulk
density Moisture
content Absorption
Value Aggregate
crushing strength
Aggregate impact
value Abrasion value
Flakiness index
Elongation index
Limits of deleterious substances in the aggregate
Soundness of aggregate
Potential reactivity of aggregates.

All tests shall be conducted in accordance with IS 2386 (Part-I to VIII).

(iii) Change in quality of aggregate as per trade group name shall not be acceptable in the work. Change in source of aggregates shall also not be acceptable under normal circumstances, even if the aggregate belong to the same trade group. Engineer-in-Charge may with his discretion allow a change in the source. But, in that case, all test mentioned in para 5.8.9.1.2 above shall have to be repeated for the aggregates form the changed source and

the test results submitted to Engineer-in-Charge for his approval before the delivery of material at site.

(iv) In addition to above, the following tests have to be performed on representative samples from every lot of aggregate after delivery at site. These test results are to be submitted to the Engineer-in-Charge for his approval. Acceptance criteria for aggregates shall be based on the
results of this set of tests only. If in the opinion of the Engineer-in-Charge, the test results are not with in permissible limits, the lot of aggregates from which the samples have been obtained for testing shall stand rejected and the material shall be removed from the site.

Mandatory tests on Aggregates at site

Tests	*Nos. of test on each 50 cum of Material or part thereof*
1. Specific gravity	3
2. Bulk density	3
3. Aggregate crushing strength	3
4. Limits of deleterious substances	3
5. Aggregate impact value	3

Mean value of the results from above test shall be taken as the representative value and the acceptance criteria shall be based on these. All test procedures and computations for test results shall be as per IS 2386.

(v) All other tests in para iv being in compliance with requirements set in specifications, if only the limits of deleterious substances do not meet the requirements, and attempt may be made to wash the aggregate to bring the limits within permissible values. Under such circumstances, moisture content check shall be made and allowance made before batching.

(vi) Apart from mandatory tests specified above, the Engineer-in-Charge may at his discretion, call for any additional tests that he may consider necessary. Sampling, procedure and computations for such test shall be done in accordance with IS 2430 and IS 2386 as applicable.

5.11.3.2 ***Cement*** *:* Supplier of cement shall furnish the following documents before the cement is delivered to site:-

(i) Certificate confirming that chemical composition and physical characteristics are within the stipulated values for types of cement supplied as per relevant codes.

(ii) Certificate confirming that the chloride content in the cement is not in excess of 0.05 percent of mass of cement.

(iii) If during subsequent testing of cement supplied in lots any of the properties are found to be outside the acceptable limits, the lot of cement shall be rejected.

(iv) Each 1000 bags or part thereof the cement or each wagon load of cement shall constitute one lot of cement for the purpose of conducting tests at site before cement is accepted.

(v) Samples for testing at site shall be taken at random from 2% of the total quantity supplied in one lot. For cement supplied in bags, samples shall be drawn from minimum of 5 bags and the 2% value shall be rounded off to the next higher integer.

For bulk cement, sampling shall be done with the help of slotted sampler to be as per IS 3535.

(vi) Results of test conducted on samples drawn shall be submitted to the Engineer-in-Charge for his approval. If in the opinion of the Engineer-in-Charge, the test results are not within permissible limits, the lot of cement from which samples have been obtained from testing shall stand rejected and the material shall be removed from site.

(vii) Following tests shall be conducted at site on each lot of cement delivered:-

Mandatory tests	*Number of test per lot*
1. Consistency of standard cement paste	5
2. Initial and final setting time	5 each
3. Compressive strength test	10

Mean values of the results from the above results shall be taken as the representative value and the acceptance criteria shall be based on these test. All test procedures and computation of test results shall be as per IS 4031.

(viii) Apart from mandatory tests specified above, the Engineer-in-Charge may at his discretion, call for any additional tests that he may consider necessary. All such tests shall be done on representative samples taken from each lot and testing and computation of test results shall be done as per IS 4031.

5.11.3.3 *Water*

(i) Water to be used in manufacturing and curing of concrete shall be tested before use. All such test results shall be submitted to the Engineer-in-Charge for his approval before water is used.

(ii) Manufacturer/ Contractor responsible for curing concrete shall identify and inform the Engineer-in-Charge, precisely the location of source of water intended to be used. Each such source of water shall be separately tested. In the event of a change in the source of water all tests specified herein shall have to be repeated.

(iii) In the event water is drawn from tube wells or open-wells, water samples shall be tested for seasonal fluctuations in water table or at intervals to be directed by the Engineer-in-charge.

(iv) Water sample from each source shall be tested as under:-

Test	*Number of test for each source*
Acidity	3
Alkalinity	3
Presence of solids	3

Mean values of the above test shall be taken as the representative value and the acceptance criteria shall be based on these test results. All testing procedure and computation of test results shall conform to IS 3025.

5.11.3.4 *Admixtures*

(i) Suppliers of Admixtures for concrete shall supply the following before any admixtures is approved by the Engineer-in-Charge for their used:-

Certificate confirming that the use of a particular brand of admixture shall not be harmful to concrete in any way.

Certificate confirming the exact dosage of admixture of a particular brand. Certificate stating the specific purpose for which the admixture is to be used.

Special precautionary measures to be taken in the manufacturer of concrete when using the particular brand of admixture.

Certificate confirming that the admixture conforms to specifications of IS 9103 or to ASTM-C260, ASTM – C10, ASTM – C 595 or to ASTM- C 618.

(ii) Engineer-in-Charge at his discretion may require tests to be performed to reconfirm the characteristic properties of any admixture. All such tests shall be done in accordance with IS: 9103.

(iii) All tests described in paras 5.4.8 to 5.4.10 above shall be done at the site laboratory or at a laboratory to be identified by the Engineer-in-Charge depending on the test to be conducted.

(iv) All test shall be done in the presence of a representative nominated by the Engineer-in-Charge and a representative of the concrete Manufacturer/ Contractor when tests are performed at the site laboratory. All observation and reports of test shall be jointly signed by the two representatives before the test results are submitted to the Engineer-in-Charge.

(v) Expenses for all materials used for testing, sampling procedures and testing including preparing reports shall be borne by the concrete Manufacturer/ Contractor.

(vi) Rate of concrete is inclusive of cost of admixtures. The contractor shall not be paid anything extra for admixtures required for achieving direct workability without any change in specified water cement ration for RCC/CC work.

5.11.4 Sampling and Testing for Quality Control of Fresh Concrete

Fresh concrete shall be tested for

(a) Slump

(b) Compacting Factor/ Workability

(c) Consistency

(d) Weight per cubic metre, cement factor and air content

5.11.4.1 *Slump*

(i) For concrete totally mixed in a central plant, slump shall be checked at:-

(a) Immediately during loading of trucks

(b) Point of discharge from the delivery truck

(c) Final placement location

(d) At placement location the slump measured shall conform to the design slump. Manufacturer of concrete shall adjust for loss of slump in transit and establish the requirements of design mix. All slump measurements shall be done within a period of 20 minutes from the time cement is added to the mixer. Placement contractor shall transport concrete from truck discharge point to actual placement location within 10 minutes of delivery, before the final slump reading is taken at placement location.

(ii) For concrete entirely mixed in transit or for shrink mix concrete, slump reading shall be taken at:-

(a) Point of discharge from delivery trucks

(b) Final placement location

In this case also, the slump measured at the final placement location shall conform to the design slump. The placement contractor shall be responsible for transporting concrete from delivery truck discharge point to final placement location within 10 minutes. However, in this case, the truck shall discharge the concrete within 1 hour and 30 minutes from the time cement is added in the mixer and slump measured at point of discharge immediately on delivery. Manufacturer of concrete shall ensure that the final slump measurement corresponds to the ordered slump.

(iii) For measuring concrete slump at point of discharge from delivery trucks, samples shall be taken from concrete omitting the first and the last 15% of the load. For concrete delivery of placed by pumping, sampling shall be similar to those specified for delivery trucks.

(iv) Slump measurements of ready mix concrete transported by buckets shall be at locations specified in para 5.11.4.1 with same limits on time. Sampling from buckets shall be such that the buckets containing discharge from mixer for the last 15% are omitted.

(v) At placement locations, samples for checking slump shall be collected from every 20 cum of concrete or part thereof placed at location for each type to concrete.

(vi) For all slump checks in the field at least two recordings shall be made and the average value taken as the recorded slump.

(vii) Slump checks for concrete in the laboratory shall be carried out as and when required by the manufacturer of concrete during the mix design stage and during the progress of work for control on field results.

(viii) Slump readings shall only be a guideline for concrete consistency and shall not be taken as the acceptability criteria for concrete placed at location. All slump test shall be carried out in accordance with IS 1199.

5.11.4.2 ***Compacting Factor***

(i) For concrete whose ordered slump is 50 mm or less, compacting factor test shall be conducted at both field and central batch plant in addition to slump tests mentioned above.

(ii) Compacting factor check shall be done in field only at placement location, and shall also be conducted at central batch plant if concrete is totally mixed in plant.

(iii) For this test, sampling shall be done as for slump measurements in field and within the same frame as for slump test.

(iv) Only one compaction factor test shall be conducted for every 20 cum of concrete or part thereof placed at location for each type of concrete. Since the test is sensitive, every care shall be taken to conduct this test totally in compliance with procedure mentioned in IS 1199.

(v) Laboratory tests for determining compacting factor of concrete shall be done as per manufacturer's requirements for establishing and controlling the design mix of concrete.

(vi) Compacting factor test shall not be taken as an acceptance criteria and shall be treated only as a guideline to workability of concrete.

5.11.4.3 ***Consistency of Concrete :*** This test shall be performed only at the batching plant laboratory using a Vee -Bee Consist meter, for determining and predicting the slump of concrete. Number and frequency of these tests shall be based on requirements of the manufacturer of concrete. Care shall be taken in producing mix design of required characteristic strengths of concrete within limits of Vee-Bee - Degrees between 1.6 and 4.5 for concrete transported and placed by normal method and between 0.8 and 3.5 for concrete transported and placed by pumping methods.

5.11.4.4 ***Weight, Cement Factor and Air contents Test*** *:* Freshly mixed concrete for every type shall be tested in the batch plant laboratory for each batch of concrete produced to determine weight per cubic metre of freshly mixed concrete, cement factor in concrete and the air content of the concrete. Frequency and number of test shall be finalized by the manufacturer of concrete in consultation with the Engineer-in-Charge for his requirement of the mode of measurement of concrete produced.

The Engineer-in-Charge may at his discretion require further tests over and above those specified above in para 5.11.4.1 to be conducted on fresh concrete. The manufacturer and the placement contractor shall have to comply with all such requirements.

5.11.5 Sampling and Testing for Quality Control of Hardened Concrete

(i) Test on cube crushing strength of concrete in accordance and compliance with IS 456 and IS 516 shall done as under:-

(a) Sample of fresh concrete shall be taken from concrete at central batch plant mixer while loading delivery trucks or other transport and also from concrete transported to placement location.

(b) Test on specimens made form samples collected at placement location shall be considered as field test specimens and results therefrom shall be the criterion of concrete strength. Test in specimens made from samples at the batch plant shall only be taken as guidelines test. Only in the case of doubtful result, the Engineer-in-Charge may refer to such guideline results for deciding on the quality of concrete.

(c) For truck mix concrete and shrink mix concrete guideline test specimens shall be made from samples collected at discharge location from mixing trucks. For this purpose first and last 15% of the load shall be omitted while collecting samples.

(d) Frequency of sampling shall be as given below in Table 5.8 for each grade of concrete of different workability's and for each type of specimens (field test specimens and guideline test specimens) for conducting 28 days crushing strength tests.

TABLE 5.8

Quantity of concrete Delivered (cum)	*Number of samples*
Less than 5	1
6 to 15	2
31 to 50	3
51 and above sample for each	4 plus one additional 50 cum or part thereof

Each sample shall be of adequate quantity so that a minimum of 3 specimen cubes can be made test of the sample in accordance with IS 516.

(e) All test specimens shall be made compacted cured and tested in compliance with IS 516 and test result interpreted in accordance with IS 456 for acceptance of concrete strength, field specimens test results shall not be less than values given in Table 5.6.

(f) In addition to 28 day crushing strength test on specimens made at frequencies specified in para 4 above, early strength tests at 7 days shall also be conducted on field specimens as well as guideline test specimens. Frequency of sampling for this set of test shall also be same as those specified in Table 5.8 above. 7 day strength shall conform to values given in Table 5.5. But these test results even if conforming to specified values shall only be taken a guideline values for projecting concrete strength and shall not be construed as conforming to specifications.

(g) For each grade of concrete and for all workability conditions with different water – cement ratios and compositions of admixtures, preliminary test shall be conducted for crushing strength on finalization to design mix for each type of concrete. Such test shall be conducted both at 7 days and 28 days under laboratory conditions. Six test specimens shall be made for 7 days test and six test specimens shall be made for 28 days test.

Average of the six test results of different periods shall not be less than those specified in Table 5.5.

(h) Crushing strengths on cubes shall also be conducted during the process of finalization of concrete design mix. Frequency and number of such tests shall be as per Mix of requirements of concrete manufacturer.

(i) All test specimens for conducting crushing strength shall be properly labeled for identification indicating:-

(i) Date of making specimen

(ii) Grade of concrete

(iii) Placement location exact

(iv) Purchasers order number

(j) In addition to crushing strength test on concrete, the Engineer-in-Charge may call for other tests on hardend concrete. The placement contractor and the manufacturer of concrete shall comply with all such instructions.

(ii) Non-destructive Tests

(a) When the 28 days crushing values on field specimens and/ or specimens and/or specimens made for guideline test fall short of specified values, or in case of doubtful placement of concrete, the Engineer-in-Charge shall call for non-destruction tests on the structure. Such tests may be any one or a combination of the following:-

- Rebound hammer test
- Windsor Penetration Probe test
- Pulse velocity (sonic or Ultrasonic) test
- Core test
- Load test

(b) Interpretation of rebound hammer, Windsor Probe and Pulse velocity test results shall rest with the Engineer-in-Charge.

(c) Core test, if ordered by the Engineer-in-Charge, shall be done in accordance with IS 516. Samples for such test shall be taken from locations to be identified by the Engineer-in-Charge and such samples shall be collected in compliance with IS:1199.

(d) If felt necessary, the Engineer-in-Charge may instruct load testing for any part of the structure based on doubtful concrete strengths. Such test shall be carried out as per details to be provided by the Engineer-in-Charge in consultation with the structural consultants.

(e) The concrete manufacturer/ concrete placement contractor shall arrange for all test to be conducted in accordance with these specifications, including all necessary tools, plants, equipment and material, and shall be responsible for conducting all test at his cost.

(f) All test conducted at the filed laboratory shall be carried out by qualified technicians employed by the concrete manufacturer/ concrete placement contractor, in presence of authorized representative of the Engineer-in-Charge. All test reports and observation reports shall be jointly signed by the Engineer-in-Charge authorized representative and the technician conducting such test.

(g) Engineer-in-Charge shall alone decide where such tests are to be conducted. He may instruct tests to be conducted at laboratories other than the field laboratory and such instructions shall be followed without claiming extra charges on this account.

(h) The Concrete Manufacturer/ Placement contractor shall set up a laboratory at this own expense which shall have facilities, for conducting all necessary field test on materials and field and laboratory test on concrete. The laboratory shall be staffed by the concrete Manufacturer/ Placement Contractor with qualified and experienced scientists and technicians.

5.12 EXPANSION JOINT SYSTEM

5.12.1 FLOOR JOINT

5.12.1.1 General requirement of material

The expansion joint system will be of extruded aluminum base members, self aligning /self centering arrangement and support plates etc. as per ASTM B221-02. The system shall be such that it provides floor to floor/ floor to wall expansion control system for various vertical locations in load application areas that accommodate multi directional seismic movement without stress to its components. The system shall consist of metal profiles with universal aluminum base member designed to accommodate various project conditions and finish floor treatments. The cover plate shall be designed of width and thickness required to satisfy projects movement and loading requirements and secured to base members by utilizing manufacturer's pre-engineered self centering arrangement that freely rotates/ moves in all directions. The self-centering arrangements shall exhibit circular sphere ends that lock and slide inside the corresponding aluminum extrusion cavity to allow freedom of movement and flexure in all directions including vertical displacement. Provision of moisture barrier membrane in the joint system to have water tight joint is mandatory requirement. The scope of work includes all labour, materials, equipments and services and perform all operations required for complete installation of expansion joint system.

5.12.1.2 Performance Requirement: Material and works shall conform to the latest edition of reference specifications as specified in the item and to all applicable codes and requirement of local authorities having jurisdiction.

5.12.1.3 Approval of expansion joint system : Sample of expansion joint system along with manufacturers latest published literature for material specified herein, material test reports, shop drawings etc. shall be submitted for obtaining approval before material are delivered at the site. The expansion joint cover assembly should be from one source (from single manufacturer)

5.12.1.4 Installation of expansion joint system: In all cases the manufacturer's standard written instruction or specific instructions for installation shall be followed.

5.12.1.5 Measurement : The length of expansion joint shall be measured, correct to a cm.

5.12.1.6 Rate : The rate shall be inclusive of all material and labour involved in providing & fixing of expansion joint.

5.12.2 WALL JOINT

5.12.2.1 General requirement of material

The expansion joint system related with wall joint (internal/ external) shall be of extruded aluminum base members, self aligning / centering arrangement and support plates as per ASTM B221-02. The material shall be such that it provides an Expansion joints systems suitable for vertical wall to wall/ wall to corner application, both new and existing construction in office buildings & complexes with no slipping down tendency amongst the components of the joint system. The Joint System shall utilize light weight aluminum profiles exhibiting minimal exposed aluminum surfaces mechanically snap locking the multicellular to facilitate movement. (Material shall confirm to ASTM 6063)

5.12.2.2 Performance Requirement: Material and works shall conform to the latest edition of reference specifications as specified in the item and to all applicable codes and requirement of local authorities having jurisdiction.

5.12.2.3 Approval of expansion joint system : Sample of expansion joint system along with manufacturers latest published literature for material specified herein, material test reports, shop drawings etc. shall be submitted for obtaining approval before material are delivered at the site. The expansion joint cover assembly should be from one source (from single manufacturer)

5.12.2.4 Installation of expansion joint system: In all cases the manufacturer's standard written instruction or specific instructions for installation shall be followed.

5.12.2.5 Measurement : The length of expansion joint shall be measured, correct to a cm.

5.12.2.6 Rate : The rate shall be inclusive of all material and labour involved in providing & fixing of expansion joint.

5.12.3 ROOF JOINT

5.12.3.1 General requirement of material

Theexpansion joint system for various roof locations shall be of extruded aluminum base members with, self aligning and self centering arrangement support plates as per ASTM B221-02. The system shall be such that provides that is capable to accommodating multidirectional seismic movement without stress to its components. System shall consist of metal profile that incorporates a universal aluminum base member designed to accommodate various project conditions and roof treatments. The cover plate shall be designed of width and thickness required to satisfy movement and loading requirements and secured to base members by utilizing manufacturer's pre-engineered self-centering arrangement that freely rotates/ moves in all directions. The self centering arrangement shall exhibit circular sphere ends that lock and slide inside the corresponding aluminum extrusion cavity to allow freedom of movement and flexures in all directions including vertical displacement. The joint system shall resists damage or deterioration from the impact of allying ice, exposure to UV, airborne contaminants and occasional foot traffic from maintenance personnel. Provision of moisture barrier membrane in the joint system to have water tight joint is mandatory requirement.

5.12.3.2 Performance Requirement: Material and works shall conform to the latest edition of reference specifications as specified in the item and to all applicable codes and requirement of local authorities having jurisdiction.

5.12.3.3 Approval of expansion joint system : Sample of expansion joint system along with manufacturers latest published literature for material specified herein, material test reports, shop drawings etc. shall be submitted for obtaining approval before material are delivered at the site. The expansion joint cover assembly should be from one source (from single manufacturer)

5.12.3.4 Installation of expansion joint system: In all cases the manufacturer's standard written instruction or specific instructions for installation shall be followed.

5.12.3.5 Measurement : The length of expansion joint shall be measured, correct to a cm.

5.12.3.6 Rate : The rate shall be inclusive of all material and labour involved in providing & fixing of expansion joint.

CUBE TEST FOR COMPRESSIVE STRENGTH OF CONCRETE - MANDATORY LAB TEST
(Clause 5.4.9.1)

A-0 One sample (consisting of six cubes 15x15x15 cm shall be taken for every 20 cum or part thereof concrete work ignoring any part less than 5cum or as often as considered necessary by the Engineer-in-Charge. The test of concrete cubes shall be carried out in accordance with the procedure as described below. A register of cubes shall be maintained at the site of work in Appendix C. The casting of cubes, concrete used for cubes and all other incidental charge, such are curing, carriage to the testing laboratory shall be borne by the contractors. The testing fee for the cubes, if any, shall be borne by the department.

A-1 Test Procedure

A-1.1 ***Mould***

The mould shall be of size 15 cmx15 cmx15 cm for the maximum nominal size of aggregate not exceeding 40 mm. For concrete with aggregate size more than 40 mm size of mould shall be specified by the Engineer- in-charge, keeping in view the fact that the length of size of mould should be about four times the size of aggregate.

The moulds for test specimens shall be made of non- absorbent material and shall be substantially strong enough to hold their form during the moulding of test specimens. They shall not vary from the standard dimensions by more than one percent. The moulds shall be so constructed that there is no leakage of water from the test specimen during moulding. All the cube moulds for particular site should, prior to use, be checked for accuracy in dimensions and geometric form and such test should at least be made once a year.

Each mould shall be provided with a base plate having a plane surface and made of non-absorbent material. This plate shall be large enough in diameter to support the moulds properly without leakage. Glass plates not less than 6.5mm thick or plain metal not less than 12mm thick shall be used for this purpose. A similar plate shall be provided for covering the top surface of the test specimen when moulded.

Note: Satisfactory moulds can be made from machine or steel castings, rolled metal plates or galvanized.

A-1.2 ***Sample of Concrete***

Sample of concrete for test specimen shall be taken at the mixer or in the case of ready mixed concrete from the transportation vehicle discharge or as directed by Engineer-in-Charge. Such samples shall be obtained by repeatedly passing a scoop or pail through the discharge stream of concrete. The sampling operation should be spread over evenly to the entire discharging operation. The samples thus obtained shall be transported to the place of moulding of the specimen to counteract segregation. The concrete shall be mixed with a shovel until it is uniform in appearance. The location in the work of the batch of concrete this sampled shall be noted for further reference. In case of paving concrete, samples shall be taken from the batch immediately after deposition of the sub grade. At least five samples shall be taken from different portion of the pile and these samples shall be thoroughly mixed before being used to form the test specimen. The sampling shall be spread as evenly as possible throughout the day. When wide changes occur during concreting, additional sample shall be taken if so desired by the Engineer-in -Charge.

A-1.3 *Preparation of Test Specimens*

The interior surfaces of the mould and base plate shall be lightly oiled before the concrete is placed in the mould. The samples of concrete obtained as described under the test specimen shall be immediately moulded by one of the following methods as indicated below:-

When the job concrete is compacted by manual methods, the test specimen shall be moulded by placing the fresh concrete in the mould in three layers, each approximately one third of the volume of the mould. In placing each scoopful of concrete the scoop shall be moved around the top edge do the mould as the concrete there sided from it, in order to ensure a uniform distribution of concrete within the mould. Each layer shall be rodded 35 times with 16 mm rod, 60 cm in length, bullet pointed at the lower end. The strokes shall be distributed in uniform manner over the cross section of the mould and shall penetrate into underlying layer. The bottom layer shall be rodded through its depth. After the top layer has been rodded, the surface of the concrete shall be struck off with a trowel and covered with a glass plate at least 6.5 mm thick or a machined plate. The whole process of moulding shall be carried out in such a manner as to preclude the change of the water cement ratio of the concrete, by loss of water either by leakage from the bottom or over flow from the top of the mould.

When the job concrete is placed by vibration and the consistency of the concrete is such that the test specimens cannot be properly moulded by hand rolling as described above, the specimens shall be vibrated to give a compaction corresponding to that of the job concrete. The fresh concrete shall be placed in mould in two layers, each approximately half the volume of the mould. In placing each scoopful of concrete the scoop shall be moved around the top edge of the mould as the concrete there slides from it, in order to ensure a symmetrical distribution of concrete within the mould. Either internal or external vibrators may be used. The vibration of each layer shall not be continued longer than is necessary to secure the required density. Internal vibrators shall only be used when the concrete is required to be compacted in layers. In compacting the first layer, the vibrators shall not be allowed to rest on the bottom of the mould. In placing the concrete for top extent that there will be no mortar loss during vibrations. After vibrating the second layer enough concrete shall be added to bring level above the top of the mould. The surface of the concrete shall then the struck off with a trowel and covered with a glass or steel plate as specified above. The whole process of moulding shall be carried out in such a manner as to preclude the alteration of water-cement ratio of the concrete by loss of water, either by leakage for the bottom or over flow from the top of the mould.

A-1.4 *Curing and Storage of Test Specimen*

In order to ensure reasonably uniform temperature and moisture conditions during the first 24 hours for curing the specimen and to protect them from damage, moulds shall be covered with wet straw or gunny sacking and placed a storage box so constructed and kept on the work site that its air temperature when containing concrete specimens shall remain 22ºC to 33ºC. Other suitable means which provide such a temperature and moisture conditions may be used.

Note:- It is suggested that the storage box be made of 25 mm dressed tongued and grooved timber, well braced with battens to avoid warping. The box should be well painted inside and outside and should be provided with a hinged cover and padlock.

The test specimen shall be removed from the moulds at the end of 24 hours and stored in a moist condition at a temperature within 24ºC to 30ºC until the time of test. If storage in water is desired, a saturated lime solution shall be used.

A-1.5 *Testing*

The specimens shall be tested in accordance with procedure as described below:

(a) The tests shall be made at an age of concrete corresponding to that for which the strengths are specified.

(b) Compression tests shall be made immediately upon removal of the concrete test specimen from the curing room i.e. the test specimen shall be loaded in damp condition. The dimensions of the test specimens shall be measured in mm accurate to 0.5 mm.

(c) The metal bearing plates of the testing machine shall be placed in contact with the ends of the test specimens. Cushioning materials shall not be used. In the case of cubes, the test specimen shall be placed in the machine in such a manner that the load is applied to sides of the specimens as cast. An adjustable bearing block shall be used to transmit the load to the test specimen. The size of the bearing block shall be the same or slightly larger than that of test specimen. The upper or lower section of the bearing block shall be kept in motion as the head of the testing machine is brought to a bearing on the test specimen.

(d) The load shall be applied axially without shock at the rate of approximately 140 kg. per sq.cm. per minute. The total load indicated by the testing machine at failure of test specimen shall be recorded and the unit compressive strength is calculated in kg per sq. cm. using the area computed from the measured dimension of the test specimen. The type of failure and Appearance of the concrete shall be noted.

APPENDIX B

ADDITIONAL TESTS FOR CONCRETE
(Clause 5.4.9.2)

B-0 In case the concrete fails when tested as per the method prescribed in Appendix A, one or more of the following check tests may be carried out at the discretion of Engineer-in-Charge to satisfy the strength of the concrete laid. All testing expenditure shall be borne by the contractor, the number of additional tests to be carried out shall be determined by the Engineer-in-Charge. He shall be the final authority for interpreting the results of additional test and shall decide upon the acceptance or otherwise. His decision in this regard shall be final and binding. For the purpose of payment, the Hammering test results only shall be the criteria. Some of the tests are outlined below:-

B-1 REBOUND HAMMER TEST

If a rebound hammer is regularly used by trained personnel in accordance with procedure described in IS 13311 (part II) and a continuously maintained individual charts are kept showing a large number of reading and the relation between the reading and strength of concrete cubes made from the same batch of concrete, such charts may be used in conjunction with hammer readings to obtain an approximate indication of the strength of concrete in a structure for element. If calibration charts are available from manufactures, it can be used. When making rebound hammer test each result should be the average of at least 12 readings. Reading should not be taken within 20mm of the edge of concrete members and it may be necessary to distinguish between readings taken on a trowled face and those on a moulded face. When making the tests on a precast unit, special care should be taken to bed them firmly against the impact of the hammer.

B-2 CUTTING CORES

This method involves drilling and testing cores from the concrete for determination of compressive strength. In suitable circumstances, the compressive strength of the concrete in the structure may be assessed by drilling cores from the concrete and testing. The procedure used shall comply with the requirements of IS 1199 and IS 516.

The points from which cores shall be taken shall be representative of the whole concrete and at least three cores shall be obtained and tested. If the average of the strength of all cores cut from the structure is less than the specified strength, the concrete represented by the cores shall be liable to rejection and shall be rejected if a static load test (B-5) either cannot be carried out or is not permitted by the Engineer-in-Charge.

B-3 ULTRASONIC TEST

If an ultrasonic apparatus is regularly used by trained personnel in accordance with IS 13311 (part I) and continuously maintained individual charts are kept showing a large number of readings & the relation between the reading and strength of cubes made from the same batch of concrete, such charts may be used to obtain approximate indications of the strength of concrete in the structures. In cases of suspected lack of compaction or low cube strength the results obtained from the ultrasonic test results on adjacent acceptable section of the structures may be used for the purpose of assessing the strength of concrete in the suspected portion.

B- 4 LOAD TESTS ON INDIVIDUAL PRECAST UNITS

The load tests described in this clause are intended as check on the quality of the units and should not be used as substitute for normal design procedure. Where members require special testing. Such special testing procedures shall be in a accordance with the specification. Test loads shall be applied and removed incrementally.

B-4.1 Non Destructive Tests

The unit shall be supported at its designed point of support and loaded for five minutes with a load equal to the sum of the characteristic dead load plus one and a quarter time the characteristic imposed load. The deflection is then recorded. The maximum deflection after application of the load shall be in accordance with

the requirements defined by the Engineer-in-Charge. The recovery is measured five minutes after the removal of the load and the load then reimposed. The percentage recovery after the second loading shall be not less than that after the first loading nor less than 90% of the deflection recorded during the second loading. At no time during the tests, shall the unit show any sign of weakness or faulty construction as defined by the Engineer-in-Charge in the light of reasonable interpretation of relevant data.

B-4.2 Destructive Tests

The unit is loaded while supported at its design point of support and must not fail at its design load for collapse, within 15 minutes of time when the test load becomes operative. A deflection exceeding 1/40 of the test span is regarded as failure of the unit.

B-4.3 Special Tests

For very large units or units not readily amenable to the above test e.g. columns, the precast parts of composite beams and members designed for continuity or fixity, the testing arrangements shall be agreed upon before such units are cast.

B-5 Load Test of Structures or Parts of Structures

The test described in this clause are intended as a check where there is a doubt regarding structural strength. Test loads are to be applied and removed incrementally.

B-5.1 Age at Tests

The test is to be carried as soon as possible after the expiry of 28 days from the time of placing of the concrete. When the test is for a reason other than the quality of concrete in the structure being in doubt, the test may be carried out earlier, provided that the concrete has already reached its specified characteristic strength.

B-5.2 Test Load

The test loads to be applied for the limit state of deflection and local damage are the appropriate design loads i.e., the characteristic dead and superimposed loads. When the limit state of collapse is being considered the test load shall be equal to the sum of characteristic dead load plus one and a quarter times the characteristic imposed load and shall be maintained or a period of 24 hours. In any of the test temporary supports of sufficient strength to take the whole load shall be placed in position underneath but not in contact with the members being tested. Sufficient precautions must be taken to safeguard persons in the vicinity of the structure.

B-5.3 Measurement During Tests

Measurements of deflection and crack width shall be taken immediately after applications of the load and, in the case of 24 hour sustained load test, at the end of 24 hour loaded period, after removal of the load and after 24 hour recovery period. Sufficient measurements shall be taken to enable side effect to be taken in account. Temperature and weather conditions shall be recorded during the tests.

B-5.4 Assessment of Results

In assessing the strength of a structure or a part of the structure following a loading test, the possible effects of variation in temperature and humidity during the period of the test shall be considered.

The following requirements shall be met:

(a) The maximum width of any crack measured immediately on application of the test load for local damage, is to be not more than 2/3 of the value of the appropriate limit state requirement.

(b) For members spanning between two supports the deflection measured immediately on application of the test load for deflection is to be not more than 1/500 of the effective span limits shall be agreed upon before testing cantilevered portions of structure.

(c) If maximum deflection in mm shown during 24 hour under load is less than $40L^2/D$ where L is effective span in mm and D is overall depth of construction in mm, it is not necessary for the recovery to be measured and the requirement (D) does not apply, and

(d) If within 24 hours of the removal of test load for collapse as calculated in clause (a) a reinforced concrete structure does not show a recovery of at least 75 per cent of the maximum deflection shown during the 24 hour under load, the loading should be repeated. The structure should be considered to have failed to pass the test if the recovery after second loading is not at least 75 per cent of the maximum deflection shown during the second loading.

B-6 DETERMINATION OF WATER SOLUBLE AND ACID SOLUBLE CHLORIDES IN CONCRETE

Determination of water soluble and acid soluble chlorides in Concrete shall be done as per method of test given in IS 14959 (Part 1) which covers volumetric method of test as described below :

(a) Quality of Reagents
Unless otherwise specified, pure chemicals of analytical reagent grade and distilled water (see IS 1070) shall be used in the test.

(b) Nitric Acid (HNO_3) Concentrated (Specific Gravity 1.42)
Prepare the solution, (6N (approximately), by diluting 38ml of concentrated Nitric acid to 100 ml with distilled water.

(c) Ferric Alum($FeNH_4 (SO_4)_2$ 12 H_2O)
Dissolve 10 g of ferric alum in 100 ml of distilled water and add 1 ml of Nitric acid.

(d) Potassium Chromate 5% Solution
Dissolve 5 g of potassium chromate ($K_2 CrO_4$) 100 ml of distilled water to form 5% Solution.

(e) Nirabenzene

(f) Silver Nitrate ($AgNO_3$)Solution, 0.02 N
Weigh 1.7 g of silver nitrate, dissolve in distilled water and dilute to 500 ml in a volumetric flask. Standardize the silver nitrate solution against 0.02 N sodium chloride solution using potassium chromate solution as indicator (5 percent *m/v*) in accordance with the procedure given in IS 3025 (Part 32).

(g) Ammonium thiocyanate (NH_4 SCN) Solution
Weigh 1.7 g of ammonium thiocyanate (NH_4 SCN) and dissolve in one litre of distilled water in a volumetric flask. Shake well and standardize by titrating with 0.02 N silver nitrate solution using ferric alum solution as an indicator. Adjust the normality exactly to 0.02 N.

(h) Sodium chloride (NaCl) 0.02N
Weigh 1.1692 g of sodium chloride (NaCl) dried at 105 +/- 2ºC, dissolve in distilled water and make upto 1000 ml in a volumetric flask.

(i) Use of Filter Paper

(j) In the methods prescribed in this standard, relative numbers of Watman filter paper only have been prescribed since these are commonly used. However, any other suitable brand of filter papers with equivalent porosity may be used.

(k) Procedure for Water Soluble Chloride
Weigh 1 000+/-5 g of fresh mortar or concrete sample in a 2 litre capacity beaker and add 500 ml of distilled water (chloride free). Stir the mixture vigorously for 15 minutes. After allowing the mixture to stand for 10 to 15 minutes for settling, decant about 200 ml of the supernatant solution

into a clean dry 250 ml capacity beaker. Immediately, filter the solution through Watman filter paper No.1 and collect the filtrate.

Pipette 50 ml of filtrate in a 250 ml capacity conical flask. Add 5 ml of 6 N Nitric acid. Add a known volume (X), preferably 25 ml of nitrobenzene. Shake vigorously to coagulate the precipitate. Titrate the excess silver nitrate with 0.02 N ammonium thiocyanate solution until a permanent faint reddish brown colour appears. Note down the volume (Y) of ammonium thiocyanate used.

(l) Procedure for Acid Soluble Chloride

Weigh about 1000 +/- 5 g of the fresh mortar or concrete sample in a 2 litre capacity beaker and add 50 ml of 6 N nitric acid and 450 ml of distilled water (chloride free) after stirring for few Minutes. Stir the mixture vigorously for 15 minutes. After allowing the mixture to stand for 10 to 15 minutes for settling, decant about 200 ml of the supernatant solution into a clean dry 250 ml capacity beaker. Immediately, filter the solution through Watman filter paper No.1 and collect the filterate.

Pipette 50 ml of filtrate in a 250 ml capacity conical flask. Add 5 ml of 6 N nitric acid. Add a known volume (X) preferably 25 ml of standard silver nitrate solution. Add 1 ml ferric alum and 5 ml of nitrobenzene. Shake vigorously to coagulate the precipitate. Titrate the excess silver nitrate with 0.02 N ammonium thiocyanate solution until a permanent faint reddish brown colour appears. Note down the volume (Y) of ammonium thiocyanate used.

(m) Calculation

Calculate the percentage of chloride(acid soluble/water soluble) by mass of mortar or concrete as follows:

Chloride, percent = 0.0007 1 (X – Y),

Where

X = volume of silver nitrate added, in ml; and

Y = volume of 0.02 N ammonium thiocyanate consumed.

Note: Interference of silver chloride particles (which are generated in situ) in titration by reacting with thiocyanants can be avoided by the addition of nitrobenzenes which forms a film on silver chloride particles.

APPENDIX C

REGISTER OF WORK TEST OF CONCRETE (NOMINAL MIX)

(Clause A-O of Appendix A)

(a)	Name of work	Concrete mix, (by volume)	Compressive strength in kg/cm^2 on 7 days
(b)	Name of Contractor	1:1:2	210
(c)	Agreement No.	1:1.5:3	175
(d)	Sample No.	1:2:4	140
(e)	Identification mark		
(f)	Portion of work any quantity represented by sample		
(g)	Date and time of casting cube		
(h)	Proportion of mix/ grade of concrete		

7 Days' Test

(Clause 5.4.10.3)

(1)	Due date of test	Cube No.
(2)	Actual date of test	
(3)	(a) Minimum strength	
	(b) Maximum strength	
	(c) Average strength of three cubes	
	(d) Difference between 3a and 3b	
	(e) Difference in % age in terms of average strength i.e $\frac{3b-3a}{3c}$ x 100	
(4)	Specified compressive strength of concrete mix used	
(5)	(a) If 3(e) is more than 30%	Sample is not acceptable, then 28 days strength test shall be carried out.
	(b) If 3(e) is equal to or less than 30% then proceed as below:-	
	(i) Difference between column 4 specified compressive strength and column 3 (c) i.e., actual average is higher, it will be denoted (+) and (-) if it is less.	
	(ii) Difference in column 5(b) (i) terms of	$\frac{3c-(4)}{4}$ x 100
	(iii) If the difference in column 5(b) (i) is +ve and the same in terms of % age of specified strength (4) i.e., value of col. 5(b) (ii) is within (+15% range)	Acceptable & strength is considered in order

JE AE/AEE EE

REGISTER OF WORK TEST FOR CONCRETE (NOMINAL MIX)

(a)	Name of Work	Concrete mix, (By volume)	Compressive strength kg/cm^2 in 28 days
(b)	Name of contractor	1:1:2	315
(c)	Agreement No	1:1.5:3	265
(d)	Sample No.	1:2:4	210
(e)	Identification mark		
(f)	Portion of work any quantity represented by sample		
(g)	Date and time of casting cube		
(h)	Proportion of mix/Grade of concrete		

28 Days' Test
(Clause 5.4.10.4)

(1)	Due date of test	Cube No.
(2)	Actual date of test	
(3)	Actual compressive strength of cubes (min. no. of cubes to be tested –three)	
	(a) Minimum strength	
	(b) Maximum strength	
	(c) Average strength of three cubes	
	(d) Specified compressive strength of concrete mix used	
	(e) 70% specified strength	i.e. 70% of 3(d)
	(f) 130% of specified strength	i.e. 130% of 3(d)
(4)	If 3(b) = 3(f) and 3(a) > 3(e)	Value of 3(c) shall be compressive strength of sample
(5)	If 3 (c) is more than 3(f)	EE may order further investigation
(6)	If any test value exceeds 3(f)	It should be restricted to 3(f) for computation of strength
(7)	If 3 (c) > 3(d) but < 3(f)	Strength is in order and concrete accepted at full rates.
(8)	If 3 (c) < 3(d) and > 3(e)	Concrete may be accepted at reduced rates in accordance with para 5.4.13.2
(9)	If 3(c) < 3(e)	Work represented by this sample shall be rejected and action taken as prescribed in clause 5.4.10.4

APPENDIX D

LIST OF EQUIPMENTS REQUIRED FOR SITE LABORATORY

I. Aggregate Testing

ITEMS		*QUANTITY*
1. Aggregate Testing	1. STANDARD SIEVES (INDIAN STANDARD)	
	(a) Set of coarse sieves 30 cm dia (GI sheet frames) with aperture size. (40 mm, 25 mm, 20 mm, 16 mm, 17.5 mm, 10 mm, 4.75 mm all with lid and pan)	1 set
	(a-1) Motorised sieve shaker for the above sieves	1 No.
	(b) Set of fine sieves 20 cm dia of brass with aperture size (4.75 mm, 2.36 mm, 1.18 mm,600 mic, 300 mic, 150 mic, 75 mic all with lid and Pan)	1 set
	(b-1) Motorised sieve shaker for the above sieves.	1 No.
2. Flakiness & Elongation index screen		1 No.
3. Riffle sample divider slot width 25mm		1 No.
4. 1 Los Angeles abrasion Testing Machine		1 No.
5. Bulk Density and voids of Aggregates cylindrical metal measures with capacity (3 ltr, 10 ltr, 15 ltr or 20 ltr)		1 No. each
6. Density basket of galvanized wire height 20 cm		1 No.
7. Pycrometer 1000 ml capacity with Brass		1 No.
8. Hot – Air Blower (Hair Dryer)		1 No.
9. Aggregate impact value apparatus with automatic blow counter		
10. Hot – plate 1000 to 2000 wells with regulator cum switch		1 No.
11. Drying pans (Frying pans)		2 Nos..
12. China clay dishes with dia 10 cm & 15 cm		2 Nos./each
13. Watch glasses for above 10 cm & 15 cm		2 Nos./each

II. Concrete Testing

1.	Sieve Brushes	2 Nos.
2.	Concrete cube moulds 15x15x15cm	3. Ultrasonic Test Equipment 1
3.	Ultrasonic Test Equipment	1 No.
4.	Pruning Rods 2 Kg weight length 40 cm and ramming face 25 mm2	4 Nos.
5.	Extra Bottom plates for 15 cm cube mould	6 Nos.
6.	Standard Vibration Table for gauging the cubes	2 Nos.
7.	Compression Testing Machine with Electricity cum manually operated tamping unit with pressure guage preferable 30 cm dia, 0-150 tonne in 1 tonne divisions. Sensitivity 0.5 tonne.	1 No.
8.	1 Air content measuring apparatus	1 No.
9.	Slump test Apparatus complete	3 Nos.
10.	Pocket concrete pernetrometer 0 to 50kg/ sq.cm	1 No.
11.	Baby Mixer Machine	1 No.
12.	G.I. Tray approx 1mx1m with sides 10 cm high for hand mixing of concrete	2 Nos.
13.	Concrete temperature measuring thermometer with Brass protection sheath 0-100 degree centigrade	2 Nos.

III. Cement Testing

1.	Mortar Cube Moulds 7.07x7.07x7.07 cm	10 Nos.
2.	Standard sand Grade I,II,III	50 kgs./each
3.	Mortar Cube vibrator	1 No.
4.	Vicate needle apparatus Computer	1 No.
5.	Blaine's Apparatus	1 No.

IV. Weighing Equipment

1.	Physical Balance Capacity 200 gms with weight pony	1 No.
2.	Dial type spring balance preferable with zero correction knob capacity 100 kgs reading to ½ kg.	2 Nos.
3.	Counter scale capacity 1 kg and 10 kg	1 No./ each
4.	Weighing platform capacity 100 kg	1 No
5.	Iron Weight of 5 kg, 2 kg, 1 kg, 500 gm, 200 gm, 100 gm	2 No./each
6.	Brass Weight of 50 gm, 20 gm, 10 gm, 5 gm, 2 gm, 1 gm	2 No./each

V. Water Measuring

1.	5 litres, 2 litres, 1 litre, ½ litre	5 Nos./each

VI. Glass and Plastic Ware

1.	Measuring cylinder TPX or Poly propylene capacity 100 ml, 500 ml, 250 ml, 100 ml	2 Nos./each
2.	Pyrex, corning or Borosil beakers with cover capacity 500 ml, 200 ml, 50 ml	2 Nos./each
3.	Wash Bottles capacity 500 ml	2 Nos./each
4.	Thermometers 1-100 degree centigrades/ max. and Min/ Dry and wet with table	1 No.

VII. Laboratory Tools

1.	Set of box spanner ratchet	2 Nos.
2.	Hammer 1lb	2 Nos.
3.	Rubber Hammer	2 Nos.
4.	Hacksaw with 6 blades	1 Nos.
5.	Measuring tape 2 mtr	2 Nos.
6.	Depth gauge 20cm	2 Nos.
7.	Steel Foot Plate	2 Nos.
8.	Vernier Calliper	2 Nos.

VIII. Miscellaneous Items

1.	Trowels made from saw blade, 3 mm thick 16x10cm wooden handle	6 Nos.
2.	Showels & Spade	6 Nos./each
3.	Steel plates 5 mm thick 75x75 cm	2 Nos.
4.	Plastic or G.I. Buckets 15 ltr, 10 ltr, 5 ltr	2 Nos.
5.	Wheel Barrow	3 Nos.
6.	Floor Brushes, hair dusters, scrappers, wire brush, paint brushes, shutter steel plat oil, kerosene with stove etc.	3 Nos.

ANNEXURE – A
(Clause 5.9.3)

SAMPLING OF CONCRETE

After the truck mixer has re-mixed its delivery on site, allow at least the first one-third of a m^3 of concrete to be discharged prior to taking any samples. Take at least 4 incremental samples from the remainder of the load avoiding sampling the last cubic metre of concrete. Thoroughly re-mix this composite sample either on a mixing tray or in the sampling bucket and proceed with the required testing.

ANNEXURE – B
(Clauses 5.9.4.2 & 5.9.4.3)

CONCRETE MIX INFORMATION TO BE SUPPLIED BY THE PURCHASER

RMC : ……..

Contractor : …….

Site : …….

MIX CODE						
Grade (N/mm^2) (Characteristic strength)						
Minimum Cement Content (kg/m^3)						
Mineral Additives (Pulverized fuel ash/Slag/Others) (kg/m^3)						
Maximum Free water Cement Ratio						
Nominal Maximum Aggregate size						
Cement Type and Grade (if preferred)						
Target workability (Slump) (mm)						
Target workability at site						
Maximum Temperature of Concrete at the time of placing						
Class of sulphate Resistance (if applicable)						
Exposure condition (if applicable)						
Class of finish (if applicable)						
Mix Application						
Method of Placing						
Any other requirements (early strength workability retention, permeability testing, chloride content restriction, maximum cement content, etc.)						
Concrete Testing (Frequency)						
Material's Testing (any non-routine requirements)						
Alternatives to be offered: Yes/No						
Method of Curing to be used by contractor						
Quantity (m^3)						

Note : Additional proforma for further information may be used, such as for specific test rates to be achieved for concrete or raw materials, exact method statements of the contractors proposed site practice.

ANNEXURE – C
(Clauses 5.9.6.2 and 5.9.6.3)

CALIBRATION AND WEIGHING EQUIPMENT ACCURACY

C-1. The following limits shall apply to all ready-mixed concrete plants :

(a) The accuracy, sensitivity and arrangement of the weighing devices shall be such as to enable the materials to be batched within the following tolerances :

(1)	Cement, mineral Admixtures	:	Within $\pm$ 2 percent of the quantity of the constituent being measured.
(2)	Aggregate, chemical admixtures and water	:	Within $\pm$ 3 percent of the quantity of the constituent being measured.

(b) Analogue scales shall have scale increments not exceeding 5 kg. for cement and mineral admixtures, 25 kg. for aggregate and 2 kg. for water.

(c) Preset controls shall be calibrated in increments not exceeding 5 kg. for cement and mineral admixtures, 10 kg. for aggregate and 2 kg. for water.

(d) For continuous mixer plants calibration shall be in increments not exceeding 10 kg./m^3 for cement and mineral admixtures, 25 kg./m^3 for aggregates and 10 l/m^3 for water.

(e) Digital readous shall have a scale increments not exceeding 2 kg. for cement and mineral admixtures, 10 kg. for aggregate and 10 for water.

(f) At the time of installation, or reconditional the accuracy of the indicated mass at any point on the scale shall be within 0.25 percent of the full scale reading.

(g) Any other time during the masonry operation the accuracy shall be within 0.50 percent of the full scale reading.

(h) Chemical Admixture dispensers shall have scale increment for exceeding.

Ranger of scale in kg/l	*Scale increment in Kg/l*
0.1 – 0.5	0.01
0.5 - 1.0	0.02
1.0 – 10.0	0.2
more than 10.0	0.4

(i) All weighing and measuring equipment shall be tested and calibrated over its full working range at the following intervals :

(1) Mechanical /knife edge systems : At least once every two month

(2) Electrical /load cell systems : At least once every three months

Adequate and identified facilities shall be provided for the application of the test loads.

(j) In the case of batch weighing systems testing and calibration shall be based on the application test loads to the weigh hoppers.

(k) Checks on continuous weigh systems shall be based on comparison of preset quantities with those actually produced.

(l) To achieve the required accuracy of calibration, a minimum of 500 kg. of stamped weights required, except that for low capacity scale an acceptable limit on the total mass of calibr weight would be 20 percent of the scale capacity.

(m) When calibration of weighing equipment is carried out all personnel involved should competent and fully trained, the procedures should be fully documented, and special atte should be paid to the health and safety aspects of the procedure.

ANNEXURE – D

DELIVERY TICKET INFORMATION

(Clause 5.9.6.5)

D-1 The following information shall be included in the delivery ticket to accompany the load to the purchaser :

(a) Name or number of the ready-mixed concrete depot
(b) Serial number of the ticket
(c) Date
(d) Truck number
(e) Name of the Purchaser
(f) Name and location of site
(g) Grade or mix description of the concrete
(h) Specified target workability
(i) Minimum cement content (if specified)
(j) Type of cement and grade (if specified)
(k) Maximum free water-cement ratio (if specified)
(l) Nominal maximum size of aggregate
(m) Generic Type or name of any chemical and mineral admixtures included.
(n) Quantity of concrete in m^3
(o) Time of loading
(p) Signature of the plant operator
(q) A statement warning the purchaser of the precautions needed to be taken when working with cement and wet concrete.

D-2 On site the following information will be added. :

(a) Time of arrival on site.
(b) Time when discharge was completed.
(c) Any water/admixture added by the supplier to meet the specified workability.
(d) Any extra water /admixture added at the request of the purchaser of the concrete, or his representative, and his signature.
(e) Pouring location.
(f) Signature of the purchaser or his representative conforming discharge of the load.

TYPICAL SET UP OF STEEL WALL FORM WORK

Sub Head : R.C.C. (Form Work)
Clause : 5.2.3.6

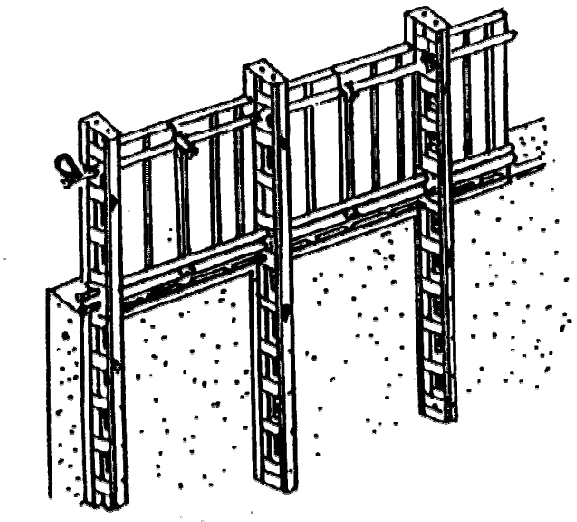


Fig. 5.1A : Single Sided Wall Form (Adjustable)

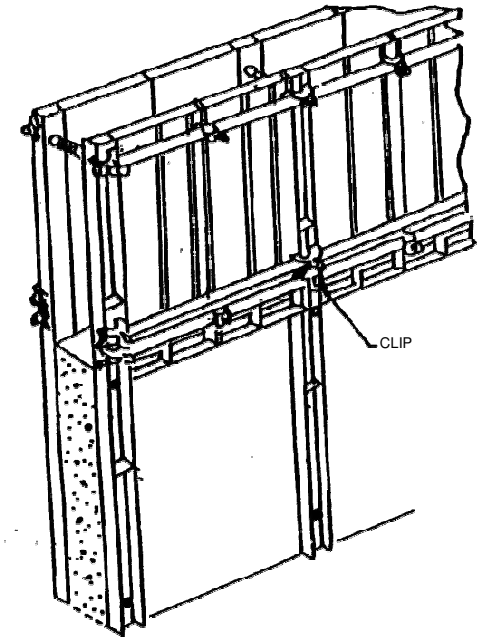


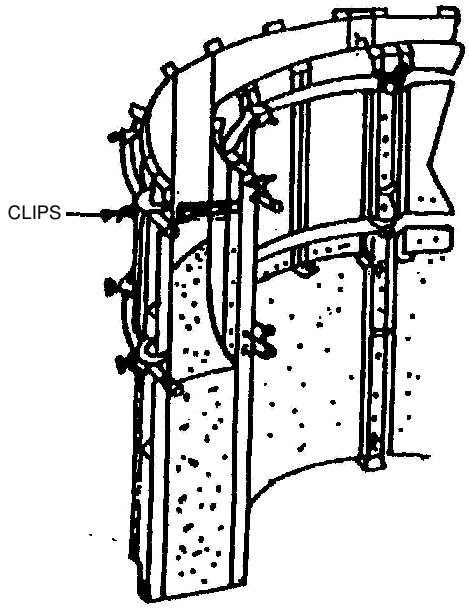
Fig. 5.1B : Double Sided Wall Form

All Members are of Steel

Fig. 5.1 : Typical Set Up of Steel Wall Form Work

WALL FORM

Sub Head : R.C.C. (Form Work)
Clause : 5.2.3.6



All Members are of Steel

Fig. 5.2 : Adjustable Curved Wall Form (Double Sided)

TYPICAL FIXING DETAILS OF WALL TIES

Sub Head : R.C.C. (Form Work)
Clause : 5.2.3.6.

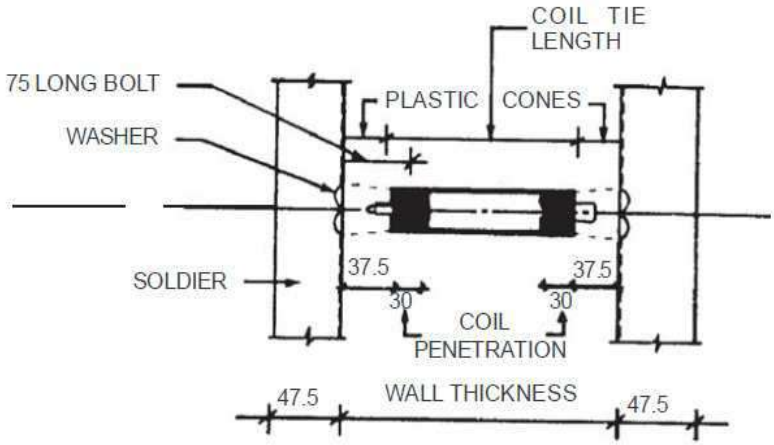


Fig. 5.3A : Wall Tie for Two Sided Shuttering

All Members are of Steel

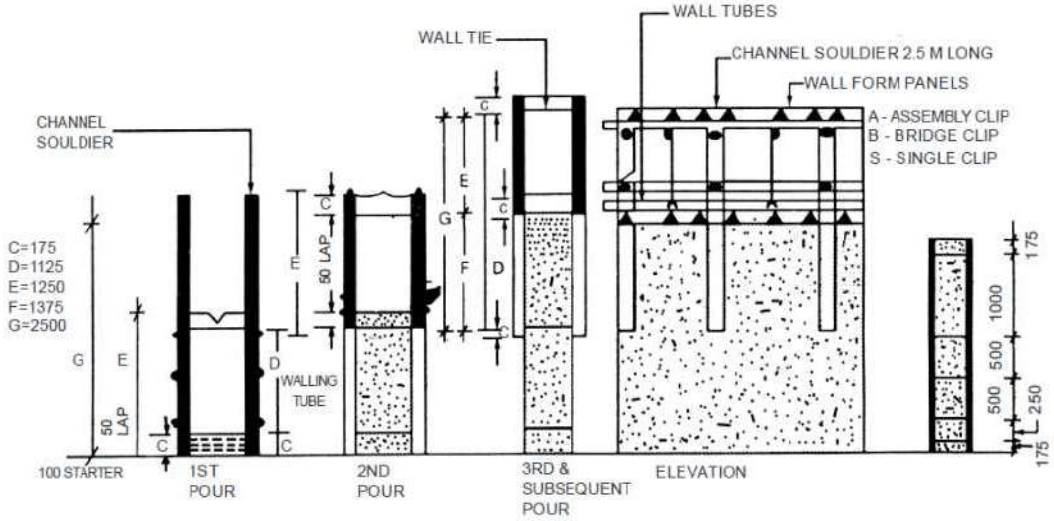


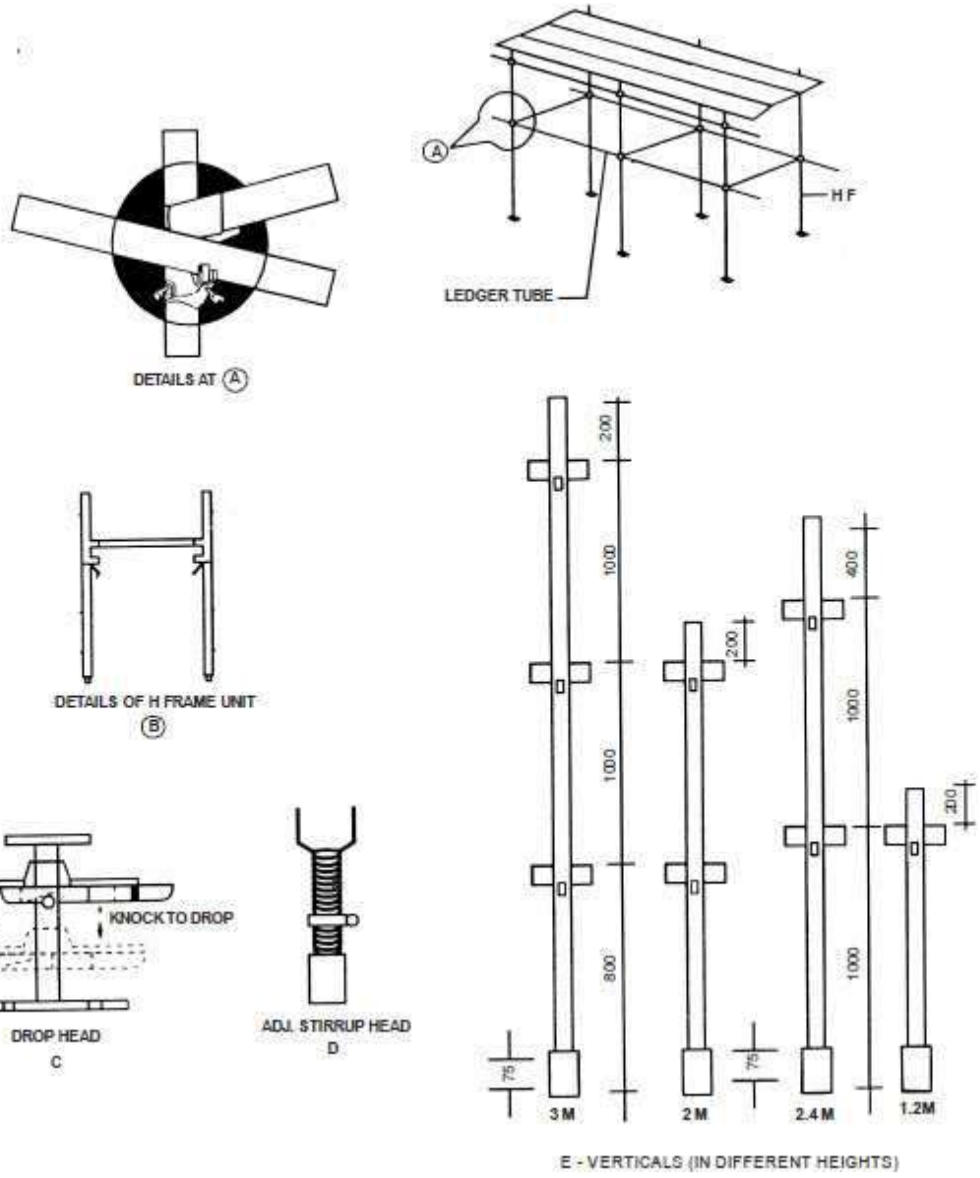
Fig. 5.3B : Position of Wall Ties & Walling Tubes
(Shuttering for 1st Pour should be properly Strutted by Rakers)

Drawing not to scale All dimensions are in MM

Fig. 5.3 : Typical Fixing Details of Wall Ties

TYPICAL STANDARD UNITS OF FORM WORK (CENTRING & SHUTTERING)

Sub Head : R.C.C. (Form Work)
Clause : 5.2.3



All Members are of Steel
All dimensions are in MM
Drawing not to scale

Fig. 5.4 : Typical Standard Units of Form Work

TYPICAL COMPONENTS OF FORM WORK

Sub Head : R.C.C. (Form Work)
Clause : 5.2.3.2

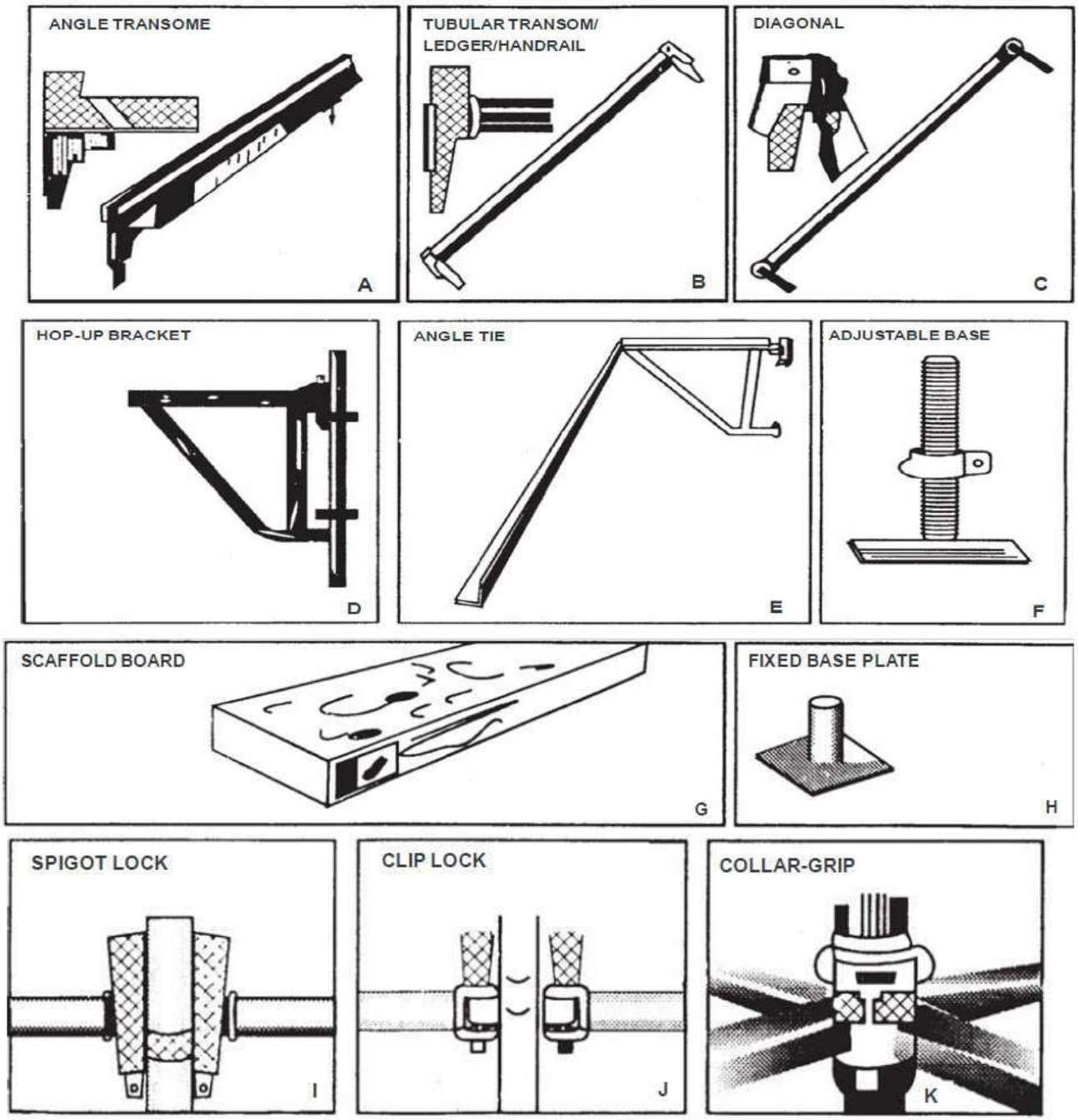


Fig. 5.5 : Typical Components of Form Work

TYPICAL ARRANGEMENT OF COLUMN FORM WORK

Sub Head : R.C.C. (Form Work)
Clause : 5.2.3.2

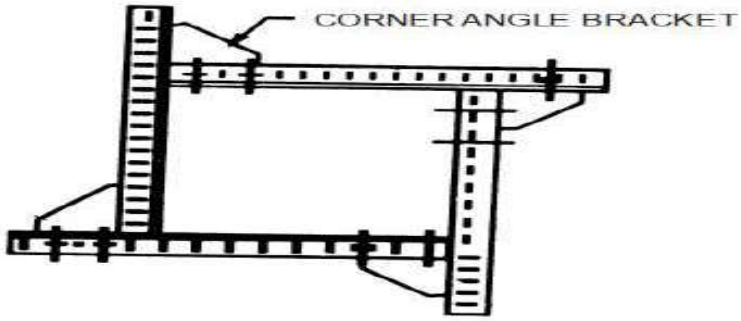


Fig. 5.6A : Four Sides Adjustable Column Form

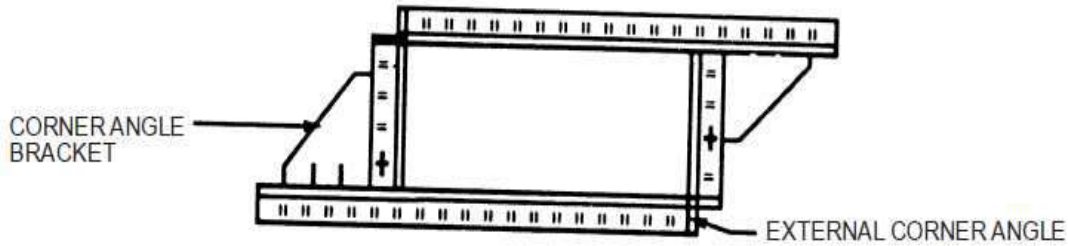


Fig. 5.6B : Two Sides Adjustable Column Form

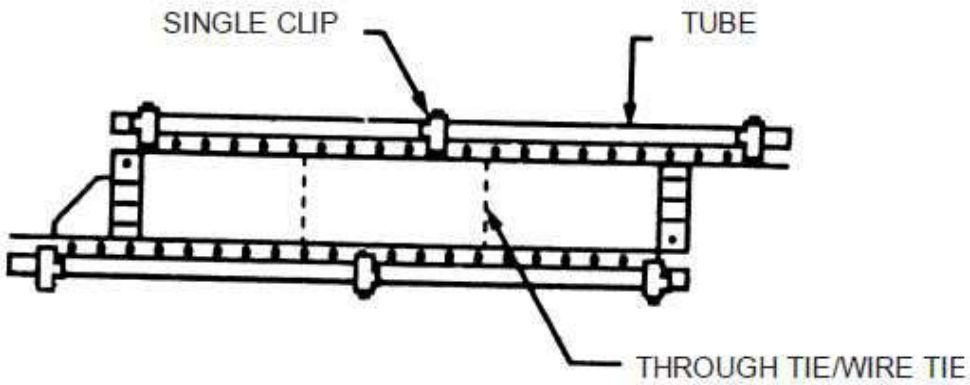


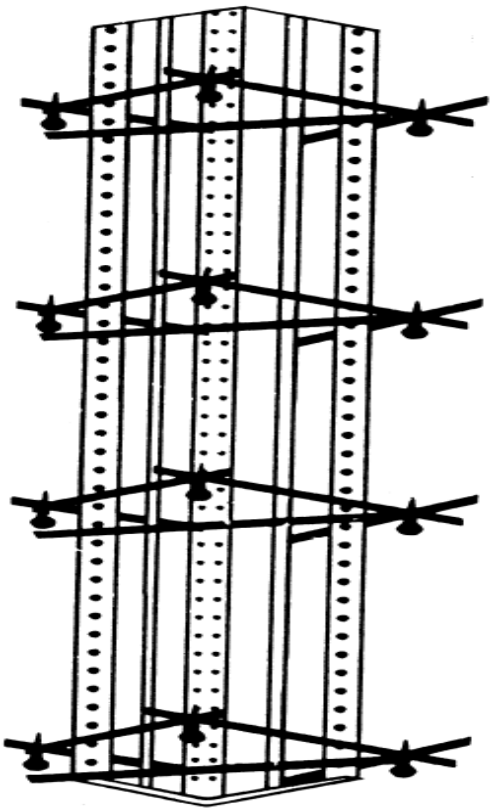
Fig. 5.6C : Column Form with Adjustable Shuttering Wall Form Type Panels

All Members are of Steel

Fig. 5.6 : Typical Arrangement of Column Form Work

TYPICAL COLUMN SHUTTERING

Sub Head : R.C.C. (Form Work)
Clause : 5.2.3.2

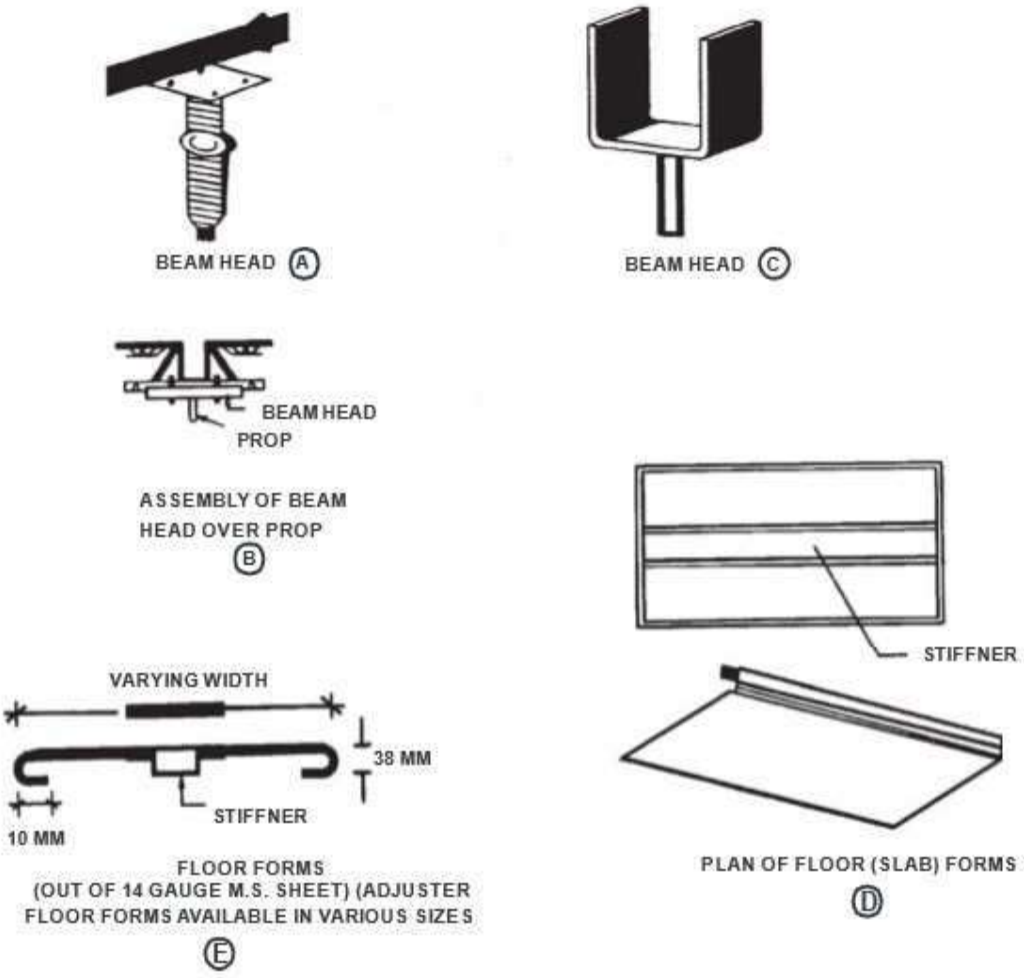


All Members are of Steel

Fig. 5.7 : Typical Column Shuttering

TYPICAL DETAIL OF BEAM HEAD AND STIFFNER

Sub Head : R.C.C. (Form Work)
Clause : 5.2.3.3

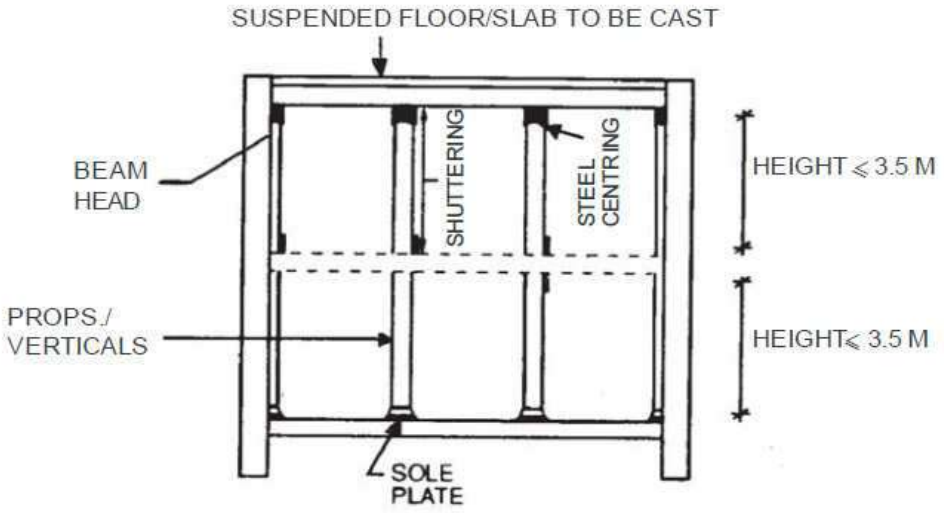


All Members are of Steel

Fig. 5.8 : Typical Detail of Beam Head and Stiffner

TYPICAL DETAILS OF MULTI STAGE SHUTTERING

Sub Head : R.C.C. (Form Work)
Clause : 5.2.3.4



All Members are of Steel

Fig. 5.9A : Suspended Floor – Multi Stage Shuttering (Vertical Section)

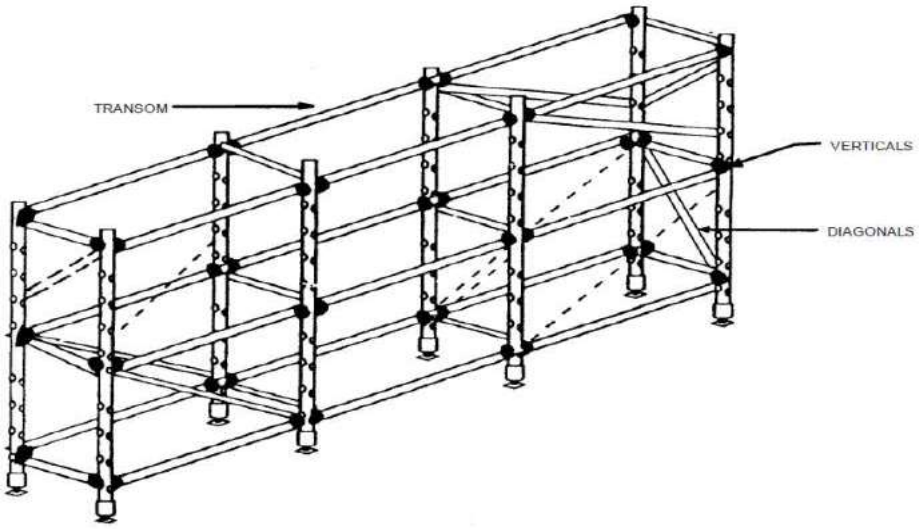


Fig. 5.9B

Fig. 5.9 : Typical Details of Multi-State Shuttering

DETAILS OF EXPANSION JOINTS (IN VARIOUS LOCATIONS)

Sub Head: R.C.C.
Clause : 5.4.5

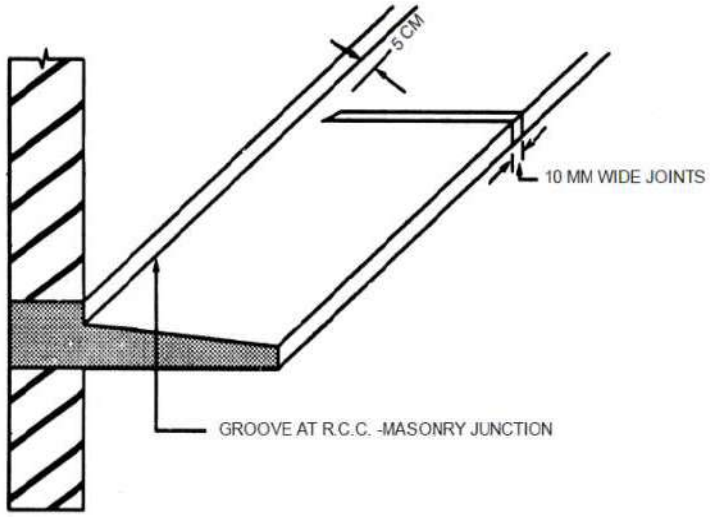


Fig. 5.10 : Expansion Joints in Long Sun Shade

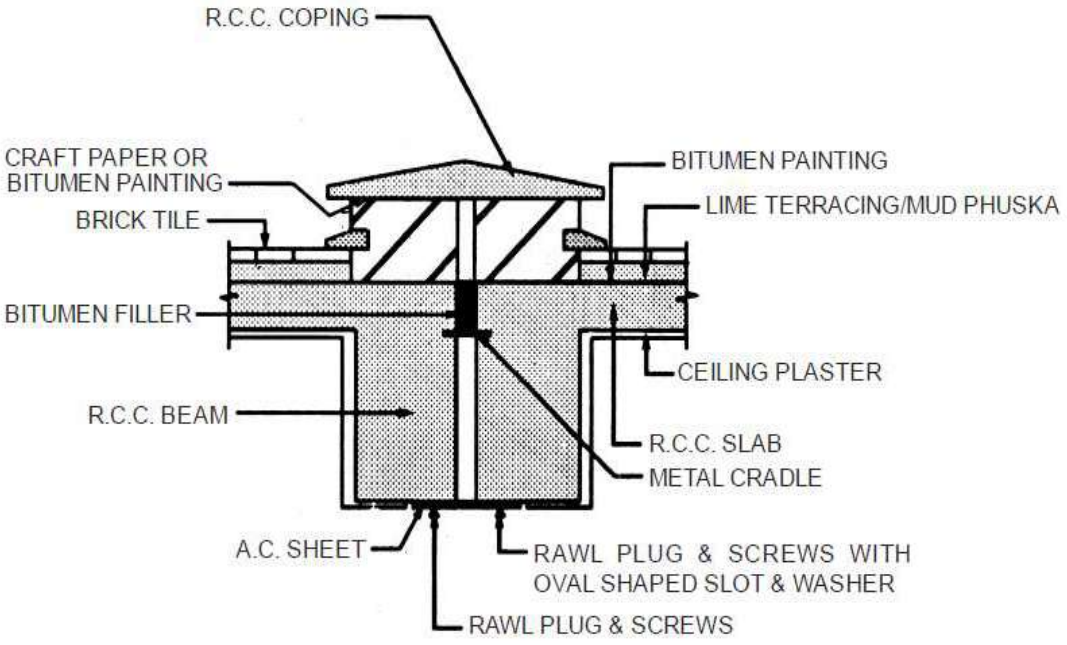


Fig. 5.11 : Details of Raised Type Expansion Joint at Roof

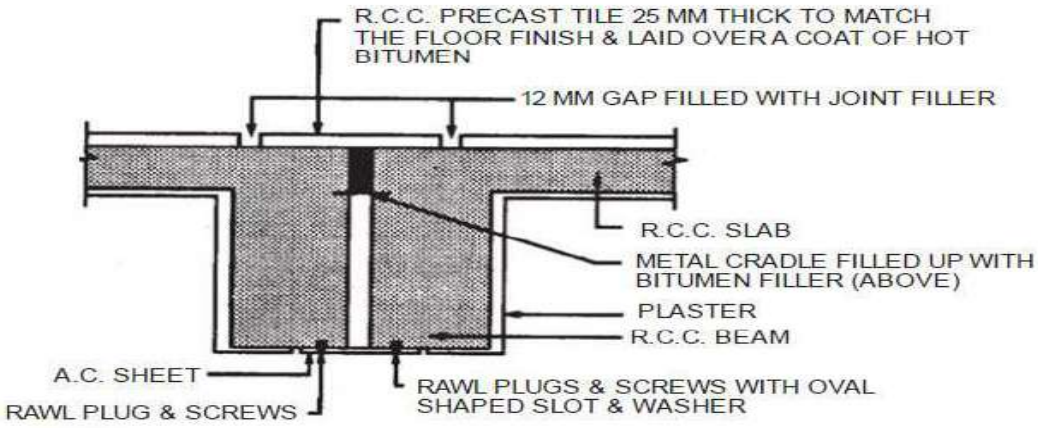


Fig. 5.12 : Typical Details of Expansion Joint at Floor

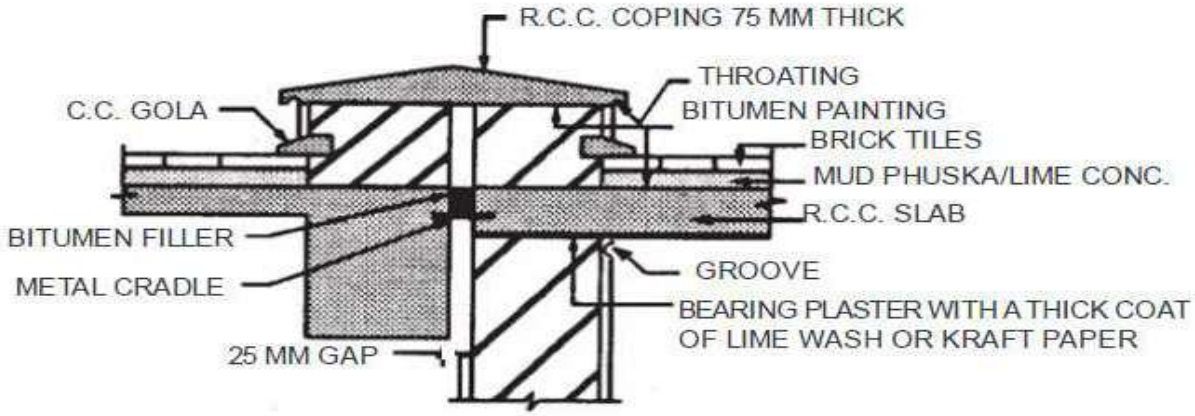


Fig. 5.13 : Typical Details of Expansion Joint at Wall & Beam Junction

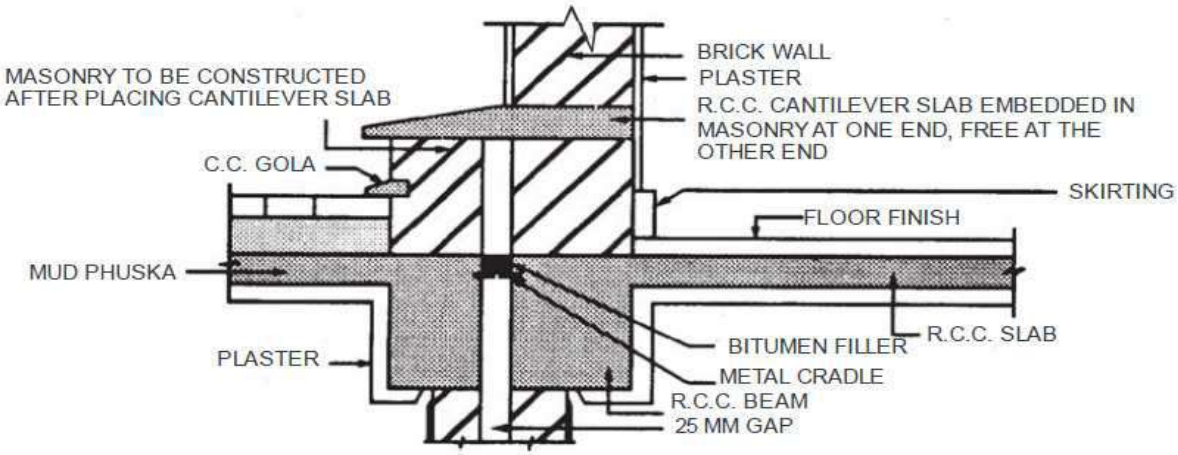


Fig. 5.14 : Typical Details of Expansion Joint at Roof & Floor Junction

EXPANSION JOINTS (CONTD.)

Sub Head : R.C.C.
Clause : 5.4.5

A. TWIN BEAM WITH TWIN COLUMNS

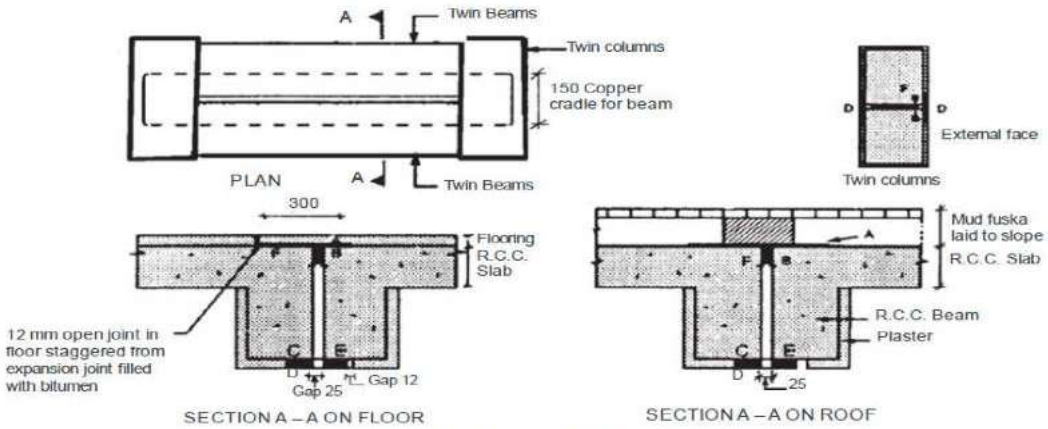


Fig. 5.15 : Twin Beam with Twin Columns

B. SLAB & T-BEAM CONSTRUCTION OF LONG LENGTH

(T-Beam changed into rectangular beam to provide intermediate expansion joint)

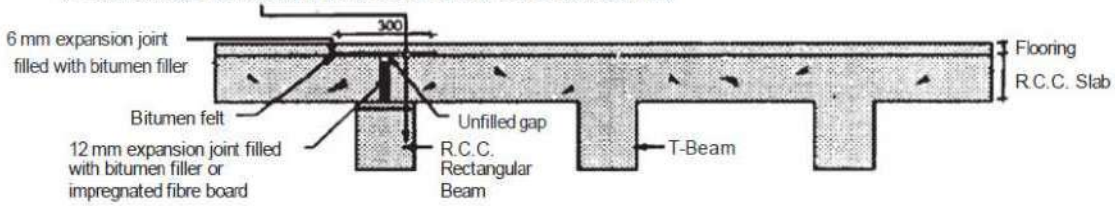


Fig. 5.16 : Slab & T-Beam Construction of Long Length

C. LONG VERANDAH SLAB

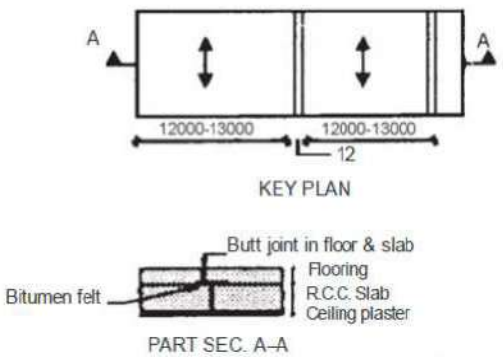


Fig. 5.17 : Long Verandah Slab

D. LONG WATER-RESERVOIR SLAB

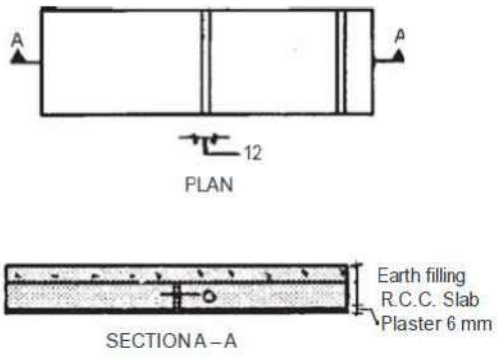


Fig. 5.18 : Long Water Reservoir Slab

A Hot bitumen painting @ 1.7 k.g/sqm.
B Bitumen filler
C Rawl plugs & 50 mm screws @ 300 mm c/c
D Asbestos sheet 150 mm wide or P.V.C. sheet
E Rawl plugs & screws with oval shaped slot & washers @ 300 mm c/c
F Copper cradle

Drawing not to scale
All dimensions are in mm

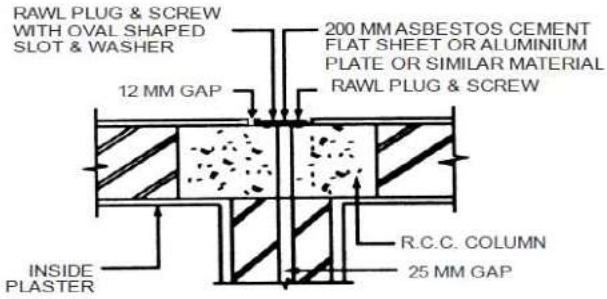


Fig. 5.19 : Typical Details of Expansion Joint Covering on Outer Face of Columns (Plan)

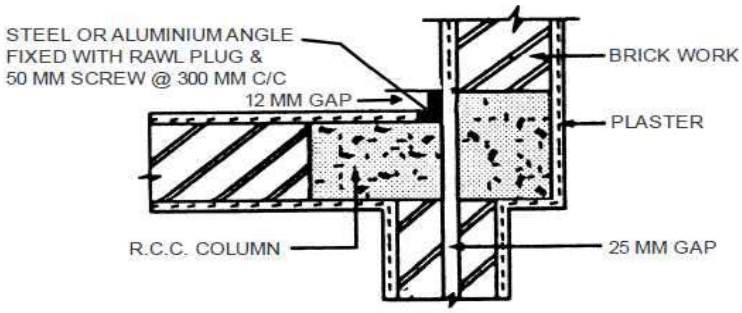


Fig. 5.20 : Typical Details of Expansion Joints at Corner Column

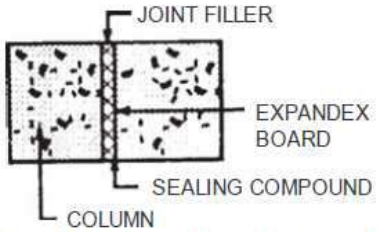


Fig. 5.21 : Typical Details of Expansion Joint at Isolated Twin Columns

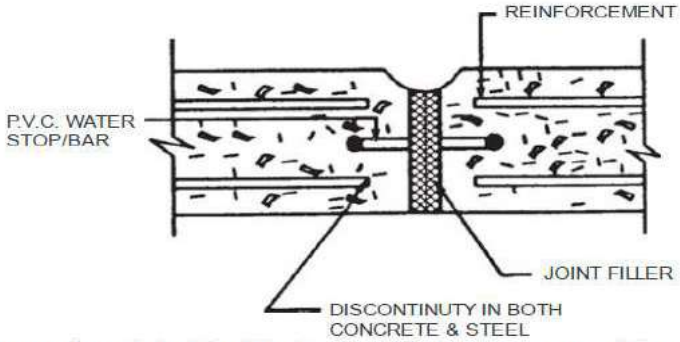
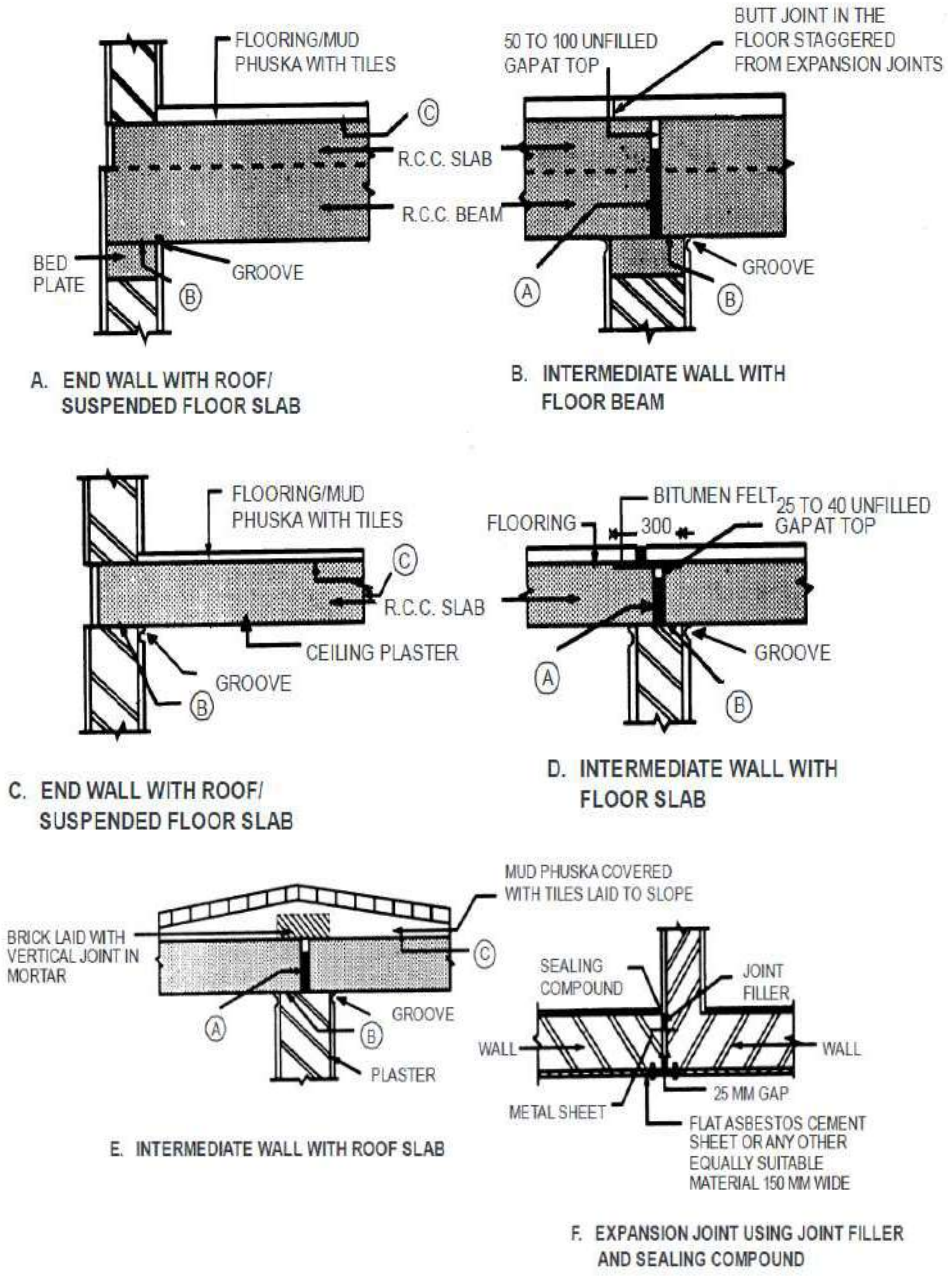


Fig. 5.22 : Expansion Joint Subjected to Water Pressure (For water Tanks)

EXPANSION JOINTS (CONTD.)

Sub Head : R.C.C.
Clause : 5.4.5



A 12 MM EXPANSION JOINTS FILLED WITH BITUMEN FILLER OR IMPREGNATED FIBRE BOARD
B 6 MM CEMENT PLASTER 1:3 (1C : 3F. SAND) FINISHED WITH A FLOATING COAT OF NEAT CEMENT AND A THICK LAID WITH KRAFT PAPER BRICK LAID WITH VERTICAL JOINT IN MORTAR FLAT ASBESTOS CEMENT SHEET OR ANY OTHER EQUALLY SUITABLE MATERIAL 150 MM WIDE COAT OF LIME WASH OR LAID WITH KRAFT PAPER
C HOT BITUMEN PAINTING @ 1.7 K.G./SQM. IN CASE OF ROOF SLAB/BEAM
C HOT BITUMEN PAINTING @ 1.7 KG./SQM. BELOW BRICK WALL ONLY ON SUSPENDED FLOOR BEAM/SLAB

Drawing not to scale
All dimensions are in mm

Fig. 5.23 : Expansion Joint (Contd.)

SEISMIC SEPARATION JOINTS

Sub Head : R.C.C.
Clause : 5.4.5

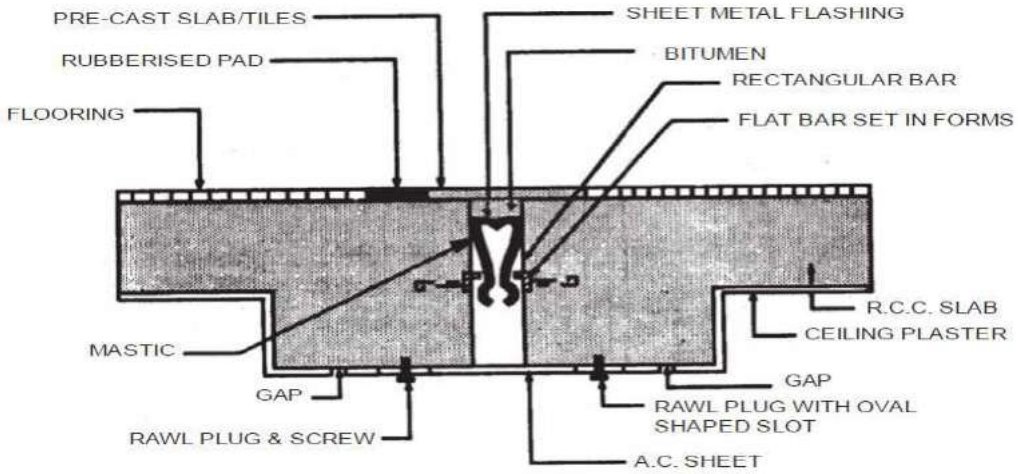


Fig. 5.24: Seismic Separation at Floor Level

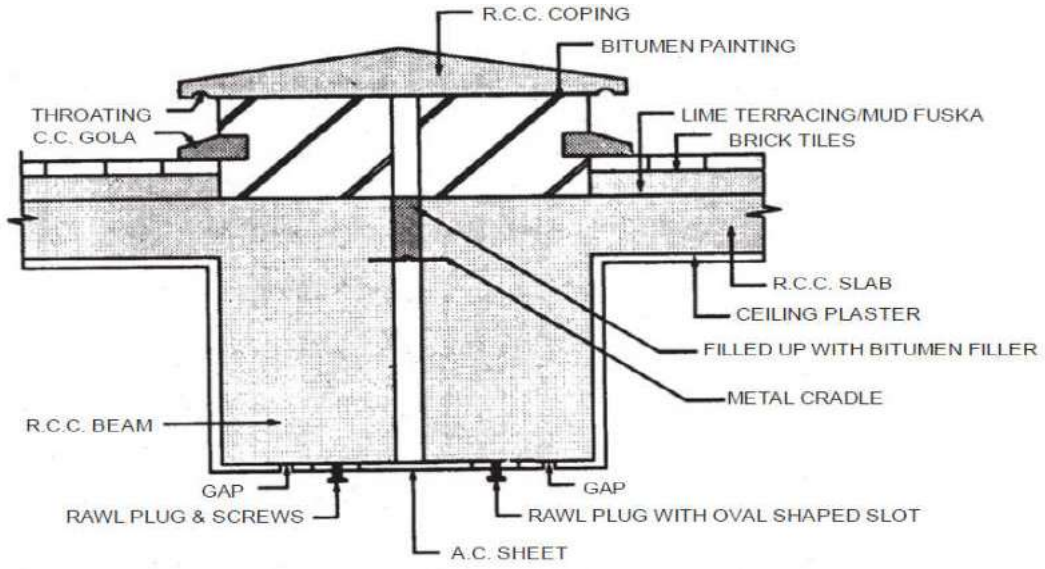
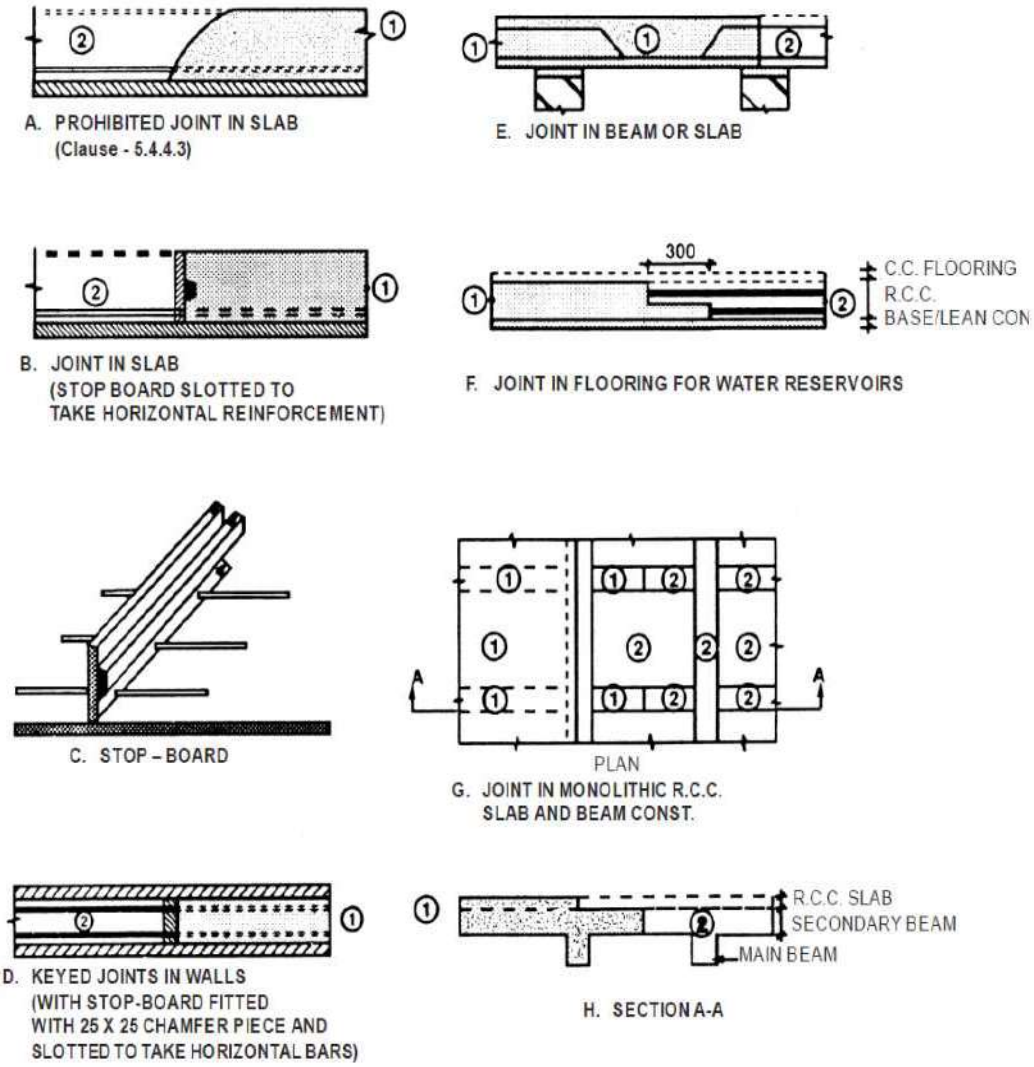


Fig. 5.25 : Seismic Separation Joints Detail at Roof

CONSTRUCTION JOINTS

Sub Head : R.C.C.
Clause : 5.4.4



1. REPRESENTS FIRST PLACING OF CONCRETE
2. REPRESENTS SUBSEQUENT PLACING OF CONCRETE

Drawing not to scale
All dimensions are in mm

Fig. 5.26 : Construction Joints

ENCASING ROLLED STEEL SECTION

Sub Head : R.C.C.
Clause : 5.5.2

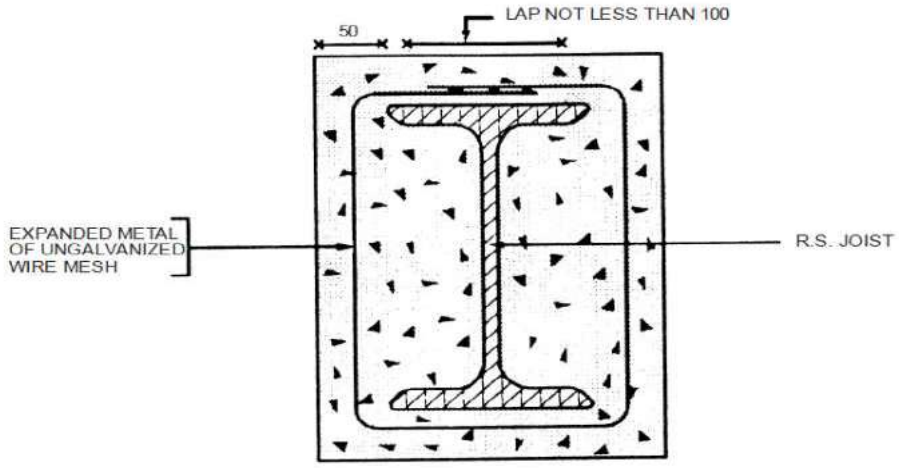


Fig. 5.27 : Steel Column

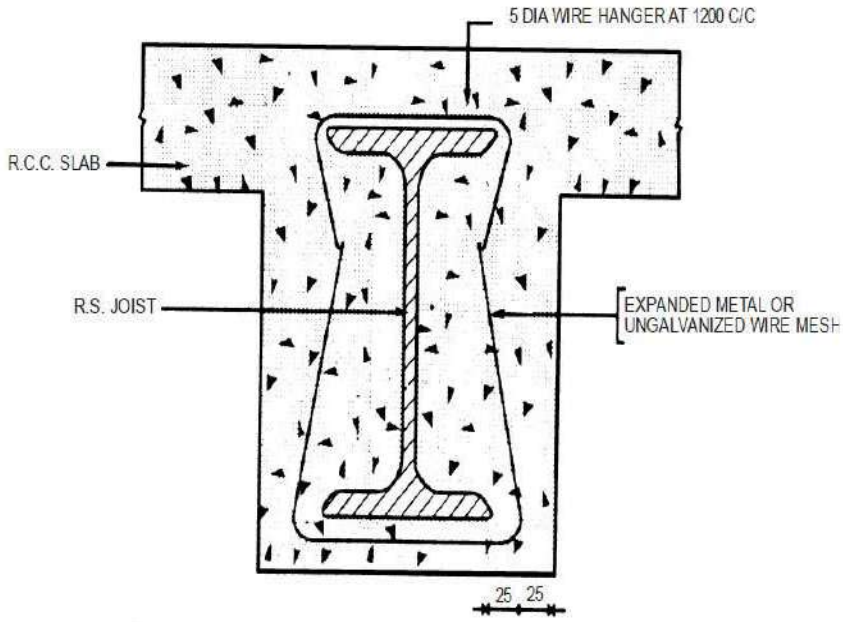


Fig. 5.28 : Steel Beam with slab

Normally Cement Concrete 1 : 2 : 4 (1 Cement : 2 Coarse Sand : 4 Graded Stone Aggregate 12.5 Nominal Size) shall be used.

Drawing not to scale
All dimensions are in mm

SUB HEAD : 6.0

MASONRY WORK

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LIST OF MANDATORY TESTS

Sl. No.	*Material*	*Clause*	*Test*	*Field/ laboratory Test*	*Test Procedure*	*Minimum Qty. of material for carrying out test*
(i)	Bricks/ Brick Tiles	6.1.3, 6.1.4, 6.1.5	Testing of Bricks/Brick Tiles for dimensions, Compressive strength, Water absorption and efflorescence	Laboratory	Appendix A, B, C & D of Chapter 6	As per Table 6.3 and 6.4
(ii)	Sewer Bricks	6.1.4	Dimensions, Compressive strength, Water absorption and Efflorescence	Laboratory	Appendix A, B, C & D of Chapter 6	As per Table 6.3 and 6.4
(iii)	Burnt clay perforated building bricks	6.1.5	--do--	-- do --	-- do--	-- do--

LIST OF BUREAU OF INDIAN STANDARDS CODES

S. No.	IS. No.	Subject
1.	IS 269	Specification for Ordinary Portland cement (33 Grade)
2.	IS 383	Specification for coarse and fine aggregate
3.	IS 456	Plain and reinforced concrete - Code of practice
4.	IS 712	Specification for building limes.
5.	IS 1077	Common burnt clay building bricks.
6.	IS 1200 (Part 3)	Method of measurements of brick works
7.	IS 2212	Code of practice for brick work. (1st Revision)
8.	IS 2222	Specification for burnt clay perforated building bricks.
9.	IS 2645	Specification for integral water proofing compounds for cement mortar and concrete
10.	IS 2849	Specification for non load bearing gypsum partition blocks, (Solid and hollow types)
11.	IS 3346:1980	Method of the determination of thermal conductivity of thermal insulation materials
12.	IS 3495	Method of test for burnt clay building bricks.
13.	IS 3812	Specification for fly ash for use as pozzolana and admixture.
14.	IS 4082:1977	Stacking & storage of construction materials and components at site – Recommendations
15.	IS 4139	Specification of calcium silicate bricks
16.	IS 4885	Specification for sewer brick
17.	IS 5454	Methods of sampling of clay building bricks.
18.	IS 6441 (Part-1): 1972	Methods for test for Autoclaved Cellular concrete Products: Determination of unit weight or bulk density and moisture content
19.	IS 6441 (Part-2): 1972	Methods for test for Autoclaved Cellular concrete Products: Determination of dry shrinkage
20.	IS 6441 (Part-5): 1972	Methods for test for Autoclaved Cellular concrete Products: Determination of compressive strength
21.	IS 9103	Specification for concrete admixtures
22.	IS 12894	Pulverized fuel ash lime bricks specification,
23.	IS 13757	Specification of burnt clay fly ash bricks.

6.0 MASONRY WORK

6.0. TERMINOLOGY

Bond

The arrangement of the bricks in successive courses to tie the brick work together both longitudinally and transversely. The arrangement is usually designed to ensure that no vertical joint of one course is exactly over the one in the next course above or below it, and there is greatest possible amount of lap.

Bed Joint

Horizontal joint in brick work or masonry.

Closer

Any portion of a brick used in constructing a wall, to close up the bond next to the end brick of a course (See Fig. 6.3).

Coping or Weathering

The cover applied over or the geometrical form given to a part of structure to enable it to shed rain water.

Corbel

A cantilever projecting from the face of a wall to form a bearing (see Fig. 6.1D)

Cornice

Horizontal or ornamental feature projecting from the face of a wall (see Fig. 6.1D)

Course

A layer of bricks including bed mortar.

Cross joint

A joint other than a bed joint normal to the wall face.

Efflorescence

A powdery incrustment of salts left by evaporation. This may be visible on the surface or may be below surface. In the latter case, this is termed as crypto Efflorescence.

Header

A brick laid with its length across the wall.

Indenting

The leaving recesses into which future work can be bonded.

Jamb

The part of the wall at the side of an opening.

Joint

A junction of bricks.

Jointing

The operation of finishing joints as the masonry work proceeds.

Pier

A thickened section forming integral part of the wall placed at intervals along the wall primarily to increase the stiffness of the wall or to carry a vertical concentrated load. The thickness of a pier is the over all thickness including the thickness of the wall, or when bonded into one leaf of a cavity wall the thickness obtained by treating this leaf as an independent wall (see Fig. (6.1A, 6.1B)).

Pillar

Pillar means a detached masonry support. This can be rectangular, circular, elliptical etc. In case of rectangular pillar, the breadth shall not exceed three times the thickness and thickness itself shall not exceed more than thrice the length of brick (See Fig. 6.1C).

Quoin

An external corner in brick work, the term may also denote the brick used to form the quoin.

Scaffolding

A temporary erection of timber or steel work used in the construction, alteration, demolition or repairs of a building to support or to attend of the hoisting or lowering of workmen, their tools and materials. Scaffoldings are of two types, namely single and double scaffoldings. Single scaffolding consists of a row of verticals connected to wall by horizontal supported on and tied to the structure. Double scaffolding consists of two rows of verticals secured or leashed together with horizontal and diagonal bracings forming essentially a structure independent of the building. It may also connect to the structure at convenient points for the sake of better stability.

Sill

A brick work forming the lower boundary of door or window opening (see Fig. 6.1D).

Spandrel

The space between the haunches and the road decking of an arch.

Strecher

A brick laid with its length in the direction of the wall.

String course

A horizontal course projecting from a wall usually introduced at every floor level or windows or below parapet for imparting architectural appearance to the structure and also keeping off the rain water. (see Fig. 6.1D).

Templet

A pattern of sheet metal used as a guide for setting out specific section and shape.

Toothing

Bricks left projecting in alternate courses to bond with future work.

Wall joint

A joint parallel to the wall face.

6.1 BRICKS/BRICK TILES/BRICK BATS/MECHANIZED AUTOCLAVE FLY ASH LIME BRICK

Bricks used in the masonry may be of the following type.

(a) The ***Common Burnt Clay Bricks*** shall conform to IS:1077 and shall be hand moulded or machine moulded. They shall be free from nodules of free lime, visible cracks, flaws warpage and organic matter, have a frog 100 mm in length 40 mm in width and 10 mm to 20 mm deep on one of its flat sides. Bricks made by extrusion process and brick tiles may not be provided with frogs. Each brick shall be marked (in the frog where provided) with the manufacturer's identification mark or initials.

(b) Fly Ash Lime Bricks (FALG Bricks) : The Fly Ash Lime Bricks (FALG Bricks) shall conform to IS 12894. Visually the bricks shall be sound, compact and uniform in shape free from visible cracks, warpage, flaws and organic matter. The bricks shall be solid and with or without frog on one of its flat side.

Fly Ash: Fly ash shall conform to IS 3812.

Note: This item will be operated only for load bearing structure upto 2 storeys and for non-load bearing walls 23 cms thick for multi-storeyed building's.

Bottom ash used as replacement of sand shall not have more than 12% loss on ignition when tested.

Sand: Deleterious materials, such as clay and silt in the sand shall preferably be less than 5%.

Lime: Lime shall conform to class 'C' hydrated lime of IS 712.

Additives: Any suitable additive considered not detrimental to the durability of bricks may be used.

(c) ***Clay Fly Ash Bricks:*** The clay fly ash bricks shall conform to IS 13757. The bricks shall be sound, compact and uniform in shape and colour. Bricks shall have smooth rectangular faces with sharp and square corners. The bricks shall be free from visible cracks, flaws, warpage, nodules of free lime and organic matter, the bricks shall be hand or machine moulded. The bricks shall have frog of 100 mm in length 40 mm width and 10 to 20 mm deep on one of its flat sides. If made by extrusion process may not be provided with frogs. Fly Ash shall conform to grade I or grade II of IS 3812.

(d) ***Calcium Silicate Bricks:*** The bricks shall conform to IS 4139. The Calcium silicate bricks shall be sound, compact and uniform in shape. Bricks shall be free from visible cracks, warpage, organic matter, large pebbles and nodules of free lime. Bricks shall be solid and with or without frog. The bricks shall be made of finely grounded sand siliceous rock and lime. In addition limited quantity of fly ash conforming to IS 3812 may be used in the mix. These bricks are also known as Fly Ash Sand Lime bricks in the construction industry.

(e) ***Tile Brick:*** The bricks of 4 cm height shall be moulded without frogs. Where modular tiles are not freely available in the market, the tile bricks of F.P.S. thickness 44 mm (1-3/4") shall be used unless otherwise specified.

(f) ***Brick Bats:*** Brick bats shall be obtained from well burnt bricks.

(g) ***Mechanized Autoclave Fly Ash Lime Brick:*** These bricks shall be machine moulded and prepared in plant by appropriate proportion of fly ash and lime. The autoclave fly ash bricks shall conform to IS 12894. Visually, the bricks shall be sound, compact and uniform shape, free from visible cracks, warpage and organic matters. The brick shall be solid with or without frog, and of 100/80 mm in length, 40 mm width and 10 to 20 mm deep one of its flat side as per IS 12894. The brick shall have smooth rectangular faces with sharp corners and shall be uniform in shape and colour. Fly ash shall conform to IS 3812 and lime shall conform to class 'C' hydrated lime of IS 712.

6.1.1 Dimensions

The brick may be modular or non-modular. Sizes for both types of bricks/tiles shall be as per Table 6.1. While use of modular bricks/tiles is recommended, non-modular (FPS) bricks/tiles can also be used where so specified. Non-modular bricks/tiles of sizes other than the sizes mentioned in Table 6.1 may also be used where specified.

TABLE 6.1

Type of Bricks/ Tiles	*Nominal Size mm*	*Actual Size mm*
Modular Bricks	200 × 100 × 100 mm	190 × 90 × 90 mm
Modular tile bricks	200 × 100 × 40 mm	190 × 90 × 40 mm
Non-modular tile bricks	229 × 114 × 44 mm	225 × 111 × 44 mm
Non-modular bricks	229 × 114 × 70 mm	225 × 111 × 70 mm

6.1.2 Classification

Bricks/Brick tiles shall be classified on the basis of their minimum compressive strength as given below :

TABLE 6.2

Class Designation	*Average compressive strength*			
	Not less than		*Less than*	
	N/mm^2	*(kgf/cm^2)*	*N/mm^2*	*(kgf/cm^2)*
12.5 (125)	12.5	*125*	*15.0*	*150*
10 (100)	10	100	12.5	125
7.5 (75)	7.5	75	10	100
5 (50)	5	50	7.5	75
3.5 (35)	3.5	35	5.0	50

The bricks shall have smooth rectangular faces with sharp corner and shall be uniform in colour and emit clear ringing sound when struck.

(**Note:** Upper limits specified in Table 6.2 are for calculating the average compressive strength in accordance with Appendix B of Chapter 6).

6.1.3 Sampling and Tests

Samples of bricks shall be subjected to the following tests :

(a) Dimensional tolerance.

(b) Water absorption.

(c) Efflorescence.

(d) Compressive strength.

6.1.3.1 ***Sampling:*** For carrying out compressive strength, water absorption, efflorescence and dimensional tests, the samples of bricks shall be taken at random according to the size of lot as given in Table 6.3 below. The sample thus taken shall be stored in a dry place until tests are made. For the purpose of sampling, the following definition shall apply.

(a) Lot: A collection of bricks of same class and size, manufactured under relatively similar conditions of production. For the purpose of sampling a lot shall contain a maximum, of 50,000 bricks.

In case a consignment has bricks more than 50,000 of the same classification and size and manufactured under relatively similar conditions of production, it shall be divided into lots of 50,000 bricks or part thereof.

(b) Sample: A collection of bricks selected for inspection and/or testing from a lot to reach the decision regarding the acceptance or rejection of the lot.

(c) Defective: A brick failing to meet one or more of the specified requirements.

6.1.3.2 The samples shall be taken as below:

(i) Sampling from a Stack: When it is necessary to take a sample from a stack, the stack shall be divided into a number of real or imaginary sections and the required number of bricks drawn from each section. For this purpose bricks in the upper layers of the stack shall be removed to enable units to be sampled from places within the stack.

Note: For other methods of sampling i.e. sampling in motion and sampling from lorries or trucks, IS :5454 may be referred.

Scale of sampling and criteria for conformity for visual and dimensional characteristics:—

Visual characteristics: The bricks shall be selected and inspected for ascertaining their conformity to the requirements of the relevant specification.

The number of bricks to be selected from a lot shall depend on the size of lot and shall be in accordance of Col. 1 and 2 of Table 6.3 for visual characteristics in all cases and dimensional characteristics if specified for individual bricks.

(ii) ***Visual Characteristics:*** All the bricks selected above in accordance with Col. 1 and 2 of Table 6.3 shall be examined for visual characteristics. If the number of defective bricks found in the sample is less than or equal to the corresponding number as specified in Col. 3 of Table 6.3 the lot shall be considered as satisfying the requirements of visual characteristics, otherwise the lot shall be deemed as not having met the visual requirements.

(iii) ***Dimensional Characteristics:*** The number of bricks to be selected for inspecting the dimensions and tolerance shall be in accordance with Col. 1 and 4 of Table 6.3. These bricks will be divided into groups of 20 bricks at random and each of the group of 20 bricks thus formed will be tested for all the dimensions and tolerances. A lot shall be considered having found meeting the requirements of dimensions and tolerance if none of the groups of bricks inspected fails to meet the specified requirements.

TABLE 6.3
Scale of Sampling and Permissible Number of Defectives for Visual and Dimensional Characteristics

No. of bricks in the lot	*For characteristics specified for individual bricks*		*For dimensional characteristics for group of 20 bricks*
	No. of bricks to be selected	*Permissible no. of defective in the sample*	*No. of bricks to be selected*
(1)	*(2)*	*(3)*	*(4)*
2001—10000	20	1	40
10001—35000	32	2	60
35001—50000	50	3	80

Note: In case the lot contains 2000 or less bricks the sampling shall be as per decision of the Engineer-in-Charge.

(iv) ***Scale of Sampling and Criteria for Physical Characteristics:*** The lot which has been found satisfactory in respect of visual and dimensional requirements shall be next tested for physical characteristics like compressive strength, water absorption, effloresence as specified in relevant material specification. The bricks for this purpose shall be taken at random from those already selected above. The number of bricks to be selected for each of these characteristics shall be in accordance with relevant columns of Table 6.4.

TABLE 6.4
Scale of Sampling for Physical Characteristics

Lot size	*Sample size for compressive strength, water absorption and efflorescence*	*Permissible No. of defectives for efflorescence*	*Warpage Sample Size*	*Permissible No of defects*
(1)	*(2)*	*(3)*	*(4)*	*(5)*
2001—10000	5	0	10	0
10001—35000	10	0	20	1
35001—50000	15	1	30	2

Note: In case the lot contains 2000 or less bricks, the sampling shall be as per decision of Engineer-in-Charge.

(v) A lot shall be considered having satisfied the requirements of physical characteristics if the condition stipulated here in are all satisfied.

(a) From the test results for compressive strength, the average shall be calculated and shall satisfy the requirements specified in relevant material specification.

Note: In case any of the test results for compressive strength exceeds the upper limit for the class of bricks, the same shall be limited to the upper limit of the class for the purpose of averaging.

(b) Wherever specified in the material specification, the compressive strength of any individual bricks tested in the sample shall not fall below the minimum average compressive strength specified for the corresponding class of brick by more than 20 per cent.

(c) From the test results for water absorption, the average for the bricks in the sample shall be calculated and shall satisfy the relevant requirements specification in material specification.

(d) The number of bricks failing to satisfy the requirements of the efflorescence specified in the relevant specification should not be more than the permissible no. of defectives given in Col. 3 of Table 6.4.

6.1.3.3 ***Dimensional Tolerances:*** The dimensions of, modular bricks when tested as described above as per procedure described in Appendix A of Chapter 6 shall be within the following limits per 20 bricks or locally available size as approved by Engineer-in-charge.

(a) For modular size
Length 7320 to 3880 mm (3800 ± 80 mm)

Width 1760 to 1840 mm (1800 ± 40 mm)

Height 1760 to 1840 mm (1800 ± 40 mm) for 90 mm high bricks

760 to 840 mm (800 ± 40 mm) for 40 mm high bricks

(b) For non modular bricks
Length 4520 to 4680 mm (4600 ± 80 mm)

Width 2240 to 2160 mm (2200 ± 40 cm)

Height 1440 to 1360 mm (1400 ± 40 mm) for 70 mm high bricks

640 to 560 mm (600 ± 40 mm) for 30 mm high bricks

Brick Tiles

760 to 840 mm (800 ± 40 mm) for 40 mm high brick tiles

In case of non-modular bricks, % age tolerance will be ± 2% for group of 20 numbers of class 10 bricks, and ± 4% for other class of bricks.

6.1.3.4 ***Compressive Strength:*** The bricks, when tested in accordance with the procedure laid down in Appendix B of Chapter 6 shall have a minimum average compressive strength for various classes as given in Table 6.2. The compressive strength of any individual brick tested shall not fall below the min. average compressive strength specified for the corresponding class of brick by more than 20%. In case compressive strength of any individual brick tested exceeds the upper limit specified in Table 6.2 for the corresponding class of bricks, the same shall be limited to upper limit of the class as specified in Table 6.2 for the purpose of calculating the average compressive strength.

6.1.3.5 ***Water Absorption:*** The average water absorption of bricks when tested in accordance with the procedure laid down in Appendix C of Chapter 6 shall be not more than 20% by weight.

6.1.3.6 ***Efflorescence:*** The rating of efflorescence of bricks when tested in accordance with the procedure laid down in Appendix D of Chapter 6 shall be not more than moderate.

6.1.4 Sewer Bricks

6.1.4.1 Sewer bricks are intended for the lining of walls, roofs and floors of sewers used for ordinary sanitary (domestic) sewage. The general practice in the country is also to utilize common building bricks in the construction of sewers which is not satisfactory. However, these sewer bricks may not be suitable for sewers dealing with industrial effluent (sewage) for which the use of acid resistant bricks in accordance with IS 4860 may be considered. Sewer bricks shall conform to IS 4885.

6.1.4.2 ***Dimensions and Tolerances***

Dimensions: The standard sizes of the sewer bricks shall be as follows:

Length mm	*Width mm*	*Height mm*
190	90	90
190	90	40

For sewers of special shapes, such as the oval sewers, the bricks may have to be suitable tapered to conform to the radii of curvature of the arches and barrels and sides of sewers.

Tolerance: The permissible tolerance on the dimensions specified in 6.1.4.2 shall be as follows :

Dimensions mm	*Total tolerance for 20 bricks mm*
190	±80
90	±40
40	±40

6.1.4.3 ***Compressive Strength:*** The average compressive strength obtained on a sample of sewer bricks when tested in accordance with the procedure laid down in IS 3495 (Part I) shall be not less than 17. 5 N/mm^2 (175 kgf/cm^2 approximately) and the individual strength of any brick shall be not less than 16 N/mm^2 (160 kgf/cm^2 approximately).

6.1.4.4 ***Water Absorption:*** The average value of water absorption for five bricks after 24 h cold water immersion test when tested in accordance with IS 3495 (Part 2) shall not exceed 10 per cent of the average dry weight of the brick and the absorption for any individual brick shall not exceed 12 per cent.

6.1.4.5 ***Efflorescence:*** When the bricks are tested in accordance with the method laid down in IS 3495 (Part 3), the rating of efflorescence shall not be more than 'slight'.

6.1.5 Burnt Clay Perforated Building Bricks

6.1.5.1 ***General Quality:*** The bricks shall be made of suitable clay and shall be thoroughly burnt at the maturing temperature of clay. They shall be free from cracks, flaws and nodules of free lime. They shall have rectangular face with sharp straight edge at right angle. They shall be of uniform colour and texture. These bricks generally should conform to IS 2222.

6.1.5.2 ***Dimensions and Tolerances:*** The standard size of burnt clay perforated bricks shall be as follows:

Type of Brick	*Length (L) mm*	*Width (W) mm*	*Height (H) mm*
Modular	190	90	90
Non Modular	230	110	70

The permissible tolerances on the dimensions shall be as follows:

Dimension mm	*Tolerance mm*
70, 90	±4
110, 190	± 7
230	± 10

Note: The tolerances specified above shall apply to measurements on individual bricks.

6.1.5.3 ***Perforations:*** The area of perforation shall be between 30% and 45% of the total area of the corresponding face of the bricks.

The perforation shall be uniformly distributed over the surface. In the case of rectangular perforations, the larger dimension shall be parallel to the longer side of the brick. The shorter side of the perforation shall be less than 20 mm incase of rectangular perforations and less than 25 mm diameter in case of circular perforations.

The area of each perforation shall not exceed 500 mm^2.

The thickness of any shell shall not be less then 15 mm and that of any web not less than 10 mm.

6.1.5.4 ***Compressive Strength:*** The bricks when tested in accordance with the procedure laid down in IS 3495 (Parts 1 to 4) shall have a minimum average compressive strength of 7 N/ mm^2 on net area.

The compressive strength of any individual brick tested shall not fall below the minimum compressive strength specified for the corresponding class of bricks. The lot shall then be checked for next lower class of brick.

6.1.5.5 ***Water Absorption:*** The bricks when tested in accordance with the procedure laid down in IS 3495 (parts 1 to 4): after immersion in cold water for 24 hours water absorption shall not be more than 20 percent by weight.

6.1.5.6 ***Efflorescence:*** The bricks when tested in accordance with the procedure laid down in IS 3495 (Parts 1 to 4) shall have a rating of efflorescence not more than 'slight'.

6.1.5.7 ***Warpage:*** The bricks when tested in accordance with the procedure laid down in IS 3495 (parts 1 to 4) the average warpage shall not exceed 3%.

6.2 BRICK WORK

6.2.1 Classification

The brick work shall be classified according to the class designation of bricks used.

6.2.2 Mortar

The mortar for the brick work shall be as specified, and conform to accepted standards. Lime shall not be used where reinforcement is provided in brick work.

6.2.3 Soaking of Bricks

Bricks shall be soaked in water before use for a period for the water to just penetrate the whole depth of the bricks. Alternatively bricks may be adequately soaked in stacks by profusely spraying with clean water at regular intervals for a period not less than six hours. The bricks required for masonry work using mud mortar shall not be soaked. When the bricks are soaked they shall be removed from the tank sufficiently early so that at the time of laying they are skin -dry. Such soaked bricks shall be stacked on a clean place where they are not again spoiled by dirt earth etc.

Note I: The period of soaking may be easily found at site by a field test in which the bricks are soaked in water for different periods and then broken to find the extent of water penetration. The least period that corresponds to complete soaking will be the one to be allowed for in construction work.

Note II : If the bricks are soaked for the required time in water that is frequently changed the soluble salt in the bricks will be leached out, and subsequently efflorescence will be reduced.

6.2.4 Laying

6. 2.4.1 Bricks shall be laid in English Bond (Fig. 6.2, 6.3, 6.4) unless otherwise specified. For brick work in half brick wall, bricks shall be laid in stretcher bond. Half or cut bricks shall not be used except as closer where necessary to complete the bond. Closers in such cases, shall be cut to the required size and used near the ends of the wall. Header bond shall be used preferably in all courses in curved plan for ensuring better alignment.

Note: Header bond shall also be used in foundation footings unless thickness of walls (width of footing) makes the use of headers impracticable. Where thickness of footing is uniform for a number of courses, the top course of footing shall be headers.

6.2.4.2 All loose materials, dirt and set lumps of mortar which may be lying over the surface on which brick work is to be freshly started, shall be removed with a wire brush and surface wetted. Bricks shall be laid on a full bed of mortar, when laying, each brick shall, be properly bedded and set in position by gently pressing with the handle of a trowel. Its inside face shall be buttered with mortar before the next brick is laid and pressed against it. Joints shall be fully filled and packed with mortar such that no hollow space are left inside the joints.

6.2.4.3 The walls shall be taken up truly in plumb or true to the required batter where specified. All courses shall be laid truly horizontal and all vertical joints shall be truly vertical. Vertical joints in the alternate course shall come directly one over the other. Quoin, Jambs and other angles shall be pro-perly plumbed as the work proceeds. Care shall be taken to keep the perpends properly aligned within following maximum permissible tolerances :

(a) Deviation from vertical within a storey shall not exceed 6 mm per 3 m height.

(b) Deviation in verticality in total height of any wall of building more than one storey in height shall not exceed 12.5 mm.

(c) Deviation from position shown on plan of any brick work shall not exceed 12.5 mm.

(d) Relative displacement between load bearing wall in adjacent storeys intended to be vertical alignments shall not exceed 6 mm.

(e) A set of tools comprising of wooden straight edge, masonic spirit levels, square, 1 metre rule line and plumb shall be kept on the site of work for every 3 masons for proper check during the progress of work.

6.2.4.4 All quoins shall be accurately constructed and the height of brick courses shall be kept uniform. This will be checked using graduated wooden straight edge or storey rod indicating height of each course including thickness of joints. The position of damp proof course, window sills, bottom of lintels, top of the wall etc. along the height of the wall shall be marked on the graduated straight edge or storey rod. Acute and obtuse quoins shall be bonded, where practicable in the same way as square quoins. Obtuse quoins shall be formed with squint showing three quarters brick on one face and quarter brick on the other.

6.2.4.5 The brick work shall be built in uniform layers.

No part of the wall during its construction shall rise more than one metre above the general construction level. Parts of wall left at different levels shall be raked back at an angle of 45 degrees or less with the horizontal. Toothing shall not be permitted as an alternative to raking back. For half brick partition to be keyed into main walls, indents shall be left in the main walls.

6.2.4.6 All pipe fittings and specials, spouts, hold fasts and other fixtures which are required to be built into the walls shall be embedded, as specified, in their correct position as the work proceeds unless otherwise directed by the Engineer-in-Charge.

6.2.4.7 Top courses of all plinths, parapets, steps and top of walls below floor and roof slabs shall be laid with brick on edge, unless specified otherwise. Brick on edge laid in the top courses at corner of walls shall be

properly radiated and keyed into position to form cut (maru) corners as shown in Fig 6.4. Where bricks cannot be cut to the required shape to form cut (maru) corners, cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size) equal to thickness of course shall be provided in lieu of cut bricks.

6.2.4.8 Bricks shall be laid with frog (where provided) up. However, when top course is exposed, bricks shall be laid with frog down. For the bricks to be laid with frog down, the frog shall be filled with mortar before placing the brick in position.

6.2.4.9 In case of walls one brick thick and under, one face shall be kept even and in proper plane, while the other face may be slightly rough. In case of walls more than one brick thick, both the faces shall be kept even and in proper plane.

6.2.4.10 To facilitate taking service lines later without excessive cutting of completed work, sleeves (to be paid separately) shall be provided, where specified, while raising the brick work. Such sleeves in external walls shall be sloped down outward so as to avoid passage of water inside.

6.2.4.11 Top of the brickwork in coping and sills in external walls shall be slightly tilted. Where brick coping and sills are projecting beyond the face of the wall, drip course/throating (to be paid separately) shall be provided where indicated.

6.2.4.12 Care shall be taken during construction that edges of jambs, sills and projections are not damaged in case of rain. New built work shall be covered with gunny bags or tarpoulin so as to prevent the mortar from being washed away. Damage, if any, shall be made good to the satisfaction of the Engineer-in-Charge.

6.2.4.13 Vertical reinforcement in the form of bars (MS or high strength deformed bars or thermo-mechanically treated bars as per direction of Engineer-in- Charge)), considered necessary at the corners and junction of walls and jamb opening doors, windows etc. shall be encased with cement mortar not leaner than 1:4 (1 cement : 4 coarse sand), or cement concrete mix as specified. The reinforcement shall be suitably tied, properly embedded in the foundation and at roof level. The dia. of bars shall not be less than 8 mm and concrete grade shall be minimum 1:3:6 (1 cement : 3 coarse sand : 6 graded stone aggregate 20 mm nominal size).

6.2.4.14 In retaining walls and the like, where water is likely to accumulate, weep holes, 50 to 75 mm square shall be provided at 2 m vertically and horizontally unless otherwise specified. The lowest weep hole shall be at about 30 cm above the ground level. All weep holes shall be surrounded by loose stones and shall have sufficient fall to drain out the water quickly.

Note : Work of providing loose stone will be payable extra.

6.2.4.15 Work of cutting chases, wherever required to be made in the walls for housing G.I. pipe, CI pipe or any other fixtures shall be carried out in various locations as per guidelines given below :

(a) Cutting of chases in one brick thick and above load bearing walls.

(i) As far as possible services should be planned with the help of vertical chases. Horizontal chases should be avoided.

(ii) The depths of vertical chases and horizontal chases shall not exceed one-third and one-sixth of the thickness of the masonry respectively.

(iii) When narrow stretches of masonry (or short length of walls) such as between doors and windows, cannot be avoided they should not be pierced with openings for soil pipes or waste pipes or timber joints, etc. Where there is a possibility of load concentration such narrow lengths of walls shall be checked for stresses and high strength bricks in mortar or concrete walls provided, if required.

(iv) Horizontal chases when unavoidable should be located in the upper or lower one-third of height of storey and not more than three chases should be permitted in any stretch of a wall. No continuous horizontal chase shall exceed one metre in length. Where unavoidable, stresses in the affected area should be checked and kept within the permissible limits.

(v) Vertical chases should not be closer than 2 m in any stretch of a wall. These shall be kept away from bearings of beams and lintels. If unavoidable, stresses in the affected area should be checked and kept within permissible limits.

(vi) Masonry directly above a recess, if wider than 30 cm horizontal dimension) should be supported on lintel. Holes in masonry may be provided upto 30 cm width and 30 cm height without any lintel. In the case of circular holes in the masonry, no lintel need be provided for holes upto 40 cm in diameter.

(b) Cutting of chases in half brick load bearing walls.
No chase shall be permitted in half brick load bearing walls and as such no reccessed conduits and concealed pipes shall be provided with half brick thick load bearing walls.

(c) Cutting of chases in half brick non-load bearing wall :
Services should be planned with the help of vertical chases. Horizontal chase should be provided only when unavoidable.

6.2.5 Joints

The thickness of all types of joints including brick wall joints and cross joints shall be such that four course and three joints taken consecutively shall measure as follows:

(i) In case of modular bricks conforming to IS 1077 specification for common burnt clay buildings bricks, equal to 39 cm.

(ii) In case of non-modular bricks, it shall be equal to 31 cm.

Note : Specified thickness of joints shall be of 1 cm. Deviation from the specified thickness of all joints shall not exceed one-fifth of specified thickness.

6.2.5.1 ***Finishing of Joints:*** The face of brick work may be finished flush or by pointing. In flush finishing either the face joints of the mortar shall be worked out while still green to give a finished surface flush with the face of the brick work or the joints shall be squarely raked out to a depth of 1 cm while the mortar is still green for subsequently plastering. The faces of brick work shall be cleaned with wire brush so as to remove any splashes of mortar during the course of raising the brick work. In pointing, the joints shall be squarely raked out to a depth of 1.5 cm while the mortar is still green and raked joints shall be brushed to remove dust and loose particles and well wetted, and shall be later refilled with mortar to give ruled finish. Some such finishes are 'flush', 'weathered', ruled, etc.

6.2.6 Curing

The brick work shall be constantly kept moist on all faces for a minimum period of seven days. Brick work done during the day shall be suitably marked indicating the date on which the work is done so as to keep a watch on the curing period.

6.2.7 Scaffolding

Scaffolding shall be strong to withstand all dead, live and impact loads which are likely to come on them. Scaffolding shall be provided to allow easy approach to every part of the work.

6.2.7.1 ***Single Scaffolding:*** Where plastering, pointing or any other finishing has been indicated for brick work, single scaffolding may be provided, unless otherwise specified. In single scaffolding, one end of the put-logs/pole shall rest in the hole provided in the header course of brick masonry. Not more than one header for each put-log/pole shall be left out. Such holes shall not be allowed in the case of pillars, brick work less than one metre in length between the openings or near the skew backs of arches or immediately under or near the structural member supported by the walls. The holes for putlogs/poles shall be made good with brick work and wall finishing as specified.

6.2.7.2 ***Double Scaffolding:*** Where the brick work or tile work is to be exposed and not to be finished with plastering etc. double scaffolding having two independent supports, clear of the work, shall be provided.

6.2.8 Measurements

6.2.8.1 Brick work shall be measured in cubic metres unless otherwise specified. Any extra work over the specified dimensions shall be ignored. Dimensions shall be measured correct to the nearest 0.01 m i.e. 1 cm.

Areas shall be calculated to the nearest 0.01 sq mtrs and the cubic contents shall be worked out to the nearest 0.01 cubic metres.

6.2.8.2 Brick work shall be measured separately in the following stages:

(a) From foundation to floor one level (Plinth level)
(b) Plinth (floor one) level to floor two level
(c) Between two specified floor levels above floor two level

Note : (i) Brick work in parapet walls, mumty, lift machine room and water tanks constructed on the roof upto 1.2 m height above roof shall be measured together with the corresponding work of the floor next below.

6.2.8.3 No deductions or additions shall be done and no extra payment made for the following :

Note : Where minimum area is defined for deduction of an opening, void or both, such areas shall refer only to opening or void within the space measured.

(a) Ends of dissimilar materials (that is, joists, beams, lintels, posts, girders, rafters, purlins, trusses, corbels, steps, etc.); up to 0.1 m^2 in section;
(b) Opening up to 0.1 m^2 in area (see Note);
(c) Wall plates, bed plates, and bearing of slabs, chajjas and the like, where thickness does not exceed 10 cm and bearing does not extend over the full thickness of wall;
(d) Cement concrete blocks as for hold fasts and holding down bolts;
(e) Iron fixtures, such as wall ties, pipes upto 300 mm diameter and hold fasts for doors and windows; and
(f) Chases of section not exceeding 50 cm in girth.
(g) Bearing portion of drip course, bearing of moulding and cornice.

Note : In calculating area of an opening, any separate lintel or sills shall be included with the size of the opening but end portions of lintel shall be excluded. Extra width of rebated reveals, if any, shall also be excluded.

6.2.8.4 Walls half brick thick and less shall each be measured separately in square metres stating thickness.

6.2.8.5 Walls beyond half brick thickness shall be measured in multiples of half brick which shall be deemed to be inclusive of mortar joints. For the sizes of bricks specified in 6.1.1, half brick thickness shall mean 100 mm for modular and 115 mm for non-modular bricks.

Where fractions of half brick occur due to architectural or other reasons, measurement shall be as follows :

(a) upto 1/4th brick-actual measurements and
(b) exceeding 1/4 brick-full half bricks.

6.2.8.6 String courses, projecting pilasters, aprons, sills and other projections shall be fully described and measured separately in running metres stating dimensions of each projection.

6.2.8.7 Square or rectangular pillars shall be measured separately in cubic metres in multiple of half brick.

6.2.8.8 Circular pillars shall be measured separately in cubic metres as per actual dimensions.

6.2.8.9 Brick work curved on plan shall be measured like the brick work in straight walls and shall include all cutting and wastage of bricks, tapered vertical joints and use of extra mortar, if any. Brick work curved on plan to a mean radius not exceeding six metres shall be measured separately and extra shall be payable over the rates for brick work in straight walls. Nothing extra shall be payable if the mean radius of the brick work curved in plan exceeds six metres.

6.2.8.10 Tapered walls shall be measured net as walls and extra payment shall be allowed for making tapered surface for brick work in walls.

6.2.8.11 Brick work with brick tiles shall be measured and paid for separately.

6.2.9 Rate

The rate shall include the cost of materials and labour required for all the operations described above except the vertical reinforcement and its encasement in cement mortar or cement concrete. The rate shall also include the following :

(a) Raking out joints or finishing joints flush as the work proceeds;
(b) Preparing tops of existing walls and the like for raising further new brick work.
(c) Rough cutting and waste for forming gables, splays at eaves and the like.
(d) Leaving holes for pipes upto 150 mm dia. and encasing hold fasts etc.
(e) Rough cutting and waste for brick work curved in plan and for backing to stone or other types of facing.
(f) Embedding in ends of beams, joists, slabs, lintels, sills, trusses etc.
(g) Bedding wall plates, lintels, sills, roof tiles, corrugated sheets, etc. in or on walls if not covered in respective items and
(h) Leaving chases of section not exceeding 50 cm in girth or 350 sq cm in cross-section.
(i) Brick on edge courses, cut brick corners, splays reveals, cavity walls, brick works curved on plan to a mean radius exceeding six metres.

6.3 BRICK WORK IN ARCHES (FIG. 6.5)

6.3.0 The detailed specifications for brick work mentioned in 6.2 shall apply, in so far as these are applicable. Arch work shall include masonry for both gauged as well as plain arches. In gauged arches, cut or moulded bricks shall be used. In plain arches, uncut bricks shall be used.

Brick forming skew-backs shall be dressed or cut so as to give proper radial bearing to the end voussiors. Defects in dressing of bricks shall not be covered by extravagant use of mortar, nor shall the use of chips or bats etc. be permitted.

The bricks of the spandrel wall at their junctions with the extrudes of the arch shall be cut to fit the curvature of the arch.

6.3.1 Circular Arches

These shall be either (a) plain arches, and shall be built in half brick concentric rings with break joints, or (b) gauged arches built with bricks cut or moulded to proper shape. The arch work shall be carried up from both ends simultaneously and keyed in the centre. The bricks shall be flush with mortar and well pressed into their positions so as to squeeze out a part of their mortar and leave the joints thin and compact. All joints shall be full of mortar and thickness of joints shall not be less than 5 mm nor more than 15 mm.

After the arch is completed, the haunches shall be loaded by filling up the spandrels upto the crown level of the arch. Care shall be taken to load the haunches on two sides of the spandrels.

When the arch face is to be pointed (and not plastered), the face bricks shall be cut to proper shape or moulded, so as to have the joints not more than 5 mm thick. These shall be laid with radial joints to the full depth of the arch. The voussoirs shall break joints to the full depth of the arch.

6.3.2 Flat Arches

These shall be gauged arches of brick cut or moulded to proper shape. The extrados shall be kept horizontal and the intrados shall be given slight camber of 1 in 100 of the span. The centre of the arch from which joints shall radiate, shall be determined by the point of the inter-section of the two lines drawn from the ends of the arch at the springing level and at 60° to horizontal.

In flat arches, bricks shall be laid with radial joints to the full depth of arch and voussoirs breaking joints with each other. The arch work shall be carried up from both ends simultaneously and keyed in the centre. The thickness of the joints shall not exceed 5 mm. Flat arches may be used for the sake of appearance but for purpose of carrying loads of the wall above, these shall be used in conjunction with relieving arches, lintels placed below.

6.3.3 Centring and Shuttering

The centring and shuttering for the arch shall be got approved by the Engineer-in- Charge before the arch work is started. It shall be strong enough to bear the dead load of the arch and the live loads that are likely to come upon it during construction, without any appreciable deflections.

The shuttering shall be tightened with hard wood wedged or sand boxes, so that the same could be eased without jerks being transmitted to the arch. The sequence of easing the shuttering shall be got approved from the Engineer- in-Charge. The shuttering shall be struck within 48 hours of the completion of the arch but not before 24 hours. This shall be done after the spandrel has been filled in and the arch loaded.

6.3.4 Measurements

The length of the arch shall be measured as the mean of the extrados and intrados of the arch correct to a cm. The thickness of the arch shall be measured in multiples of the half brick.

The breadth in the direction of the thickness of wall shall be measured as specified.

The cubical contents shall be calculated in cubic metre, correct to two places of decimal.

For arches exceeding 6 m in spans extra payment shall be made on the actual area of the soffit for additional cost of centring including all strutting, bolting, wedging, easing, striking and its removal.

6.3.5 Rate

The rate is inclusive of the cost of the materials and labour required for all the operations described above.

6.4 HALF BRICK WORK

Brick work in half brick walls shall be done in the same manner as described above in 6.2.4 except that the bricks shall be laid in stretcher bond. When the half brick work is to be reinforced, 2 Nos. M.S. bars of 6 mm dia., shall be embedded in every third course as given in the item (the dia of bars shall not exceed 8 mm). These shall be securely anchored at their end where the partitions end. The free ends of the reinforcement shall be keyed into the mortar of the main brick work to which the half brick work is joined. The mortar used for reinforced brick work shall be rich dense cement mortar of mix 1:4 (1 cement: 4 coarse sand). Lime mortar shall not be used. Over laps in reinforcement, if any shall not be less than 30 cm.

The mortar interposed between the reinforcement bars and the brick shall not be less than 5 mm.

The mortar covering in the direction of joints shall not be less than 15 mm.

6.4.1 Measurements

The length and height of the wall shall be measured correct to a cm. The area shall be calculated in sq.m. where half brick wall is joined to the main walls of one brick or greater thickness and measurements for half brick wall shall be taken for its clear length from the face of the thicker wall.

6.4.2 Rate

The rate includes the cost of the materials and labour involved in all the operations described above except reinforcement which is to be paid for separately.

6.5 BRICK TILE WORK

6.5.0 The work shall be done in the same manner as described in 6.2.4 except that brick tile shall be used instead of bricks. The measurement and rate shall be same as specified under 6.2.

6.6 HONEY COMB BRICK WORK

The honeycomb brick work shall be done with specified class of brick, laid in specified mortar. All joints and edges shall be struck flush to give an even surface.

The thickness of the brick honeycomb work shall be half-brick only, unless otherwise specified. Openings shall be equal and alternate with half brick laid with a bearing of 2 cm on either side.

6.6.1 Measurements

The length and height shall be measured correct to a cm. Area shall be calculated in square metres correct to two places of decimal. Honeycomb openings shall not be deducted.

6.6.2 Rate

The rate includes the cost of materials and labour involved in all the operations described above.

6.7 JOINING OLD BRICK WORK WITH NEW BRICK WORK

6.7.1 In case the height of the bricks of old as well as new work is same, the old work shall be toothed to the full width of the new wall and to the depth of a quarter of brick in alternate courses. In case the height of the bricks is unequal, then the height of each course of new work shall be made equal to the height of the old work by adjusting thickness of horizontal mortar joints in the new wall. Where necessary, adjustment shall be made equal to thickness of old wall by adjusting the thickness of vertical joints.

6.7.2 For joining new cross wall to old main walls, a number of rectangular recesses of width equal to the thickness of cross wall, three courses in height and half a brick in depth shall be cut in the main walls. A space of the three courses shall be left between two consecutive recesses. The new cross wall shall be bonded into the recesses to avoid any settlement.

6.7.3 Joining of old brick work with the new brick work shall be done in such a way that there shall not be any hump or projection at the joint.

6.7.4 Measurement

The height and thickness of vertical face in contact with new work shall be measured to the nearest 0.01 m and the area shall be calculated to the nearest 0.01 sqm.

6.7.5 Rate

The rate includes the cost of labour and material involved in all the operations described above.

6.8 MOULDING AND CORNICES

6.8.0 The specifications described under 6.2 shall apply in so far these are applicable. Mouldings and cornices shall be made with bricks as specified for brick work. The bricks shall be cut and dressed to the required shape as shown in the architectural drawings.

6.8.1 Cornices shall not ordinarily project by more than 15 cm to 20 cm and this projection shall be obtained by projecting each brick course by more than one fourth of the length. For cornices projecting more than 20 cm and requiring more than quarter bricks projection, metal cramps shall be used and paid for separately.

6.8.2 Corbelling shall be brought roughly to shape by plastering with the specified mortar. When the mortar is still green, the mouldings shall be finished straight and true with the help of metal templates.

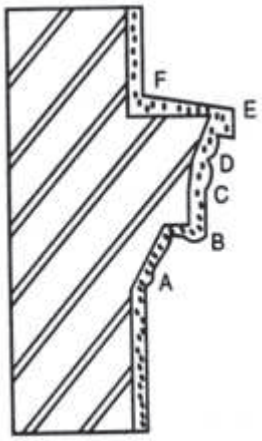
6.8.3 Curing and Protection

The mouldings and cornices shall be cured for at least seven days. These shall be protected from the effects of sun and rain by suitable covering and also from damage during the execution of the work.

6.8.4 Measurements

For the purpose of measurements, the sectional periphery of mouldings and cornices (excluding the portion in contact with wall) shall be measured in centimetres and length in metres (fig. below) .

The girth and length shall be measured correct to a cm. No deduction shall be made from the masonry of wall for the bearing of the moulding and cornices.



Note : 1 The sectional periphery curve ABCDEF.
2. Length FA shall not be measured.

6.8.5 Rate

The rate includes the cost of materials and labour involved in all the operations described above.

6.9 BRICK WORK UNDER WATER OR FOUL CONDITIONS

Brick Work under following conditions :

(i) Work in or under water/or liquid mud;

(ii) Work in or under foul positions

Shall be measured separately for payment of extra rate over and above the quantity measured and paid under para 6.2.8.

6.10 EXPOSED BRICK WORK

6.10.1 Facing Bricks

The facing bricks made from suitable soils shall be free from cracks, flaws, nodules of free lime warpage and organic matter. These shall be thoroughly burnt and shall have plane rectangular faces with parallel sides and sharp straight right angled edges. Facing bricks shall have uniform colour and even texture. Unless otherwise specified, facing bricks shall be machine moulded only. As far as possible, total requirement of facing bricks for a work shall be arranged from the same kiln. Bricks with chipped edges and broken corners shall not be used.

6.10.2 Dimensions and Tolerances

The standard sizes of machine moulded facing bricks shall be as specified in 6.1.1.

6.10.2.1 The permissible tolerances shall be as under:

Dimension mm		*Tolerance (For Machine moulded bricks) mm*
Length	190 or 225	±3
Width	90 or 111	±1.5
Thickness	40 or 44	±1.5

Note: Tolerance and Dimensions for selected hand moulded bricks ± 4 mm in length and ± 3 mm in width and thickness).

6.10.3 Sampling

As per Para 6.1.3 and 6.1.3.2.

6.10.4 Physical Requirements

Facing bricks shall be of class designation 75 unless otherwise specified. Average compressive strength shall not be less than 7.5 N/mm^2, water absorption shall not exceed 20 per cent by weight and efflorescence rating shall be nil when tested in accordance with the procedure laid down and tolerance in dimensions shall be checked as per the procedure laid down in Appendix A-2.

Mortar, Soaking of Bricks and laying shall be as specified in Para 6.2.2, 6.2.3 and 6.2.4 respectively.

6.10.5 Joints in the exposed brick work shall be truly horizontal and vertical and kept uniform with the help of wooden or steel strips. The thickness of joints shall be as per 6.2.5.

6.10.6 Curing and scaffolding shall be as specified in 6.2.6 and 6.2.7 to 6.2.7.2 respectively.

6.10.7 Measurements

Exposed brick work in face using machine moulded bricks and selected hand moulded bricks shall be measured separately and the measurement shall be as specified in 6.2.8.

6.10.8 Rate

The rates shall be as specified in 6.2.9 and shall also include the following :

(a) Labour for selecting bricks and wastage of bricks where use of selected hand moulded brick is specified.

(b) Leaving uniform horizontal and vertical grooves of specified depth and providing joints of required thickness using wooden or steel strips as the work proceeds.

6.11 CAVITY WALL

It is a wall comprising of two leaves, each leaf being built of masonry units and separated by a cavity so as to provide an air space within the wall and tied together with metal ties or bonding units to ensure that two leaves act as one structural unit. The width of the cavity shall not be less than 50 mm and not more than 115 mm. Each leaf of the cavity wall shall not be less than 75 mm. The space between the leaves being either left as cavity or filled with non-load bearing insulating and water proofing material.

6.11.1 Metal Ties

These may be of galvanised iron, wrought iron, gun metal, brass, copper, stainless steel or any such corrosion resistant metal, made of flats 20 x 5 mm cranked or twisted at their mid point with ends split and fish tailed. The ties shall be built into horizontal bed joints during erection, placed sloping towards the exterior side to prevent water from flowing along it from outer to inner leaf side (For details refer Fig. 6.6 of Chapter 6).

6.11.2 Bonding Units

These shall be preferably precast R.C.C. units having cross-section as per Fig. No. 6.6.

Length of the Bonding units will be sum of thickness of both leaves plus width of cavity if the leaves are 75 mm or 115 mm. If the leaves are more than 115 mm thick, then the length of a unit will be 2 × 115 + width of cavity as shown in Fig. 6 of Chapter 6. Precast RCC units shall be provided with 2 no., 6 mm mild steel reinforcement bars tied with 2 no. 3 mm. dia. M.S. wire/hard drawn wire cross bars (As shown in Fig. 6 of Chapter 6) placed in the centre of units.

Cement concrete used in the bonding units shall not be leaner than 1:3:6 (1 cement : 3 coarse sand : 6 graded stone aggregate 20 mm nominal size).

6.11.3 Spacing

Metal ties/bonding units shall be spaced not more than 90 cm apart horizontally and 45 cm vertically and staggered in each course. Additional ties shall be used near openings.

6.11.4 Restrictions

Cavity walls shall not normally be built more than 7.5 metres in height and 9 metres in length. Where large lengths and heights are desired, the wall shall be divided into panels with strengthening measures such as pillars etc. Cavity shall be covered at the top with at least two courses of masonry unit and/or a coping over it.

Adoption of cavity walls is not recommended when heavy concentrated load from beam etc. are to be supported by walls.

6.11.5 Measurements and Rate

(a) Brick work in cavity walls shall be included and measured with general brick work. The width of the cavity shall not be measured. Skin of cavity wall, half brick thickness shall be measured as and paid as described in para 6.2.8 and 6.4.

(b) The forming of the cavity shall be given in square metres stating the width of the cavity and shall include the metal ties/bonding unit specifying the numbers per square metre.

(c) Labour and material for closing cavities at the jambs, sills and heads of opening shall be as described and measured separately in running metres.

(d) The item shall include use of device for keeping cavity clear and forming the requisite weep and vent holes and nothing extra on this account shall be payable.

6.12 GYPSUM PARTITION PANELS

6.12.1 The material shall conform to IS:2849.

6.12.2 Dimensions

As per the item nomenclature.

6.12.3 Laying

(i) Panels are stored in a dry place and water should not come in contact with panels during or after construction. If the panels get wet, they should be dried before use.

(ii) The floor should be perfectly level before laying the first course. All panels must be properly aligned to the plumb. Successive layer of panels must be alternatively staggered so that vertical joints are not in the same line.

(iii) The recommended quantity of Gypsum Bonding Plaster must be used for joints and filling the grooves made for conduits, pipelines, etc. Excess Bonding Plaster must be scooped and removed, so that the joints and the places where the grooves are filled in are flush and even.

(iv) The walls should be dry and sanding done properly especially at joints before the primer is applied so that the surface is even and joints will not be visible after painting. Avoid chasing with chisel and hammer. Use electrical saw or grooving tools for conduiting etc.

(v) The recommended span of walls is maximum 6 meters and maximum height is 4.5 meters.

(vi) Gypsum panel can easily be cut with coarse tooth hand saw, electric jigsaw, etc. The panels can be cut, sawn, drilled, milled or dowelled on the job. For concealed piping and conduit, the depth of groove should not exceed 50 mm. Hammer and chisel techniques to form chases must be avoided.

(vii) Sanding: This application is to make the surface level without undulations. To make the gypsum wall surface level (in particular at joints, where there is excess bonding plaster), do sanding with sand paper at joints and other places, wherever you find uneven surface, otherwise joints will be visible after painting. It is important to sand all joints uniformly.

(viii) Primer Application: The purpose of the primer is to give a better adhesion to the paint and also to reduce consumption of paint on the wall. Water thinable primers shall be used only.

6.12.4 Measurements

The length and height shall be measured correct to a cm. Area shall be calculated in square meters correct to two place of decimal. No deduction shall be made for ducts, opening made from the standard size of panel.

6.12.5 Rate

The rate shall include the cost of materials and labour involved in all the operations described above.

6.13 BRICK EDGING

6.13.1 The edging shall be of bricks of class specified in the item. The specifications of bricks shall be as described in 6.1. Trenches of required depth and width shall first be made along the edge of the plinth protection to receive the bricks for edging. The bed of trenches shall be compacted to a firm and even surface. The brick shall be laid true to line in cement mortar 1:4 (1 cement: 4 fine sand) with length parallel and butting the plinth protection. The top face of the brick edging shall be in one level to conform to the finished level of the plinth protection adjacent to the edging. After the concreting is done, no portion of the brick edging shall project above the adjacent concrete surface. Cement mortar shall conform to the specification described in chapter 3.0.

6.13.2 Measurements

The brick edging shall be measured in running metere correct a cm.

6.13.3 Rate

Rate shall include the cost of materials and labour involved in all operations.

6.14 AUTOCLAVED AERATED CONCRETE BLOCK MASONRY WORK

6.14.1 Terminology

For the purpose of, Autoclave Aerated Concrete Block masonry work, the following definitions shall apply

1. **Autoclaved** -Steam curing of concrete Products, sand lime bricks, asbestos cement products, hydrous calcium silicate insulation Products, or cement in an autoclave at maximum ambient temperatures generally between 170^0C to 215^0C.
2. **Block -** A concrete masonry unit, any one of the external dimensions of which is greater than the corresponding dimension of a brick as specified in IS : 3952-1978 and of such size and mass as to permit it to be handled by one man. Furthermore, to avoid confusion with slabs and Panels, the height of the block shall not exceed either its length or six times its width.
3. **Block Density** - The density calculated by dividing the mass of a block by the overall volume, including holes or cavities and end recesses..
4. **Drying Shrinkage** - The difference between the length of specimen which has been immersed in water and then subsequently dried to constant length, all under specified conditions; expressed as a percentage of the dry length of the specimen.
5. **Gross Area**-The total area occupied by a block on its loading face, including areas of the cavities and end recesses.
6. **Height** -The vertical dimension of the exposed face of a block, excluding any tongue or other device designed to provide mechanical keying
7. **Length** - The horizontal dimension of the exposed face of a block excluding any tongue or other device designed to provide mechanical keying.
8. **Width -**The external dimension of a block at the bedding plane, measured at right angles to the length and height of the block.

6.14.2 Dimensions & Tolerances:

Autoclave Aerated Concrete Block shall be made in sizes and shapes to fit different concrete needs. They include stretcher, corner, double corner or pier, jamb, header, bull nose, partition block and concrete floor units.

Autoclave Aerated Concrete Block shall be referred to by its normal dimension the term ‘normal’ means that the dimension includes the thickness of the mortar joints. The actual dimension shall be 10mm short of the normal dimension (or 6mm short in special areas finer joints as specified).

6.14.2.1 The normal dimension of the concrete block shall be as follows:-

Length	:	400, 500 or 600 mm
Height	:	200, 250 or 300 mm
Width	:	100, 150, 200 or 250 mm

In addition, Autoclave Aerated Concrete Block shall be manufactured in half length of 200, 250 or 300 mm correspond to the full lengths.

6.14.2.2 The nominal dimensions of the units are so designed that taking account of the thickness of mortar joints, they will produce wall length sand heights which will conform to the principles of modular co-ordination.

6.14.2.3 Block of sizes other than those specified above, may also be used if so specified in the case of special Autoclave Aerated Concrete Block such as jallie or screen wall and ornamental block ,the specified size may not necessarily apply.

6.14.2.4 The maximum variation in the length of the Autoclave Aerated Concrete Block shall not be more than plus/minus 5mm and maximum variation in the height and width of Autoclave Aerated Concrete Block, not more than plus/minus 3mm.

6.14.2.5 The faces of Autoclave Aerated Concrete Block shall be flat & Rectangular, opposite faces shall be parallel and all arises shall be square. The bedding surfaces shall be at right angle to the face of the Blocks.

6.14.2.6 The Autoclave Aerated Concrete Block with special faces shall be manufactured and supplied if so specified.

6.14.3 The autoclaved Autoclave Aerated Concrete Block shall be classified in two grades according to their compressive strength as indicated in table:

S. No.	Density in oven dry condition (Kg/m^2)	Compressive Strength (Min)		Thermal Condition in Air dry condition (W/m.k)
		Grade-I (N/mm^2)	Grade-II (N/mm^2)	
1	451 to 550	2.00	1.50	0.21
2	551 to 650	4.00	3.00	0.24
3	651 to 750	5.00	4.00	0.30
4	751 to 850	6.00	5.00	0.37
5	851 to 1000	7.00	6.00	0.42

6.14.4 Materials

6.14.4.1 Cement complying with any of the Indian Standard may be used as per the direction of the manufacturer.

6.14.4.2 Use of Fly ash conforming to IS 3812-1981 may be permitted to a limit of 20% in cement conforming to IS 269-1976.

6.14.4.3 The lime shall satisfy the requirement for class C lime specified as IS 712-1973.

6.14.4.4 The aggregate used for the manufacture of Autoclave Aerated Concrete Block shall conform to the following requirements

(a) Sand-Conforming to IS 383-1970 except for the grading which may be made to suit the product and silica content shall not be less than 80%.

(b) Fly ash – Conforming to IS 3812-1981 with loss on ignition not more than 6%.

6.14.4.5 The water used in the manufacture of Autoclave Aerated Concrete Block shall be free from matter harmful to concrete or reinforcement or matter likely to cause efflorescence in the block and shall meet the requirements of IS 456-2000.

6.14.4.6 Additives and Admixtures may be added either as additives to the cement during manufacturing or as additive or admixtures to the concrete mix. Additive or admixtures used in the manufacture of concrete block may be

(a) Accelerating , water reducing and air –entraining admixtures conforming to IS 9103-1979

(b) Water proofing agent conforming to IS 2645-1975

(c) Colouring pigments

6.14.5 Physical requirements

6.14.5.1 All Autoclave Aerated Concrete Block shall be sound, free of cracks or other defects which interfere with the proper placing of block units, impair the strength or performance of the construction.

6.14.5.2 Where block units are to be used in exposed wall construction, the face or faces that are to be exposed shall be free of chips, cracks or other imperfections except that if not more than 5% of a consignment contains slight cracks or small chippings not larger than 25mm, this shall not be deemed grounds for rejection.

6.14.5.3 Dimensions- The overall dimension of the block units when measured shall be in accordance with para 6.14.2.1 subjected to the tolerances mentioned in para 6.14.2.4

6.14.5.4 Block Density - The Block density shall conform to the requirements specified in table of para 6.14.3, when tested accordance with para 6.14.6 (1)

6.14.5.5 Compressive Strength - The min. compressive strength being the average of twelve block units shall be as prescribed in table of para 6.14.3, when tested accordance with para 6.14.6(2)

6.14.5.6 Thermal Conductivity - The thermal conductivity shall be not exceed the values specified in table of para 6.14.3 when tested accordance with para 6.14.6(3)

6.14.5.7 Drying Shrinkage – the drying shrinkage shall be not more than 0 .05% for grade –1 block and 0.10% for grade-2 block when tested accordance with para 6.14.6(4)

6.14.6 Tests

1. Block Density- The block density shall be determined in the manner described in IS 6441 (part-1) -1972

2. Compressive Strength- The compressive strength of block shall be determined in accordance with IS 6441 (part-5) -1972

3. Thermal Conductivity- The thermal conductivity of block shall be determined in accordance with IS 3346 -1980

4. Drying Shrinkages-The drying shrinkage of block shall be determined in the manner described in IS 6441 (part-2) -1972

6.14.7 Sampling

6.14.7.1 **Lot** - In any consignment, all the blocks of the same size and from the same batch of manufacture shall be grouped together into a minimum number of groups of 10000 blocks or less. Each such group shall constitute a lot.

6.14.7.2 From each lot, a sample of 24 blocks shall be selected at random. The required numbers of Blocks shall be taken at regular intervals during the loading of the vehicle or unloading the vehicles depending on whether sample is taken before delivery or after delivery. When this is not practicable,

sample shall be taken from the stack in which case the required number of blocks shall be taken at random from across the top of the stacks, the sides accessible and from the interior of the stacks by opening trenches from the top.

6.14.7.3 The sample of blocks shall be marked for future identification of the consignment it represents. The blocks shall be kept under cover and protected from extreme conditions of temperature, relative humidity and wind until they are required for test. The tests shall be undertaken as soon as practicable after the sample has been taken.

6.14.8 Number of tests

6.14.8.1 All the 24 Blocks shall be checked for dimensions and inspected for visual defects.

6.14.8.2 Out of the 24 blocks, 12 blocks shall be subjected to the test for compressive strength, 3 blocks to the test for density, 3 blocks to the test for thermal conductivity and 3 blocks to the test for drying shrinkage. The remaining 3 blocks shall be reserved for re-test for drying shrinkage if a need arises.

6.14.8.3 The samples of AAC blocks (each sample consisting of 6 specimen) shall be chosen randomly from the lot procured and tested for various parameters specified in para 6 above. One samples shall be tested for every **100 cum** or part thereof. However, minimum one sample shall be tested from each lot received at site if the quantity procured in the lot is less than 100 cum. If required, Engineer-in-Charge or his authorized representative shall inspect the factory during production of the material for this work and also collect samples (of materials used for making AAC blocks and precast AAC blocks) from the factory itself. The contractor shall consider this contingency also while placing the order with one of the approved firms. Nothing extra shall be payable on this account.

6.14.9– Criteria for conformity

6.14.9.1 The number of blocks with dimensions outside the tolerance limit and or with visual defects, among those inspected, shall not be more than two.

6.14.9.2 For density, the mean value shall be within the range specified in Table of para3

6.14.9.3 For compressive strength, the mean value, say X shall be determined. The test results shall be grouped into groups of 4, individual values of ranges shall be determined, the average range a calculated from these values and shall satisfy the following condition:
$\underline{X}$- 0.6 R> minimum value specified in Table of para3.

6.14.9.4 For thermal conductivity, the mean value shall be equal to or less than the value specified in Table of para3.

6.14.9.5 For drying shrinkage, all the test specimens shall satisfy the requirements of the test. If one or more specimens fail to satisfy the requirements, the remaining 3 blocks shall be subjected to these tests. All these blocks shall satisfy the requirements.

6.14.10 Manufacturer's Certificate

6.14.10.1 The manufacturer shall satisfy himself that the masonry units conform to the requirements of this specification and, if requested, shall supply a certificate to this effect to the purchaser or his representative.

6.14.11 Independent Tests

6.14.11.1 If the purchaser or his representative requires independent tests, the samples shall be taken before or immediately after delivery, at the option of the purchaser or his representative and the tests shall be carried out in accordance with this specification.

6.14.11.2 The manufacturer shall supply free of charge the units required for testing.

6.14.12 Storage

6.14.12.1 General requirements of storage of autoclaved cellular (aerated) concrete blocks shall be as described in IS : 4082-1977*.

6.14.13 Marking

6.14.13.1 Each lot of concrete masonry units manufactured in accordance with this specification shall be suitably marked with information-

(i) The identification of the manufacture

(ii) The grade and block density of the unit

(iii) The month and year of manufacturing

Each block may also be marked with the ISI Certification mark.

6.14.14 The R.C C bend shall be provided on **150mm /230mm/300mm** thick masonry to increase the strength and compatibility . The RCC bend shall be provided at sill level and at lintel level over throughout the wall. This thickness of the bend shall be approved by the Engineer in charge or as specified in drawing. The payment of RCC bend and reinforcement shall be paid separately.

Autoclave Aerated Concrete Block masonry shall be provided with polymer modified adhesive mortar. The polymer modified adhesive mortar shall be provided @ 30 kg per cum or with cement mortar 1:4 (1 cement : 4 coarse sand).

6.14.15. Autoclave Aerated Concrete Block with **100 mm thick** masonry shall be provided with two number 6mm dia reinforcement steel bar at every third course. The payment of reinforcement shall be paid separately.

6.14.16. Autoclaved Aerated Concrete Block confirming the IS Code – 2185 (Part-3) 1984 (Reaffirmed 2005)

6.14.17 Measurements

6.14.17.1 Autoclave Aerated Concrete Block Masonry shall be measured in cubic metres unless otherwise specified.

Any extra work over the specified dimensions shall be ignored. Dimensions shall be measured correct to the nearest 0.01 metre. ie. 1 cm. Areas shall be calculated to the nearest 0.01 sqm and the cubic contents shall be worked out to the nearest 0.01 cubic metres.

Note : (i) Autoclave Aerated Concrete Block work in parapet walls, mumty, lift machine room and water tanks constructed on the roof upto 1.2 m height above roof shall be measured together with the corresponding work of the floor next below.

6.14.17.2 No deductions or additions shall be done and no extra payment made for the following:

Note: Where minimum area is defined for deduction of an opening, void or both, such areas shall refer only to opening or void within the space measured.

(a) Ends of dissimilar materials (that is, joists, beams, lintels, posts, girders, rafters, purlins, trusses, corbels, steps etc.); up to 0.1 m^2 in section;

(b) Opening up to 0.1 m^2 in area (see Note);

(c) Wall plates, bed plates, and bearing of slabs, chajjas and the like, where thickness does not exceed 10 cm and bearing does not extend over the full thickness of wall;

(d) Cement concrete blocks as for hold fasts and holding down bolts;

(e) Iron fixtures, such as wall ties, pipes upto 300 mm diameter and hold fasts for doors and windows;

(f) Chases of section not exceeding 50 cm in girth; and

(g) Bearing portion of drip course, bearing of moulding and cornice.

Note: In calculating area of an opening, any separate lintel or sills shall be included with the size of the opening but end portions of lintel shall be excluded. Extra width of rebated reveals, if any, shall also be excluded.

6.14.17.3 String courses, projecting pilasters, aprons, sills and other projections shall be fully described and measured separately in running metres stating dimensions of each projection.

6.14.17.4 Square or rectangular pillars shall be measured separately in cubic metres

6.14.17.5 Circular pillars shall be measured separately in cubic metres as per actual dimensions.

6.14.17.6 Autoclave Aerated Concrete Block work curved on plan shall be measured like the block work in straight walls and shall include all cutting and wastage of blocks, tapered vertical joints and use of extra mortar, if any. Block work curved on plan to a mean radius not exceeding six metres shall be measured separately and extra shall be payable over the rates for block work in straight walls. Nothing extra shall be payable if the mean radius of the block work curved in plan exceeds six metres.

6.14.17.7 Tapered walls shall be measured net as walls and extra payment shall be allowed for making tapered surface for block work in walls.

6.14.18 Rate

The rate shall include the cost of materials and labour required for all the operations described. The rate shall also include the following:

(a) Raking out joints or finishing joints flush as the work proceeds;

(b) Preparing tops of existing walls and the like for raising further new block work.

(c) Rough cutting and waste for forming gables, splays at eaves and the like.

(d) Leaving holes for pipes upto 150 mm dia. and encasing hold fasts etc.

(e) Rough cutting and waste for block work curved in plan and for backing to stone or other types off acing.

(f) Embedding in ends of beams, joists, slabs, lintels, sills, trusses etc.

(g) Bedding wall plates, lintels, sills, roof tiles, corrugated sheets, etc. in or on walls if not covered in respective items

(h) Leaving chases of section not exceeding 50 cm in girth or 350 sq cm in cross-section; and

(i) Block on edge courses, cut brick corners, splays reveals, cavity walls, brick works curved on plan to a mean radius exceeding six metres.

TEST FOR DIMENSIONAL TOLERANCE

(Clause 6.1.3.3)

A -1. Sampling

As per para 6.1.3.1 and 6.1.3.2.

A -2. Procedure

All the blisters, loose particles of clay and small projections shall be removed from the surface of bricks. Each specimen of 20 bricks shall then be arranged upon a level surface successively as indicated in Fig. A, B and C of para A-4 below in contact with each other and in straight line. The overall length of the assembled bricks (20 Nos) shall be measured with a steel tape sufficiently long to measure the whole row at one stretch.

A-3. Tolerance

The actual dimensions of bricks when tested as described in A-2 shall be within the following limits per 20 bricks.

Modular Bricks

Length	3720 to 3880 mm (3800 ± 80 mm)
Width	1760 to 1840 mm (1800 ± 40 mm)
Height	1760 to 1840 mm (1800 ± 40 mm) for 90 mm high brick
	760 to 840 mm (800 ± 40 mm) for 40 mm high brick

Non-Modular Bricks

For class 10

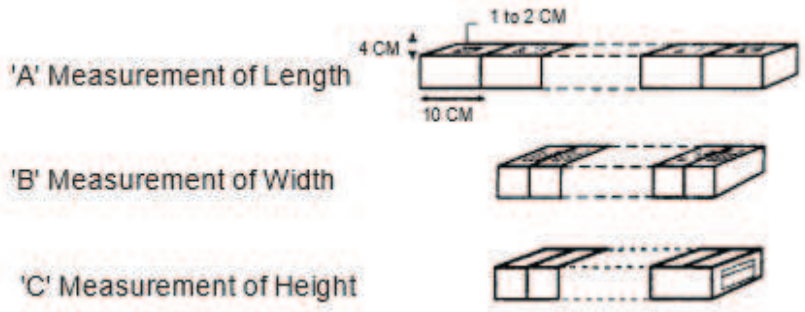
Length	(4520 to 4680) mm (4600 ± 80 mm)
Width	(2240 to 2160) mm (2200 ± 40 mm)
Height	(1440 to 1360) mm (1400 ± 40 mm) for 70 mm high bricks
	(640 to 560) mm (600 ± 40 mm) for 30 mm high bricks

For other classes

Length	(4320 to 4680) mm
Width	(2130 to 2310) mm
Height	(1340 to 1460) mm for 70 mm high bricks
	(840 to 920) mm for 44 mm high bricks

A-4. Criteria for Conformity

A lot shall be considered conforming to the requirements of dimensions and tolerances if all the groups of bricks are tested to meet the specified requirements.



APPENDIX B

TEST FOR COMPRESSIVE STRENGTH

(Clause 6.1.3.4)

B-1. Specimen

Five whole bricks shall be taken from the samples as specimens for this test. Length and width of each specimen shall be measured correct to 1 mm.

B-2. Apparatus

The apparatus consists of compression testing machine, the compression plate of which shall have a ball seating in the form of portion of a sphere the centre of which shall coincide with the centre of the plate.

B-3. Procedure

(a) Pre-conditioning: The specimen shall be immersed in the water for 24 hours at 25^0C to 29^0C. Any surplus moisture shall be allowed to drain at room temperature. The frog of the bricks should be filled flush with mortar 1:3 (1 cement : 3 clean coarse sand of grade 3 mm and down) and shall be kept under damp jute bags for 24 hours, after that these shall be immersed in clean water for three days.

After removal from water, the bricks shall be wiped out of any traces of moisture.

(b) Actual Testing: Specimen shall be placed with flat faces horizontal and mortar filled face upward between three 3 ply plywood sheets each of thickness 3 mm and carefully centred between plates of the testing machine. Plaster of Paris can also be used in place of plywood sheets to ensure a uniform surface.

Load shall be applied carefully axially at uniform rate of 14 N/mm^2 per minute till the failure of the specimen occurs.

B-4. Reporting the Test Results

The compressive strength of each specimen shall be calculated in N/mm^2 as under :

$$\text{Compressive Strength} = \frac{\text{Maximum load at failure (in N)}}{\text{Area of Specimen (in sq mm)}}$$

In case the compressive strength of any individual brick tested exceeds the upper limit of the average compressive strength specified for the corresponding class of brick, the same shall be limited to the upper limit of the class specified in 6.1.2 for the purpose of calculating the average compressive strength. Compressive strength of all the individual bricks comprising the sample shall be averaged and reported.

B-5. Criteria for Conformity

A lot shall be considered having satisfied the requirements of average compressive strength if the average compressive strength specified in 6.1.2 for the corresponding class of brick tested is not below the minimum average compressive strength specified for the corresponding class of bricks by more than 20 per cent.

APPENDIX C

TEST FOR WATER ABSORPTION

(Clause 6.1.3.5)

C-1. No. of Specimen

Five whole bricks shall be taken from samples as specimen for this test.

C-2. Apparatus

A balance required for this test shall be sensitive to weigh 0.1 percent of the weight of the specimen.

C-3. Procedure

(a) *Pre-conditioning:* The specimen shall be allowed to dry in a ventilated oven at a 110°C to 115°C till it attains a substantially constant weight. If the specimen is known to be relatively dry, this would be accomplished in 48 hours, if the specimen is wet, several additional hours may be required to attain a constant weight. It shall be allowed to cool at room temperature. In a ventilated room, properly separated bricks will require four hours for cooling, unless electric fan passes air over them continuously in which case two hours may suffice.

The cooled specimen shall be weigh (W_1) a warm specimen shall not be used for this purpose.

(b) *Actual Testing:* Specimen shall be completely dried before immersion in the water. It shall be kept in clean water at a temperature of 27°C ± 2°C for 24 hours. Specimen shall be wiped out of the traces of water with a damp cloth after removing from the water and then shall be weighed within three minutes after removing from water (W_2).

C-4. Reporting the Test Results

The water absorption of each specimen shall be calculated as follows and the average of five tests shall be reported.

$$\text{Water Absorption} = \frac{W_2 - W_1}{W_1} \times 100$$

C-5. Criteria for Conformity

A lot shall be considered having satisfied the requirements of water absorption if the average water absorption is not more than 20% by weight.

APPENDIX D

TEST FOR EFFLORESCENCE

(Clause 6.1.3.6)

D-1. No. of Specimen

Five whole bricks shall be taken as specimen for this test.

D-2. Apparatus

Apparatus required for this test shall be a shallow flat bottom dish containing distilled water.

D-3. Procedure (actual testing)

The brick shall be placed vertically in the dish with 2.5 cm immersed in the water. The room shall be warm (18ºC to 30ºC) and well ventilated. The bricks should not be removed until it absorbs whole water. When the whole water is absorbed and the brick appears to be dry, place a similar quantity of water in that dish and allow it to evaporate as before. The brick shall be examined after the second evaporation.

D-4. Reporting the Test Results

The rating to efflorescence in ascending order shall be reported as 'NIL', 'SLIGHT', 'MODERATE', 'HEAVY' or 'SERIOUS' in accordance with the following :

(a) *NIL:* When there is no perceptible deposit of efflorescence.

(b) *SLIGHT:* When not more than 10 per cent of the area of the brick is covered with a thin deposit of salts.

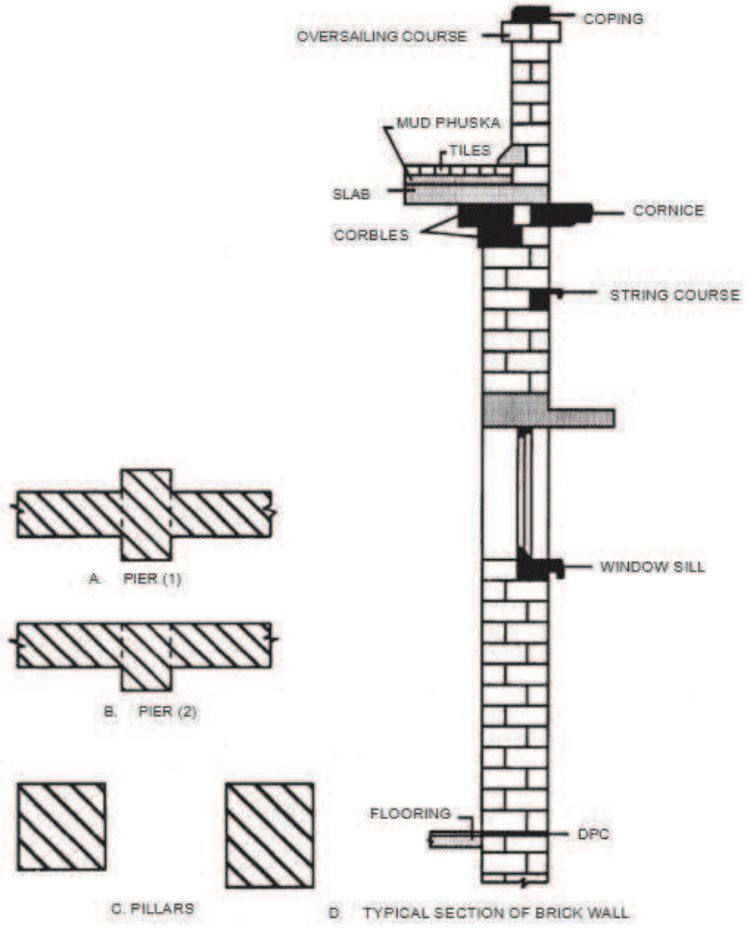
(c) *MODERATE:* When there is heavier deposit and covering upto 50% of the area of the brick surface but unaccompanied by powdering or flaking of the surface.

(d) *HEAVY:* When there is a heavy deposit of salts covering 50% or more of the brick surface but unaccompanied by powdering or flaking of the surface.

(e) *SERIOUS:* When there is heavy deposit of salts, accompanied powdering and/or flaking of the surface and tending to increase in the repeated wetting of the specimen.

D-5. Criteria for Conformity

A lot be considered having satisfied the requirements of efflorescence if for 4 out of the specimen of 5 bricks, the rating of efflorescence is not beyond "Moderate".



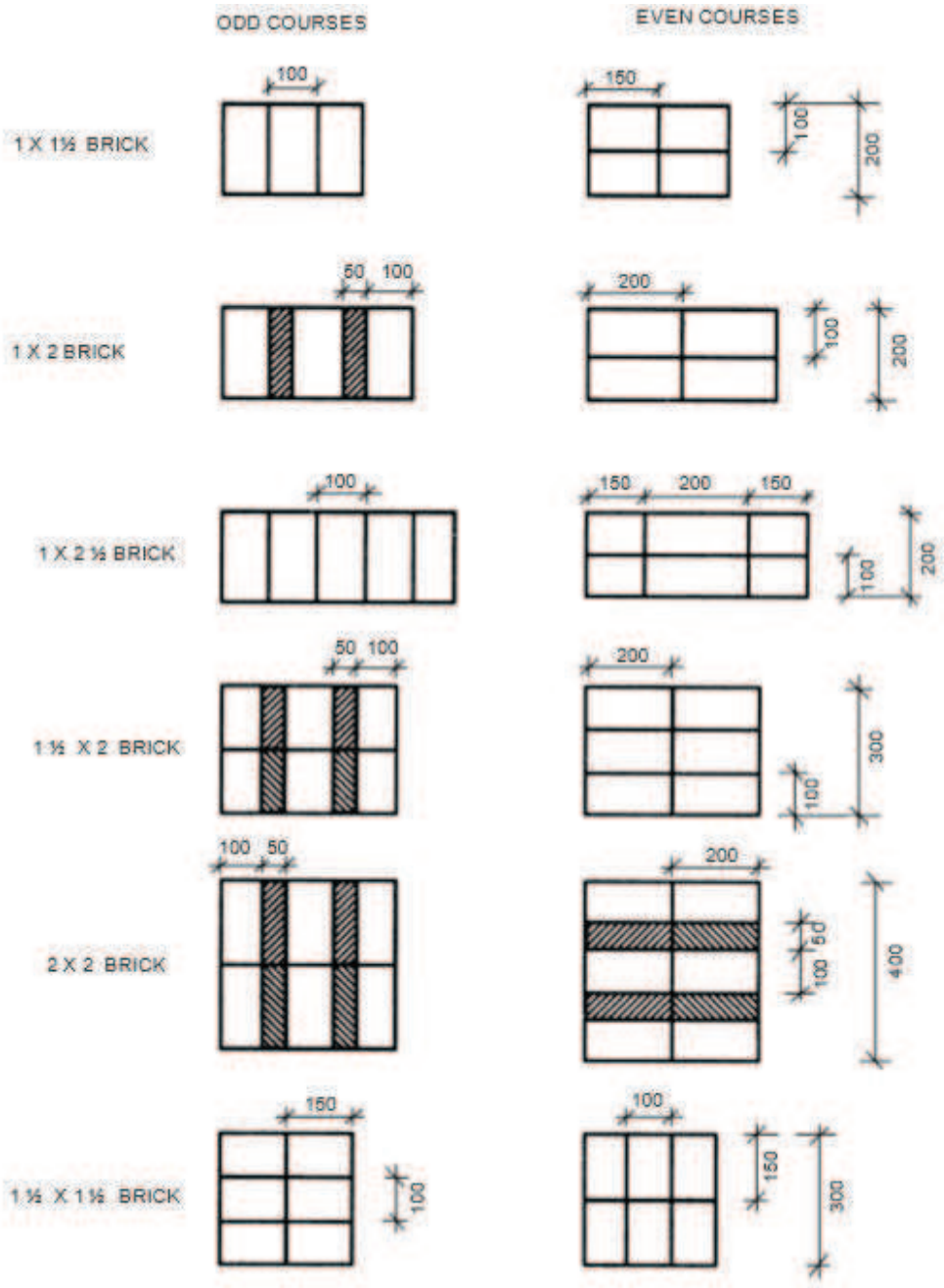
THE BREADTH SHALL NOT EXCEED THREE TIMES THE THICKNESS AND THICKNESS ITSELF SHALL NOT EXCEED MORE THAN THREE BRICKS

Drawing not to scale

Fig. 6.1 : Brick Work

BRICK PILLARS

Sub Head : Brick Work
Clause : 6.2.4.1

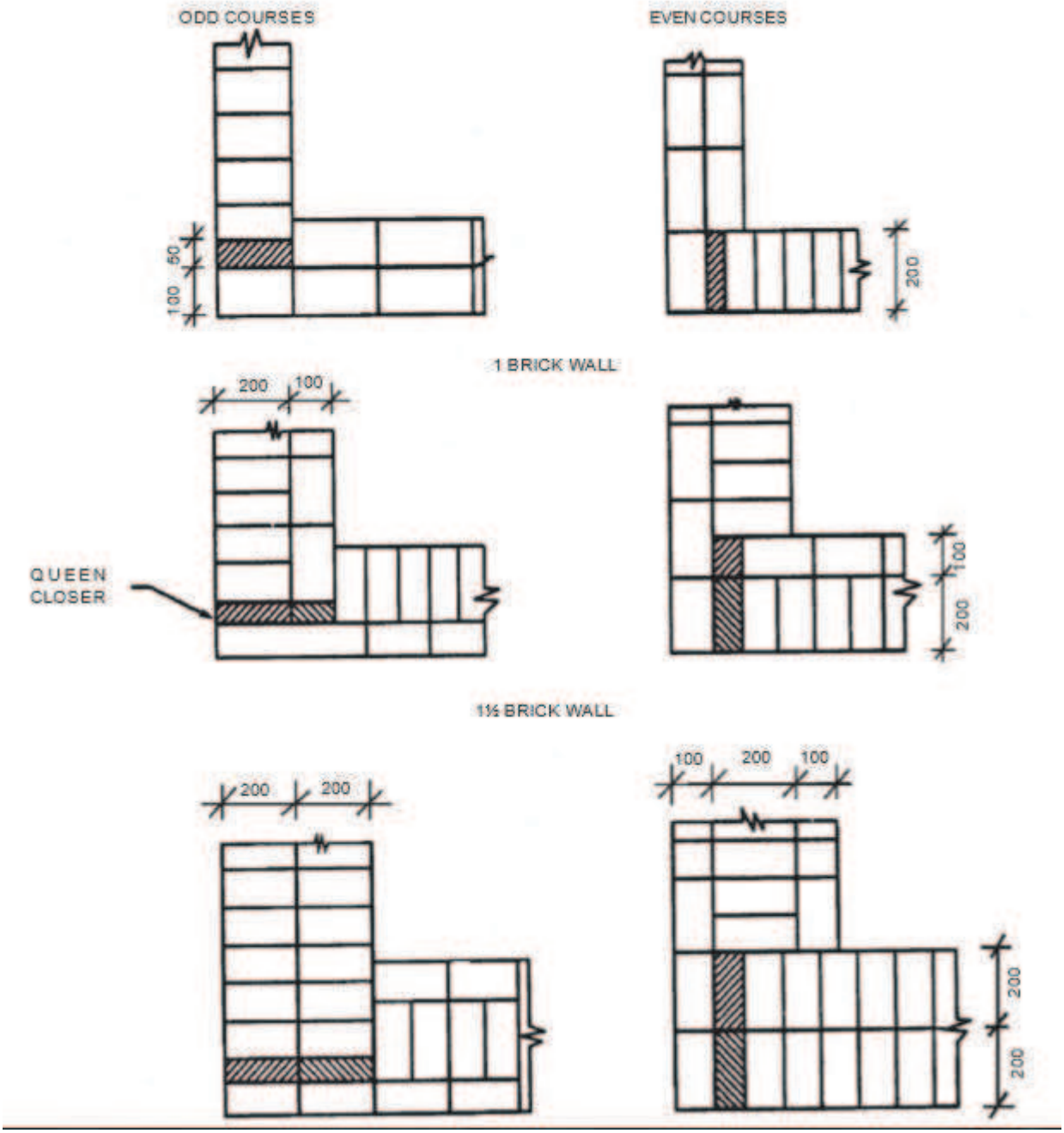


Drawing not to scale
All dimensions are in mm

Fig. 6.2 : English Bond

BRICK BONDS

Sub Head : Brick Work
Clause : 6.2.4.1



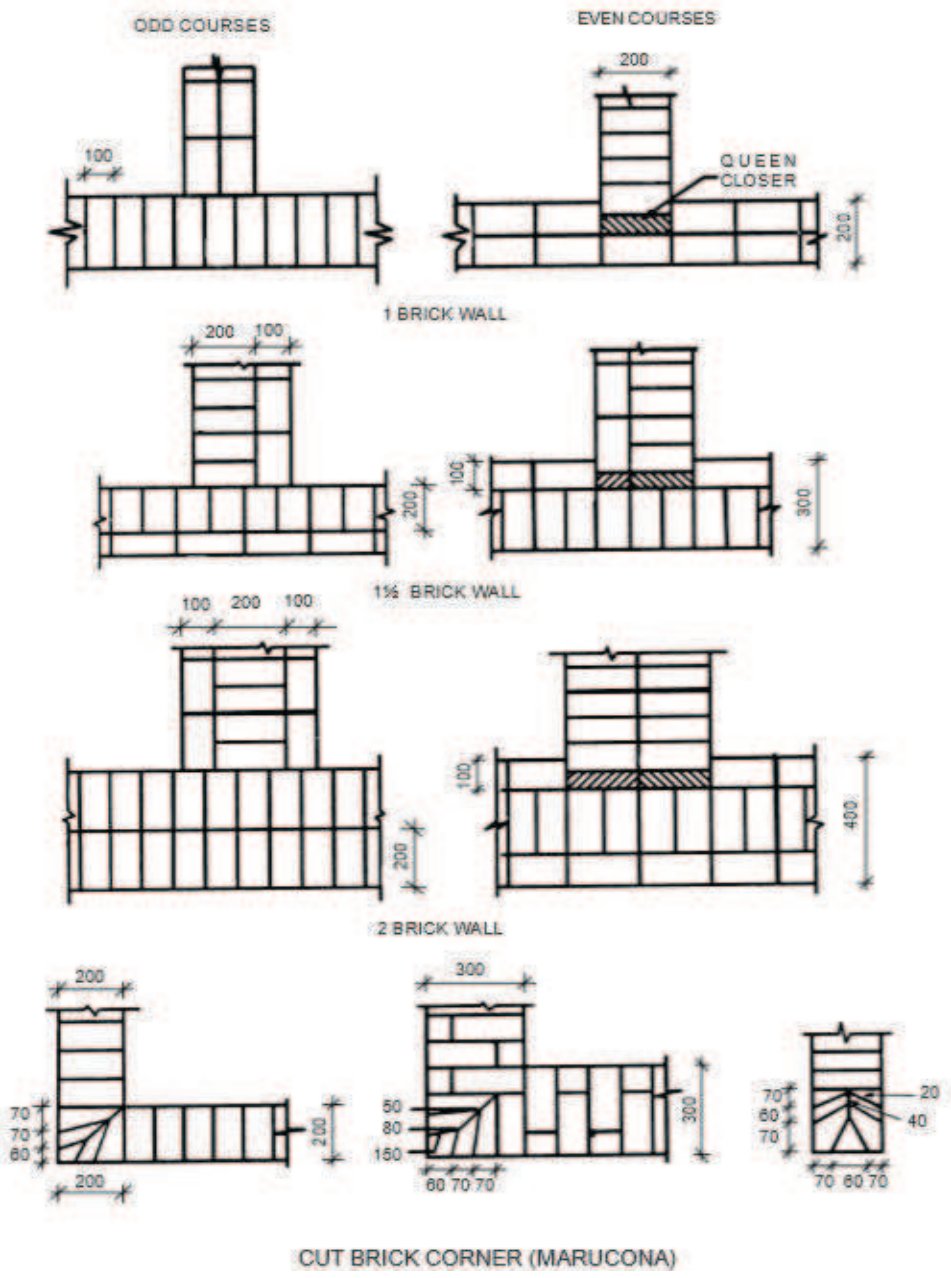
2 BRICK WALL

Drawing not to scale
All dimensions are in mm

Fig. 6.3 : English Bond

BRICK BONDS (Contd.)

Sub Head : Brick Work
Clause : 6.2.4.1

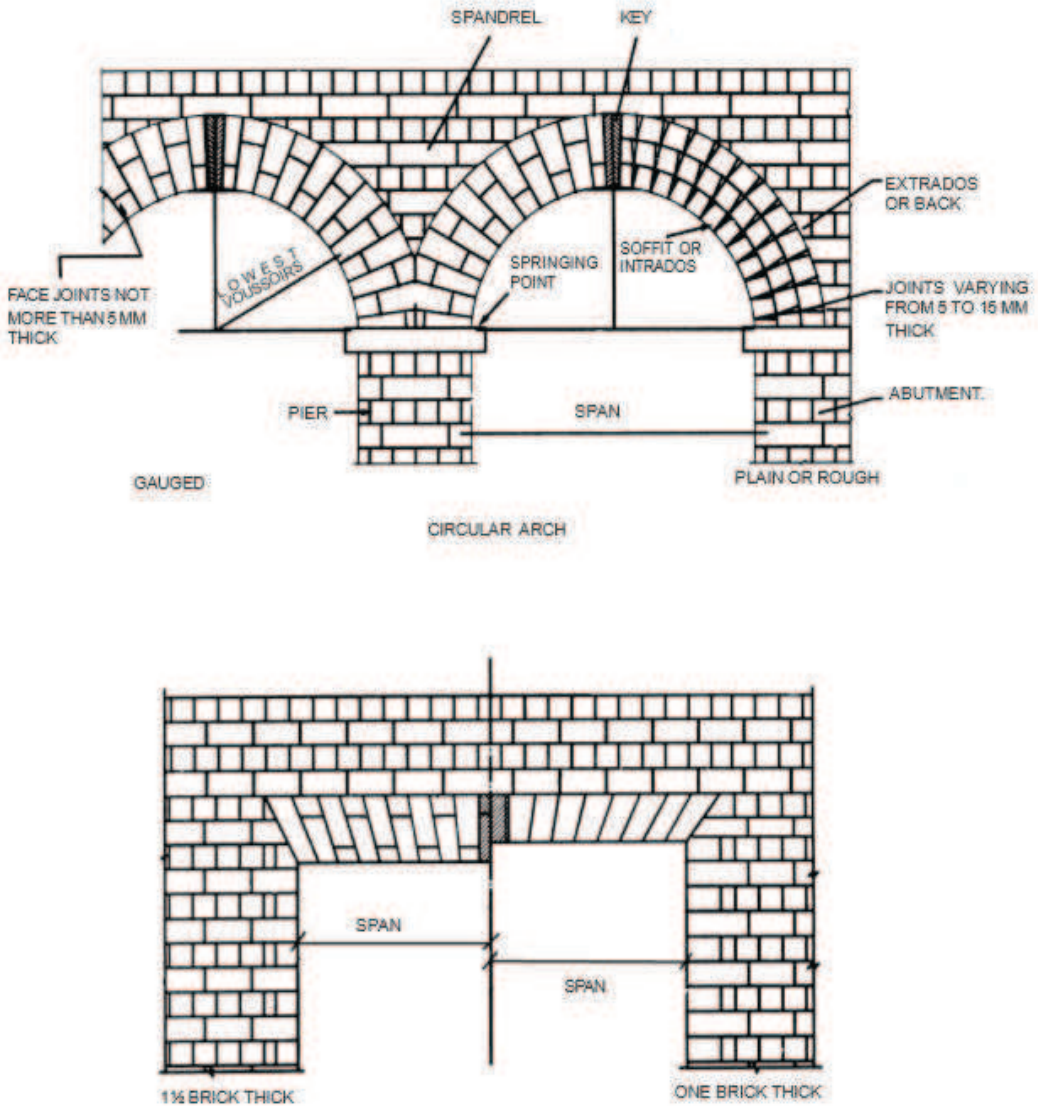


Drawing not to scale
All dimensions are in mm

Fig. 6.4 : English Bond

BRICK WORK IN ARCHES

Sub Head : Brick Work
Clause : 6.3

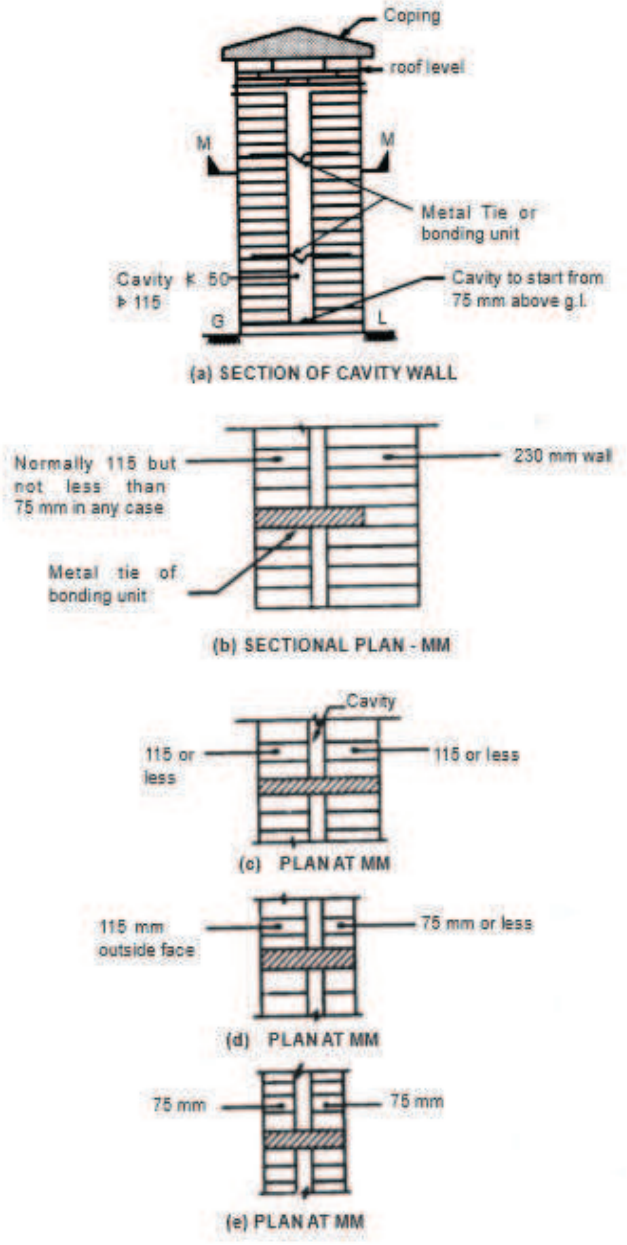


Drawing not to scale

Fig. 6.5 : Brick Work in Arches

BRICK WORK IN CAVITY WALLS

Sub Head : Brick Work
Clause : 6.11.0

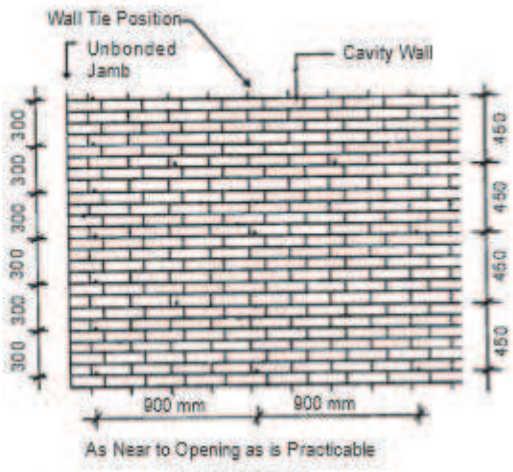


Note :
(1) Only one of the alternative a, b, c, d or e shall be applicable in each case.
(2) Ties shall be placed sloping towards exterior side.

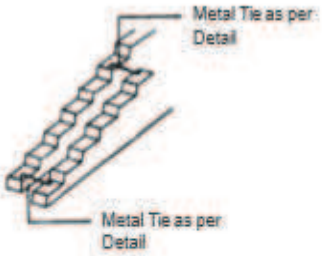
Drawing not to Scale
All dimensions are in mm

Fig. 6.6 : Brick Work in Cavity Walls

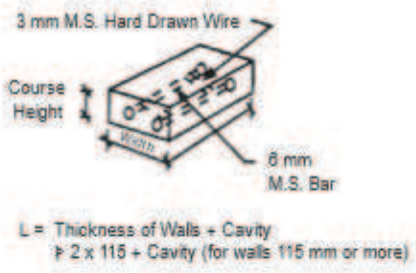
(Fig. 6.6 Contd.)



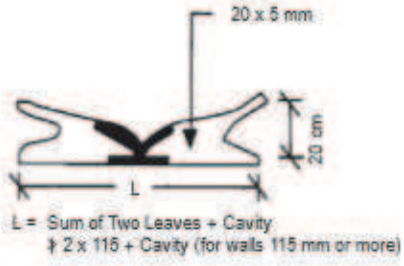
(f) ELEVATION



(g) ISOMETRIC VIEW



(h) BONDING UNIT
(Preferably Precast R.C.C.)



(i) METAL TIE



(j) DETAILS OF REINFORCEMENT IN BONDING UNIT

Drawing not to Scale
All dimensions are in mm

Fig. 6.6 (Contd.) : Brick Work in Cavity Walls

8.0 MARBLE WORK

8.0 GENERAL

Marble shall be hard, sound, dense and homogeneous in texture with crystaline texture as far as possible. It shall generally be uniform in colour and free from stains, cracks, decay and weathering.

8.0.1 Marbles are metamorphic rocks capable of taking polish, formed from the re-crystalization of lime stones or dolomitic lime stones and are distinguished from lime stone by even visibly crystalined nature and nonflaggy stratification.

Note : Marble is a product of nature hence it is difficult to guarantee uniformity of colour, veining or other characteristics that may be represented in any sample submitted. A sample will indicate only an average of colour, veining and other general texture and specified finish.

8.1 CLASSIFICATION

The marble blocks, slabs and tiles shall be classified broadly in the following two categories:

8.1.1 White Marble

Raj Nagar (plain white) Marble:

It shall be plain white marble with coarse grains predominantly showing mica particles giving reflection in light.

8.1.2 Coloured Marble

(i) Plain Black Marble

Black marble sawn along veins locally known as 'Peta Pasu sawing' available at Bhainslana.

(ii) Black Zebra Marble

(a) Bhainslana Black Zebra Marble: Black marble having grey or white veins available at Bhainslana.

(b) Kishangarh Black Zebra Marble: Black marble with grey and/or white veins available at Kishangarh.

(c) Abu Black Zebra Marble: Black marble having white patches and streaks available at Abu.

(d) Narnaul Black Zebra Marbles: Black marble with thin white veins available at Narnaul.

(e) Makrana Dhobi Doongri Zebra Marble: Greyish black marble with white flowery pattern available at Dhobi Doongri.

(iii) Green Marble

(a) Baroda Green Marble: Dark green marble with flowery pattern available at Baroda.

(b) Abu Green Marble: Light green marble with green and/or brown streaks on white ground available at Ambaji.

(c) Falna Green Marble: Green marble with prominent yellowish pattern available at Falna.

(d) Bundi Green Marble: Green marble with pinkish shades available at Umar, (Bundi).

(iv) Grey Marble

(a) Kumari Grey Marble: Grey marble having light blue shades available at Makrana.

(b) Bundi Grey Marble: Grey Marble with pink or green or black streaks available at Umar (Bundi).

(v) Brown Marble

(a) Bar Brown Marble/Brown Marble with light and dark brown shades available at Bar.

(b) Narnaul Brown Marble

Brown marble having teak wood shades available at Narnaul.

8.1.3 Granite Stone

It shall be of any colour and size as directed by Engineer-in -Charge. Granite shall be plain machine cut and mirror polished. The stone shall be smooth and of even surface without holes or pits.

8.2 SIZES AND TOLERANCES

The size of marble blocks, slabs and tiles shall be as mentioned in Table 8.1.

TABLE 8.1

Sl.No	Type	*Length*	*Width*	*Thickness*
1.	Blocks	30 to 250	30 to 100	30 to 90
2.	Slabs	70 to 250	30 to 100	2 to 15
3.	Tiles	10 to 60	10 to 60	0.8 to 2.4

(1) All dimensions are in centimetre.

(2) The length and width, of the blocks shall be in multiple of 30 cm.

(3) Length and width of slab shall be in multiple of 10 cm. and thickness in multiple of 1 cm.

(4) Tiles shall be square cut and linear dimensions in multiple of 10 cm.

(5) Only slabs and tiles shall be machine cut and factory made.

(6) For 8 mm thick tiles, special precautions will be required for fixing them like using special adhesive as per manufacturer's specifications. Such tiles are not suitable for outside veneering work exposed to rains/sun if used in large areas in continuous stretches. For tiles of thickness 20 mm and above cramps may be provided if approved by Engineer-in-Charge.

Tolerance

The following tolerances shall be allowed in the dimension of blocks, slabs and tiles:

Type	Tolerance
Blocks	
(a) Length	+ 2 per cent
(b) Width	+ 2 per cent
(c) Thickness	+ 2 per cent
Slabs	
(a) Length	+ 2 per cent
(b) Width	+ 2 per cent
(c) Thickness	+ 3 per cent
Tiles	
(a) Linear dimension	+ 3 per cent
(b) Thickness	+ 1 per cent

The sizes other than those mentioned above may be provided as directed by the Engineer-in-Charge and nothing extra shall be payble on this account.

8.3 PHYSICAL PROPERTIES

8.3.1 The physical properties of marble for blocks, slabs and tiles and method of tests are mentioned in Table 8.2.

TABLE 8.2
Physical Properties of Marble & Granite

Characteristic	Marble		Granite	
(1) Moisture absorp- tion after 24 hrs immersion in cold water	Max. 0.4%	IS 1124	Max. 0.50% by weight	IS 1124
(2) Hardness	Min. 3	Mhos scale	-	-
(3) Specific Gravity	Min. 2.5	IS 1122	Min. 2.6	IS 1122

8.3.2 Approval of Sample

Before starting the work, the contractor shall get samples of marble approved by the Engineer-in-Charge. Approved samples shall be kept in the custody of the Engineer-in-Charge and the marble supplied and used on the work shall conform to samples with regard to soundness, colour, veining and general texture.

8.4 SAMPLING

In any consignment all the blocks/slabs/tiles of the same group, size and finish shall be grouped together to constitute a lot. Sample shall be selected and tested separately for each lot for determining its conformity or otherwise to the requirements of the specification. The number of blocks/slabs/tiles to be selected for the samples shall depend upon the size of the lot and shall be in accordance with the Table 8.3.

TABLE 8.3
Sample Size and Criteria for Conformity

Number of Blocks slabs/Tiles in the lot	*Number of blocks slabs/ Tiles to be selected in sample*	*Permissible number of defectives*	*Sub Sample size in no.*
(1)	*(2)*	*(3)*	*(4)*
Up to 25	3	0	2
26 to 100	5	0	2
101 to 200	8	0	3
201 to 500	13	0	4
501 to 1000	20	1	5

Note: The blocks/slabs/tiles in the sample shall be taken at random and in order to ensure to randomness of selection, random tables may be used.

Explanation 1 : All the blocks/slabs/tiles, selected in the sample, shall be examined for dimensions workmanship and general requirements.

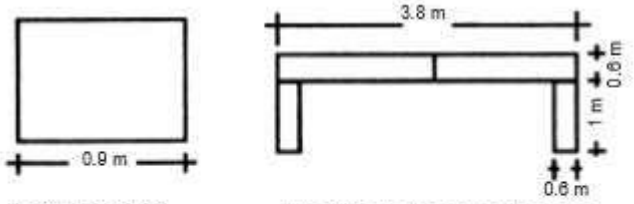
Any block/slab/tile failing in any one or more of the above requirements shall be considered as defective. A lot shall be considered as conforming to these requirements if the number of defectives obtained is not more than permissible no. of defectives given in Col. 3 of table 8.3

Explanation 2 : The lot having been found satisfactory with respect to dimensions, workmanship and general requirement shall be tested for physical properties of the marble. For this purpose a sub sample of the size given in Col. 4 of Table 8.3 shall be selected at random. These blocks/slabs/tiles in the sub sample shall be tested for moisture absorption, hardness and specified gravity. The lot shall be considered having satisfied the requirements of the physical properties if none of the blocks/ slabs/tiles tested for the requirements fails in any of these tests.

8.5 MARBLE WORK - TABLE RUBBED AND POLISHED (PLAIN WORK)

Marble work in steps, jambs, columns and other plain work shall be as specified below:

Joints in staircase treads, kitchen platforms shall be permitted only at curvature or when width/ length is more than 0.6/2 mtrs. respectively. Number of joints in each direction shall not be more than one number for every 2 mtrs. length beyond the initial 2.00 m length. Additional joints due to curvature or for providing fixture shall be provide judiciously as given in sketch 'A' below.

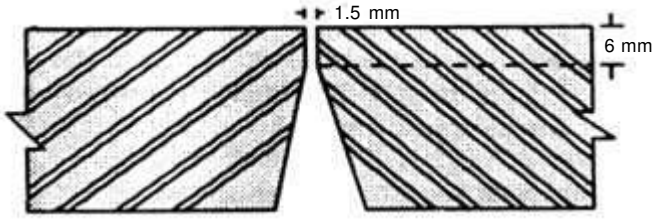


SKETCH (A)

8.5.1 Dressing, Cutting and Rubbing

Every marble stone shall be gang saw/machine cut to the required size and shape, chisel dressed machine finished on all beds and joints, so as to be free from any waviness and to give truly vertical, horizontal, radial or circular joints as required. The exposed faces and sides of stones forming joints upto 6mm. from the face shall be fine tooled machine cut such that a straight edge laid along the face of the stone is in contact with every point on it. All window sills, tread of steps, counters vanities moulding edges etc. shall be machine cut & polished to give high gloss mirror finish as per direction of Engineer-in-Charge. These surfaces shall then be rubbed smooth. All visible angles and edges shall be true, square and free from chipping. Beyond the depth of 6 mm from face, the joints shall be dressed with a slight splay so that the thickness of joint increases, in an inverted V shape as shown in Fig. below. The surfaces of the stones coming in contact with backing need not be chisel dressed.

EXTERNAL FACE



INVERTED V-SHAPE JOINT

A sample of dressed and rubbed stone shall be prepared for approval and it shall be kept on worksite after being approved by the Engineer-in Charge.

8.5.2 Mortar

The mortar used for jointing shall be as specified.

8.5.3 Laying

All marble stones shall be wetted before placing in position. These shall then be floated on mortar and bedded properly in position with wooden mallets without the use of chips or under pinning of any sort.

The walls and pillars shall be carried up truely in plumb or battered as shown in the drawings. All courses shall be laid truely horizontal and all vertical joints shall be truely vertical.

In case of work without backing of brick work or coursed rubble masonry, face stone shall be laid in headers and stretchers alternatively unless otherwise directed. The headers shall be arranged to come as nearly as possible in the middle of stretchers above and below. Stone shall be laid in regular courses of not less than 15 cm in height and all courses shall be of the same height unless otherwise specified.

For work facing with backing of brick work or coursed rubble masonry, face stone shall be laid in alternate courses of header and stretchers unless otherwise directed. Face stone and bond stone courses shall have break joint on the face of atleast half the height of the standard course and the bond shall be carefully maintained through out. All the connected masonry in a structure shall be carried up nearly at one uniform level throughout but where breaks are unavoidable the joints shall be made in good long steps so as to prevent cracks developing between new and old work.

When necessary jib crane or other mechanical appliances shall be used to hoist the heavy pieces of stones and place these in to correct positions, care being taken that the corners of the stone are not damaged. Stone shall be covered with gunny bags, before putting chain or rope is passed over it, and it shall be handled carefully. No piece which has been damaged shall be used in work. The matching of grains shall be carried out as directed by the Engineer-in-Charge.

8.5.4 Bond Stone

Bond or through stones running right through the thickness of walls, shall be provided in walls upto 60 cm thick and in case of wall above 60 cm thickness a set of two or more bond stones overlapping each other by atleast 15 cm shall be provided in a line from face to back.

At least one bond stone or a set of bond stones shall be provided for every 0.5 sqm of the wall surface. All bond stones shall be marked suitably as directed by the Engineer-in-Charge.

8.5.5 Joints

The depth of joints 6 mm from the face shall be uniform and as fine as possible but shall be not more than 1.5 mm thick on the exposed face. Beyond the depth of 6 mm from face, the thickness of joints shall increase in an inverted V shape so as to give good mortar bond between two stones. The inverted portion of the joints shall be filled with bedding mortar and the face 6 mm portion with pointing mortar.

8.5.6 Curing

The work shall be kept constantly moist on all faces for a period of atleast seven days.

8.5.7 Finishing

After the marble work is cured, it shall be rubbed with carborandum stone of different grades no. 60, 120 and 320 in succession or with electrical rubbing machines rubbed with carborandum items 0 to 6 nos.in succession, so as to give a plane true and highly smooth surface. It shall then be cleaned with a solution of oxalic acid, washed and finished clean.

8.5.8 Protection

Green work shall be protected from rain by suitable coverings. The work shall also be suitably protected from damage during construction.

8.5.9 Scaffolding

Double scaffolding having two sets of vertical supports shall be provided where necessary. The supports shall be sound and strong, tied together by horizontal pieces over which the scaffolding plank shall be fixed.

8.5.10 Tolerances

As per para 8.2

Note: The above Para 8.5. also applies to the Ashlar masonry referred in Chapter No. 7.0 - Stone Work.

8.5.11 Measurements

For plain work: Measurements shall be taken correct to a cm in length and breadth and correct to 0.5 cm in thickness.

8.5.11.1 In the case of radially dressed or circular stone used in the work, the dimensions of the circumscribing rectangle of the dressed stone, shall be measured correct to a centimetre and thickness, correct to 0.5 cm.

The cubical contents shall be calculated in cubic decimetre nearest to two places of decimal.

8.5.11.2 The marble work in arches and domes shall be measured as for plain work, but extra shall be allowed for such work over the rate for plain work.

8. 5.11.3 Sunk or moulded work in marble shall be measured by volume as per plain marble work or work in arches or domes as the case may be on the basis of circumscribed rectangular block of the finished work but extra shall be paid for such work over the rate for plain work for work in arches and domes. For the purpose of extra payment, volume of every stone sunk or moulded shall be considered.

8.5.12 Rate

The rate includes the cost of materials and labour required for all the operations i/c cutting of recesses in wall cutting moulding corners edge rounding finishing & polishing as specified.

8.5.13 Use of Finished Marble Slabs and Tiles

In case such finished tiles are used, these shall be measured and paid for separately.

8.6 WALL LINING/VENEER WORK

8.6.1 Unless and otherwise specified in the nomenclature of the item, the marble slabs used for wall lining/veneer work shall be gang saw cut (polished & machine cut) and conform to dimensions given in Table 8.1 above.

Back shall not be polished/ cut in order to ensure a good grip with the hearting of backing. The cut slabs shall be of the thickness as specified with a tolerance permissible under para 8.2 above. The tolerance in wall lining when straight edge of 3 m length is placed should not be more than 2 mm.

8.6.2 Laying

The stone shall be wetted before laying. They shall then be fixed with mortar in position without the use of chips or under pinning of any sort. Care shall be taken to match the grains of veneer work as directed by the Engineer-in-Charge. For purpose of matching the grains, the marble slabs shall be selected judiciously having uniform pattern of veins/streaks. Preferably the slabs shall be those got out of the same block from the quarry. The area to be veneered shall be reproduced on the ground and the marble slabs laid in position and arranged in the manner to give the desired matching of grains. Any adjustment needed for achieving the best results shall be then carried out by replacing or interchanging the particular slabs. Special care shall be taken to achieve the continuity of grains between the two slabs one above the other along the horizontal joints. This shall then be got approved by the Engineer-in-Charge and each marble slabs numbered properly and the same number shall be marked on a separate drawing as well as on the surface to be actually veneered, so as to ensure the fixing of the particular slabs in the correct location.

For the facing of the columns also the same procedure as mentioned above shall be followed.

8.6.2.1 Where so desired, the adjoining stones shall be secured to each other by means of copper pins 75 mm long and 6 mm diameter or as specified.

8.6.2.2 The stones shall be secured to the backing by means of cramps. The material for cramps shall have high resistance to corrosion under conditions of dampness and against the chemical action of mortar or concrete in which cramps are usually embedded.

Cramps shall be of 25 × 6 mm and 30 cm long in case of backing of stone masonry walls and brick masonry walls thicker than 230 mm. In case of backing with brick masonry walls 230 mm or less thick or RCC members cramps shall be of 25 × 6 mm and length as per requirement made out of gun metal or any other metal specified in para 8.6.2.6. Generally the outer length of cramp in half brick work backing shall be 115 mm and in one brick work backing it shall be 150 mm. Typical shape & details of cramps for such backing are as indicated in Fig. 8.2 for general guidance. This can be modified as directed by the Engineer-in-Charge if so, required at site. Cramps shall be spaced not more 60 cm apart horizontally.

Alternatively the stone may be secured to the backing by means of stone dowels 10 x 5 x 2.5 cm as per shape indicated in Fig. 8.1.

8.6.2.3 The adjoining stones shall be secured to each other by means of gun metal cramps or copper pins of the specified size. Cramps may be attached to its sides (see Fig. 8.3A, 8.3B) or top and bottom (See Fig. 8.3C, D, E, F) or sides, top and bottom (see Fig. 8.3G, 8.3H) . The general arrangement of cramps required for fixing facing unit to the wall are illustrated in Fig 8.3. The actual number of cramps and their sections, however, shall be as per requirements of design to carry the loads.

8.6.2.4 Where cramps are used to hold the unit in position only, the facings shall be provided with a continuous support on which the stones rest at the ground level and other storey levels, the support being in the form of projection from or recess into the concrete floor slab, or a beam between the columns or a metal angle attached to the floor slab or beams. These supports shall preferably be at vertical intervals not more than 3.5 m apart and also over the heads of all openings. Such supports shall also be provided where there is transition from thin facing below to thick facings above.

8.6.2.5 Alternatively cramps may be used to hold the units in position and in addition to support the units thus transferring the weight of the units to the backing. Such cramps should be properly designed as per IS 4101 (Part 1).

8.6.2.6 The cramps may be of copper alloyed with zinc, tin, nickel, lead or stainless steel.

8.6.2.7 The pins, cramps and dowels shall be laid in cement mortar 1:2 (1 cement : 2 fine sand) and their samples got approved by the Engineer-in-Charge and kept at site.

8.6.3 Joints

All joints shall be full of mortar. Special care shall be taken to see that groundings for veneer work are full of mortar. If any hollow groundings are detected by tapping the face stones, these shall be taken out and relaid. The thickness of the face joints shall be uniform, straight and as fine as possible, not more than 1.5 mm and in the face joint, the top 6 mm depth shall be filled with mortar specified for the pointing.

8.6.4 Mortar

The mortar used for jointing slabs shall be as specified.

8.6.5 Curing, Finishing, Protection and Scaffolding

It shall be as specified under 8.5.6, 8.5.7, 8.5.8 and 8.5.9.

8.6.6 Measurements

The length and breadth shall be measured correct to a cm. In case of radially dressed or circular slabs used in the work, the dimensions of the circumscribing rectangles of the dressed stone used in the work, shall be measured & paid for. The area shall be calculated in sqm nearest to two places of decimal.

Marble work in lining upto 4 cm thickness shall be paid by area under veneer work and lining of greater thickness paid by volume under plain marble work.

8.6.7 Rate

The rate includes the cost of materials and labour required for all the operations described above except for the cost of providing and fixing of dowel and cramps which shall be paid for separately, unless otherwise stipulated in the item of work.

When factory made finished slabs and tiles are used, no further finishing as mentioned in para 8.5.7 shall be required nor anything extra shall be payable.

8.7 MARBLE STONE FLOORING AND MARBLE STONE IN RISERS OF STEPS AND SKIRTING

Refer to relevant clause in subhead 11.0 of flooring of CPWD Specifications 2019.

8.7.0 Marble Slab Urinal Partitions

The partitions shall be of marble slab embedded in the wall. The size and shape of the marbles slab shall be as per direction of Engineer-in-Charge. The finished thickness shall be 18 mm. The specifications for marble/granite stone work, in general, shall be as specified. The marble granite stone shall be cut into slabs of required thickness and shall be one piece. (Fig. 8.4).

8.7.1 Finishing

The partition of the slab to be embedded in the masonry shall be rough dressed. Dressing and rubbing of the exposed portion of the slab shall be as described. The dressed slab shall be of the thickness as specified with a tolerance of $\pm$ 1.5mm. The slab shall be got approved from the Engineer-in-Charge before fixing.

8.7.2 Fixing shall be as specified except that the recess shall be 7.5 cm wide. Fixing shall be done by cutting chase with chase cutter/fine tools in a recess of 7.5 cm X 7.5 cm filled with cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 6mm nominal size). Fixing can also be done by epoxy grout in a chase of 2.0 X 7.5 cm as per direction of Engineer-in-Charge.

8.7.3 Measurement shall be as per para 8.6.6.

8.7.4 Rate shall include the cost of labour and materials involved in all the operations described above including the leaving/cutting of recess in the wall, moulding, curves, edge rounding, finishing and polishing as specified.

8.8 STONE VENEERING WORK (FIG. 8.5, 8.6 & 8.7)
Stone lining upto 8 cm shall be treated as veneering work and lining of greater thickness as plain Ashlar Masonry.

8.8.1 Stone : Shall be as specified in 7.4.1.
The stone shall be gang saw cut into slabs of required thickness along the planes parallel to the natural bed of stone.

8.8.2 Dressing: Shall be as specified in 7.4.3 except that dressing at the back shall not be done, so as to ensure better grip with the hearting or backing. The dressed slabs shall be of the thickness as specified, with permissible tolerance of ± 2 mm.

8.8.3 Mortar
Mortar for fixing shall be as specified.

8.8.4 Laying
The stone shall be wetted before laying. They shall then be fixed with mortar in position without the use of chips or underpinning of any sort.

8.8.4.1 Where so desired, the adjoining stones shall be secured to each other by means of copper pins 75 mm long and 6 mm diameter or as specified.

8.8.4.2 Further the stones shall be secured to the backing by means of cramps. The material for cramps shall have high resistance to corrosion under conditions of dampness and against the chemical action of mortar or concrete in which cramps are usually embedded.

Cramps shall be of 25 mm x 6 mm and 30 cm long in case of backing of stone masonry walls and brick masonry walls thicker than 230 mm. In case of backing with brick masonry walls 230 mm or less thick or RCC members, cramps shall be of 25 x 6 mm and length as per requirement made out of stainless steel or any other metal specified in para 7.7.4.6. Generally the outer length of cramp in half brick work backing shall be 115 mm and in one brick work backing it shall be 150 mm. Typical shape and details of cramps for such backing are indicated in Fig. 7.15 for general guidance. This can be modified as directed by the Engineer-in-Charge, if so required at site. Cramps shall be spaced not more than 60 cm apart horizontally.

Alternatively the stone may be secured to the backing by means of stone dowels 10 x 5 x 2.5 cm as per shape indicated in Fig. 7.14 and the adjoining stone secured to each other by means of stainless steel cramps or copper pins of the specified size. Minimum one cramp/stone dowel shall be used to secure one slab to the backing.

8.8.4.3 Cramps may be attached to its sides (see Fig. 7.16A, 7.16B) or top and bottom (see Fig. 7.16C to F) or sides, top and bottom (see Fig. 7.16G & H). The minimum number of cramps required for fixing facing unit to the wall are illustrated in Fig. 7.16. The actual number of cramps and their sections, however, shall be as per requirements of design to carry the loads.

8.8.4.4 Where cramps are used to hold the unit in position only, the facings shall be provided with a continuous support on which the stones rest at the ground level and other storey levels, the support being in the form of projection from or recess into the concrete floor slab, or a beam between the columns or a metal angle attached to the floor slab or beams. These supports shall preferably be at vertical intervals not more than 3.5 m apart and also over the heads of all openings. Such supports shall also be provided where there is transition from thin facings below to thick facings above.

8.8.4.5 Alternatively cramps may be used to hold the units in position and in addition to support the units thus transferring the weight of the units to the backing. Such cramp should be properly designed as per IS 4101 (Part 1).

8.8.4.6 The cramps shall be of copper alloyed with zinc or nickel or of stainless steel of grade 304.

8.8.4.7 The pins, cramps and dowels shall be laid in cement mortar 1:2 (1 cement : 2 fine sand) and their samples got approved by the Engineer-in-Charge and kept at site.

8.8.4.8 The walls shall be carried up truly plumb. All courses shall be laid truly horizontal and all vertical joints truly vertical. The stone shall break joints on the face for at least half the height of the course, unless otherwise shown in the drawings. The stone shall be laid in regular courses not less than 20 cm height and all the stones shall be of the same height unless otherwise specified. No stone shall be less in length than one and a half times its height unless otherwise specified.

8.8.4.9 As far as possible the backing shall be carried up simultaneously with the face work. In case of reinforced cement concrete backing, the lining shall be secured to the backing after it has set and got cured. The cramps shall be fixed in concrete at the required positions, while laying.

8.8.5 Joints

The joints shall be done with cement mortar 1: 3 (1 cement : 3 coarse sand) . All joints shall be full of mortar. Special care shall be taken to see that the groundings for veneer work are full of mortar. If any hollow groundings are detected by taping the face stones, these shall be taken out and relaid. The thickness of joints shall be as small as possible, not exceeding 5 mm. For a close butt jointed facing the thickness shall not exceed 1.5 mm. The face joints shall be uniform throughout.

Where joint filler or compound is to be used, the joints shall be raked out to a depth of at least 25 mm after the mortar in the joints has set sufficiently and the filler or compound applied. The joints may be subsequently finished with a mortar suited to the appearance of the work. It is preferable to use joint sealing compounds where the facings are exposed to heavy rainfall and winds and their selections would depend upon local experience and availability of joint sealing compounds. In their absence only masonry mortars 1:3 (1 cement : 3 coarse sand) which are proved to be successful from local exposure conditions shall be used.

8.8.6 Other Details

Specifications for pointing, curing, protections and scaffolding shall be specified under 7.4.

8.8.7 Measurements

The length and breadth of the finished work shall be measured in metre correct to cm. The area should be calculated in sq. metre correct to two places of decimal.

The veneering work curved on plan shall be measured as plain work, but extra payment shall be allowed for radii not exceeding six metres on external face. For radius beyond six metres the work shall be measured as plain work only, even the face may have to be dressed to curve.

8.8.8 Rate

The rate includes the cost of materials and labour involved in all the operations described above, except for the cost of providing and fixing pins, dowels and metal cramps and ledges and supports, which shall be paid for separately unless otherwise stipulated in the item of work.

Note: Clause 8.8 brought from Sub Head 7 (Stone Work) clause 7.7.

8.9 WALL LINING BUTCH WORK WITH DHOLPUR STONE

8.9.0 Stone lining upto 8 cm shall be treated as veneering work and lining of greater thickness as plain Ashlar Masonry.

8.9.1 Stone : The stone shall be red or white as specified in the description of item. The stone shall be hard, sound, tough, free from cracks, decay & weathering. In case of red sand stone, white patches or streaks shall not be allowed. However scattered spots upto 10 mm diameter will be permitted. Before starting the work the contractor shall get samples of stone approved by the Engineer-in-Charge.

The stone shall be gang saw cut into slabs of required thickness along the planes parallel to the natural bed of stone.

8.9.2 Dressing: Every stone shall be cut to the required size and shape chisel dressed on all beds and joints so as to be free from waviness and to give truly vertical and horizontal joints. In exposed masonry, the faces that are to remain exposed in the final position and the adjoining faces to a depth of 6 mm shall be the fine chisel dressed so that when checked with 60 cm straight edge, no point varies from it by more than 1 mm. The top and bottom faces that are to form the bed joints shall be chisel dressed so that variation from 60 cm straight edge at no point exceeds 3 mm. Faces which are to form the vertical joints should be chisel dressed so that variation at any point with 60 cm straight edge does not exceed 6 mm. Any vertical face that is to come against backing of masonry shall be dressed such that variation from straight edge does not exceed 10 mm. All angles and edges that are to remain exposed in the final position shall be true, square and free from chippings. A sample of dressed stone shall be prepared for approval of Engineer-in-Charge. It shall be kept at the worksite as a sample after being approved except that dressing at the back shall not be done, so as to ensure better grip with the hearting or backing. The dressed slabs shall be of the thickness as specified, with permissible tolerance of ± 2 mm.

8.9.3 Mortar

Mortar for fixing shall be as specified.

8.9.4 Laying

The stone shall be wetted before laying. They shall then be fixed with mortar in position without the use of chips or underpinning of any sort.

8.9.4.1 Where so desired, the adjoining stones shall be secured to each other by means of copper pins75 mm long and 6 mm diameter or as specified.

8.9.4.2 Further the stones shall be secured to the backing by means of cramps. The material for cramps shall have high resistance to corrosion under conditions of dampness and against the chemical action of mortar or concrete in which cramps are usually embedded.

Cramps shall be of 25 mm x 6 mm and 30 cm long in case of backing of stone masonry walls and brick masonry walls thicker than 230 mm. In case of backing with brick masonry walls 230 mm or less thick or RCC members, cramps shall be of 25 x 6 mm and length as per requirement made out of copper

alloyed with zinc or nickel or of stainless steel of grade 304. Generally the outer length of cramp in half brick work backing shall be 115 mm and in one brick work backing it shall be 150 mm. Typical shape and details of cramps for such backing are indicated in Fig. 8.6 for general guidance. This can be modified as directed by the Engineer-in-Charge, if so required at site. Cramps shall be spaced not more than 60 cm apart horizontally. Alternatively the stone may be secured to the backing by means of stone dowels 10 x 5 x 2.5 cm as per shape indicated in Fig. 8.5 and the adjoining stone secured to each other by means of stainless steel cramps or copper pins of the specified size. Minimum one cramp/stone dowel shall be used to secure one slab to the backing.

8.9.4.3 Cramps may be attached to its sides (see Fig. 8.7A, 8.7B) or top and bottom (see Fig. 8.7C to 8.7F) or sides, top and bottom (see Fig. 8.7G & H). The minimum number of cramps required for fixing facing unit to the wall is illustrated in Fig. 8.7. The actual number of cramps and their sections, however, shall be as per requirements of design to carry the loads.

8.9.4.4 Where cramps are used to hold the unit in position only, the facings shall be provided with a continuous support on which the stones rest at the ground level and other storey levels, the support being in the form of projection from or recess into the concrete floor slab, or a beam between the columns or a metal angle attached to the floor slab or beams. These supports shall preferably be at vertical intervals not more than 3.5 m apart and also over the heads of all openings. Such supports shall also be provided where there is transition from thin facings below to thick facings above.

8.9.4.5 Alternatively cramps may be used to hold the units in position and in addition to support the units thus transferring the weight of the units to the backing. Such cramp should be properly designed as per IS 4101 (Part 1).

8.9.4.6 The cramps shall be of copper alloyed with zinc or nickel or of stainless steel of grade 304.

8.9.4.7 The pins, cramps and dowels shall be laid in cement mortar 1:2 (1 cement: 2 fine sand) and their samples got approved by the Engineer-in-Charge and kept at site.

8.9.4.8 The walls shall be carried up truly plumb. All courses shall be laid truly horizontal and all vertical joints truly vertical. The stone shall break joints on the face for at least half the height of the course, unless otherwise shown in the drawings. The stone shall be laid in regular courses not less than 20 cm height and all the stones shall be of the same height unless otherwise specified. No stone shall be less in length than one and a half times its height unless otherwise specified.

8.9.4.9 As far as possible the backing shall be carried up simultaneously with the face work. In case of reinforced cement concrete backing, the lining shall be secured to the backing after it has set and got cured. The cramps shall be fixed in concrete at the required positions, while laying.

8.9.5 Joints

The joints shall be done with cement mortar 1: 3 (1 cement : 3 coarse sand). All joints shall be full of mortar. Special care shall be taken to see that the groundings for veneer work are full of mortar. If any hollow grounding are detected by taping the face stones, these shall be taken out and re-laid. The thickness of joints shall be as small as possible, not exceeding 5 mm. For a close butt jointed facing the thickness shall not exceed 1.5 mm. The face joints shall be uniform throughout. Where joint filler or compound is to be used, the joints shall be raked out to a depth of at least 25 mm after the mortar in the joints has set sufficiently and the filler or compound applied. The joints may be subsequently finished with a mortar suited to the appearance of the work. It is preferable to use joint sealing compounds where the facings are exposed to heavy rainfall and winds and their selections would depend upon local experience and availability of joint sealing compounds. In their absence only masonry mortars 1:3 (1 cement : 3 coarse sand) which are proved to be successful from local exposure conditions shall be used.

8.9.6 Other Details

8.9.6.1 Pointing

All exposed joints shall be pointed with mortar as specified. The pointing when finished shall be sunk from stone face by 5 mm or as specified. The depth of mortar in pointing work shall not be less than 15mm.

8.9.6.2 Curing

Stone work in cement or composite mortar shall be kept constantly moist on all faces for a minimum period of seven days. In case of masonry with fat lime mortar, curing shall commence two days after laying of masonry and shall continue for at least seven days thereafter.

8.9.6.3 Protections

Green work shall be protected from rain by suitable covering. The work shall also be suitably protected from damage, mortar dropping and rain during construction.

8.9.6.4 Scaffolding

Double scaffolding having two sets of vertical supports shall be provided. The supports shall be sound and strong, tied together with horizontal pieces over which scaffolding planks shall be fixed.

8.9.7 Measurements

The length and breadth of the finished work shall be measured in metre correct to cm. The area should be calculated in sq. metre correct to two places of decimal.

The veneering work curved on plan shall be measured as plain work, but extra payment shall be allowed for radii not exceeding six metres on external face. For radius beyond six metres the work shall be measured as plain work only, even the face may have to be dressed to curve.

8.9.8 Rate

The rate includes the cost of materials and labour involved in all the operations described above, except for the cost of providing and fixing pins, dowels and metal cramps and ledges and supports, which shall be paid for separately unless otherwise stipulated in the item of work.

8.10 Kota Stone Veneering work

8.10.1 Kota stone shall be of selected quality, hard, sound, dense & homogeneous in texture free from cracks, decay, weathering and flaws. They shall be machine cut to requisite size and thickness. They shall be of colour indicated in the drawings or as instructed by the Engineer-in-Charge. The stone shall have the top (exposed) face polished/rough chiselled before being brought to site unless otherwise specified. Before starting the work, the contractor shall get the samples of kota stone approved from the Engineer-in- Charge.

8.10.2 Dressing : Every stone shall be cut to the required size and shape and fine machine dressed to the full depth so that a straight edge laid along the side of stone shall be in full contact with it. The thickness of the slab after it is dressed shall be 20, 25, 30 or 40 mm as specified in the item. Tolerance of ± 2 mm shall be allowed for the thickness.

A sample of dressed kota stone shall be prepared for approval of Engineer-in-Charge. It shall be kept at the worksite as a sample after being approved.

8.10.3 Mortar

Mortar for fixing shall be as specified.

8.10.4 Laying
The stone shall be wetted before laying. They shall then be fixed with mortar in position without the use of chips or underpinning of any sort.

8.10.4.1 Where so desired, the adjoining stones shall be secured to each other by means of copper pins75 mm long and 6 mm diameter or as specified.

8.10.4.2 Further the stones shall be secured to the backing by means of cramps. The material for cramps shall have high resistance to corrosion under conditions of dampness and against the chemical action of mortar or concrete in which cramps are usually embedded.

Cramps shall be of 25 mm x 6 mm and 30 cm long in case of backing of stone masonry walls and brick masonry walls thicker than 230 mm. In case of backing with brick masonry walls 230 mm or less thick or RCC members, cramps shall be of 25 x 6 mm and length as per requirement made out of copper alloyed with zinc or nickel or of stainless steel of grade 316. Generally the outer length of cramp in half brick work backing shall be 115 mm and in one brick work backing it shall be 150 mm. typical shape and details of cramps for such backing are indicated. This can be modified as directed by the Engineer-in-Charge, if so required at site. Cramps shall be spaced not more than 60 cm apart horizontally. The adjoining stone secured to each other by means of stainless steel cramps or copper pins of the specified size. Minimum one cramp/stone dowel shall be used to secure one slab to the backing.

8.10.4.3 The minimum number of cramps required for fixing facing unit to the wall. The actual number of cramps and their sections, however, shall be as per requirements of design to carry the loads.

8.10.4.4 Where cramps are used to hold the unit in position only, the facings shall be provided with a continuous support on which the stones rest at the ground level and other storey levels, the support being in the form of projection from or recess into the concrete floor slab, or a beam between the columns or a metal angle attached to the floor slab or beams. These supports shall preferably be at vertical intervals not more than 3.5 m apart and also over the heads of all openings. Such supports shall also be provided where there is transition from thin facings below to thick facings above.

8.10.4.5 Alternatively cramps may be used to hold the units in position and in addition to support the units thus transferring the weight of the units to the backing. Such cramp should be properly designed as per IS 4101 (Part 1).

8.10.4.6 The cramps shall be of copper alloyed with zinc or nickel or of stainless steel of grade 316.

8.10.4.7 The pins, cramps and dowels shall be laid in cement mortar 1:2 (1 cement : 2 fine sand) and their samples got approved by the Engineer-in-Charge and kept at site.

8.10.4.8 The walls shall be carried up truly plumb. All courses shall be laid truly horizontal and all vertical joints truly vertical. The stone shall break joints on the face for at least half the height of the course, unless otherwise shown in the drawings. The stone shall be laid in regular courses not less than 20 cm height and all the stones shall be of the same height unless otherwise specified. No stone shall be less in length than one and a half times its height unless otherwise specified.

8.10.4.9 As far as possible the backing shall be carried up simultaneously with the face work. In case of reinforced cement concrete backing, the lining shall be secured to the backing after it has set and got cured. The cramps shall be fixed in concrete at the required positions, while laying.

8.10.5 Joints

The joints shall be done with cement mortar 1: 3 (1 cement : 3 coarse sand). All joints shall be full of mortar. Special care shall be taken to see that the groundings for veneer work are full of mortar. If any hollow grounding are detected by taping the face stones, these shall be taken out and re-laid. The thickness of joints shall be as small as possible, not exceeding 5 mm. For a close butt jointed facing the thickness shall not exceed 1.5 mm. The face joints shall be uniform throughout. Where joint filler or compound is to be used, the joints shall be raked out to a depth of at least 25 mm after the mortar in the joints has set sufficiently and the filler or compound applied. The joints may be subsequently finished with a mortar suited to the appearance of the work. It is preferable to use joint sealing compounds where the facings are exposed to heavy rainfall and winds and their selections would depend upon local experience and availability of joint sealing compounds. In their absence only masonry mortars 1:3 (1 cement : 3 coarse sand) which are proved to be successful from local exposure conditions shall be used.

8.10.6 Laying

All stones shall be wetted before placing in position. These shall be floated on mortar and bedded properly in position with wooden mallets without the use of chips or under pinning of any sort. The walls and pillars shall be carried up truly plumb or battered as shown in drawings. All Kota Stone shall be laid truly horizontal and all vertical joints shall be truly vertical. It shall be handled carefully. No piece which has been damaged shall be used in work.

8.10.7 Curing

Stone work in cement or composite mortar shall be kept constantly moist on all faces for a minimum period of seven days. In case of masonry with fat lime mortar, curing shall commence two days after laying of masonry and shall continue for at least seven days thereafter.

8.10.8 Protections

Green work shall be protected from rain by suitable covering. The work shall also be suitably protected from damage, mortar dropping and rain during construction.

8.10.9 Scaffolding

Double scaffolding having two sets of vertical supports shall be provided. The supports shall be sound and strong, tied together with horizontal pieces over which scaffolding planks shall be fixed.

8.10.10 Measurements

The length and breadth of the finished work shall be measured in metre correct to cm. The area should be calculated in sq. metre correct to two places of decimal.

The veneering work curved on plan shall be measured as plain work, but extra payment shall be allowed for radii not exceeding six metres on external face. For radius beyond six metres the work shall be measured as plain work only, even the face may have to be dressed to curve.

8.10.11 Rate

The rate includes the cost of materials and labour involved in all the operations described above, except for the cost of providing and fixing pins, dowels and metal cramps and ledges and supports, which shall be paid for separately unless otherwise stipulated in the item of work.

8.11 EXTRA FOR STONE WORK FOR WALL LINING

8.11.1 The stone lining work shall be executed at site as per the relevant item. All the specification shall be follows as per relevant items. The exterior stone work at height greater than 10.0 m from average ground level shall be measured separately.

8.11.2 Scaffolding
For all exposed stone work double scaffolding independent of the work having two sets of vertical supports shall be provided. The supports shall be sound and strong, tied together with horizontal pieces over which scaffolding planks shall be fixed.

8.11.3 Measurement :-The Exterior stone work at a height greater than 10 .0 meter from ground level shall be measured separately for every additional story height 3.0 meter or part thereof .

The Length and breadth shall be measured correct to a cm and its area shall be calculated in square metres upto two places of decimal. The area of stone work at every additional height of 3.0 m shall be added with the consequent lower story height of 3.0 m means after stone work height at greater than 10.0 m. first area of 3.0 m height (at 13.00 meter) shall be measured one times and second area of next 3.0 m height (16.0 m) shall be measured two times and third area of next 3.0 m height (19.00 meter) shall be measured three times and so on.

8.12 DRY STONE CLADDING

8.12.1 Material
Stone shall be of the type as specified in the item. It shall be hard, sound durable and tough free from cracks, decay and weathering and defects like cavities cracks, flaws, holes, veins, patches of soft or loose materials etc. Thickness of stone shall be as specified

Stone shall be cut with the gang saw to the required size and shape on all beds and joints so as to free from any waviness and to give truly vertical horizontal surface as required. The exposed face and sides of stones forming joints shall be such that the straight edge laid along the face of the stone is in contact with every point on it. All the visible angle and edges shall be square and free from chipping. The dressed stone shall be of the thickness specified with permissible tolerance of $\pm$ 2 mm.

Before starting the work, the contractor shall get the samples of stone approved by Engineer-In-charge. Approved sample shall be kept in custody of Engineer-in-Charge and stones supplied and used on the work shall conform to sample with regard to soundness, colour, veining and general texture. The stone shall be cut by gang saw into slabs of required thickness along the places parallel to the natural bed. When necessary double scaffolding for fixing the stone at greater heights, jib crane or other mechanical appliances shall be used to hoist the heavy pieces of stone and placed them into correct positions. Care shall have to be taken that corners of the stone are not damaged. Stone shall be covered with gunny bags before tying chain or rope is passed over and it shall be handled carefully. No pieces which has been damaged shall be used that work

8.12.2 Stacking and Storing
Stone slabs are thin and brittle and should never be stacked flat across timber supports. They should therefore, be stacked on edge on timber or like runners. Packing pieces inserted between the slabs may be rope or timber. Slabs shall be well covered with plastic sheeting to protect them from any possible staining.

8.12.3 Scaffolding
As specified in 7.4.11.

8.12.4 Fixing
The size & shape of the cramps shall be as per drawing and as per directions of Engineer-in-charge. The samples of steel cramps should be approved in advance before starting the stone cladding work. The cramp shall be attached to top and bottom of the stone. The cramps shall have inbuilt adjustment for vertical and horizontal alignment. The cramps used to hold support and transfer the load of stone unit to the supporting structured steel shall be designed by the manufacturer and approval of the same shall be obtained from the Engineer-in-Charge.

The minimum number of clamps required shall be as per requirement of design to carry the load of individual stone slabs. The cramps shall be spaced not more than 60 cm horizontally and vertically along the stone side for insertion of pins / bolt attached with the steel cramps. Adequate cutting in stone shall be made with precision instrument to hold the cramps pins at the joints.

Stone shall be secured with clamps with high quality workmanship. The walls shall be carried up truly plumb. All the courses shall be laid truly horizontal and all the vertical joints truly vertical. The sequence of execution for cladding work shall be approved by the Engineer-in-Charge.

8.12.5 ***Jointing:*** Joints horizontal and vertical shall be filled with weather sealant of make as approved by Engineer -in-charge with the help of pouring gun for filling the sealant. Before filling the joint with sealant, masking tape are required to be fixed on stones surface on both edges of joints of the stones, so that sealant may not spoil the surface of the stone. When all the joints are filled and sealant has dried, the masking tape may be removed.

8.12.6 ***Protection:*** Work shall be protected from rain by suitable covering. The work shall also be suitably protected from damage and rain during construction.

8.12.7 ***Measurement:*** The length and breadth shall be measured correct to a cm. The area shall be calculated in square metre correct to two places of decimal. Any opening of area 0.01 sqm. or less shall not be deducted.

8.12.8 Rate: The rate includes the cost of materials and labour involved in all operations described above including cost of support scaffolding staging, sealant, pouring guns but excluding the cost of steel cramps drilling holes / making recesses in stones which shall be paid for separately.

Note: Clause 8.12 brought from Sub Head 7 (Stone Work) clause 7.11.

8.13 STRUCTURAL STEEL FRAME WORK FOR DRY STONE CLADDING

Specification for structural frame work for dry stone cladding are same specifications as for steel work in built up sections (welded or bolted).

8.13.1 Fixing of Frame

The properly designed structural frame for withstanding the weight of stone slab are fixed/ supported on wall surface with the help of M.S. brackets/lugs of angle iron/flat etc. which is welded at each junctions of member of frame and also embedded in cement concrete block 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size) of size 300 x 230 x 300 mm. The concrete block can be made by cutting the hole of size as mentioned in brick wall and filling the hole with cement concrete including provision of necessary centring/shuttering for holding of concrete. The frame can also be supported on RCC surface with the help of approved expansion hold fastener by drilling the holes in RCC surface.

Steel cramps are either welded or bolted to the frame (by making necessary holes in frame work) for holding of stone.

8.13.2 Measurement

The mode of measurement shall be the same, as specified for steel work in built up section except that the weight of welding material shall not be added in weight of members for payment and nothing extra shall be paid for making holes for temporary fastening of members during erection before welding, which also includes cost of cement concrete block, centring and shuttering and making holes in walls, but excluding the cost of expansion fastener, steel clamps which shall be paid for separately.

8.13.3 Rate

The rate shall include the cost of all labour and material involved in all the operation described above.

Note: Clause 8.13 brought from Sub Head 7 (Stone Work) clause 7.12.

8.14 ADJUSTABLE STAINLESS STEEL CRAMPS

The cramps shall be stainless steel of make approved by the Engineer-in-charge.

8.14.1 The weight of the stainless steel clamp (including weight of nut and washer) shall not be less than 260 gms.

8.14.2 Necessary holes at suitable locations are to be done on steel frame work for dry stone cladding to be fixed.

8.14.3 Necessary recessed are required to be done in stone slab which is required to be supported by clamps.

8.14.4 The one end of steel clamp is fixed on frame with nut and bolt and other end is inserted into recesses/hole for fixing the dry cladding stone on frame.

8.14.5 The rate includes cost of materials and other operations mentioned as above.

Note: Clause 8.14 brought from Sub Head 7 (Stone Work) clause 7.13.

8.15 WALL LINING

8.15.0 Specified timber shall be used, and it shall be sawn in the direction of the grains. Sawing shall be truly straight and square. The timber shall be planed smooth and accurate to the full dimensions, rebates, roundings, and mouldings as shown in the drawings made, before assembly. Patchings or plugging of, any kind shall not be permitted except as provided.

8.15.1 Grounds

Grounds shall be provided where so specified. These shall consist of first class hard wood plugs or the class of wood used for fabricating the frames, of trapezoidal shape having base of 50 × 50 mm and top 35 × 35 mm with depth of 5.0 cm and embedded in the wall with cement mortar 1:3 (1 cement : 3 fine sand) and batten of first class hard wood or as specified of size 50 × 25 mm or as specified, fixed over the plugs with 50 mm long wood screws. The plugs shall be spaced at 45 to 60 centimetres centre to centre, depending upon the nature of work. The battens shall be painted with priming coat, of approved wood primer before fixing.

8.15.2 Panelling

8.15.2.1 ***Material :*** This panelling shall be decorative or non -decorative (Paintable) type as per design and thickness specified by the Engineer- in- Charge, of 2nd class teak wood, FPT-1 or graded wood prelaminated particle board or as specified in item.

8.15.2.2 ***Ornamental Work :*** The ornamental wood work shall be painted on the back with priming coat of approved wood primer before fixing the same to the grounds with screws, which shall be sunk into the wood work and their tops covered with putty. The ornamental work shall be made true and accurate to the dimensions shown in the working drawings. The fixing shall be done true to lines and levels. The planks for wall lining shall be tongued and grooved, unless otherwise specified.

8.15.2.3 ***Measurements :*** Length and breadth shall be measured correct to a cm. Wall panelling such as teakwood panelling and block panelling, plain lining, and plain skirting each shall be measured separately in square metre nearest to two places of decimal. The moulded work shall be measured in cm running metre i.e. in running metres stating the girth in cm. The sectional periphery (girth) of moulding excluding the portion in contact with wall shall be measured in cm correct to 5 mm and length in metre correct to a cm.

The measurements for ground shall be taken on the basis of cubical contents of battens and paid for separately, unless otherwise specified.

Where only plugs are required to be fixed for the ornamental work, the cost for the same shall be deemed to be included in the rate of ornamental work and no separate payment shall be made for plugs.

8.15.2.4 ***Rate :*** The rate includes the cost of materials and labour required for all the operation described above.

Note: Clause 8.15 brought from Sub Head 9 (Wood and PVC Work) clause 9.9.

8.16 VENEERED DECORATIVE PLYWOOD

8.16.1 Decorative plywood shall be of two grades namely BWR and MR Decorative Plywood shall be of two types. Type I and type 2 and shall conform to IS 1328.

8.16.1.1 Requirement of Type-I Veneered decorative plywood shall be as under:

(a) Open slits checks or open joints not more than 150 mm in length and 0.5 mm in width shall be permissible provided the same are rectified with a veneer insert bounded with synthetic resin adhesive, as the case may be and further provided that the insert matches with the surrounding veneer in colour as well as figure.

(b) The decorative veneered surface shall be free from torn grain, dead knots decolourisation and sapwood.

(c) The decorative veneered surface shall be selected for figure, texture, colour and grain etc. It shall be free from all manufacturing and wood defects except to the Engineer-in-charge permitted under para 8.16.1.1(a). All veneers shall be matched or mismatched to achieve a decorative effect in colour figure and grain.

8.16.2 ***Adhesive :***The adhesive for bonding veneers shall be MR and BWR type synthetic resin adhesive conforming to IS 848 for MR and BWR grade veneered decorative plywood respectively.

8.16.3 ***Dimensions and Tolerances:***

8.16.3.1 The dimensions of plywood boards shall be as follows:

2400 mm x 1200 mm	2100 mm x 900 mm
2100 mm x 1200 mm	1800 mm x 900 mm
1800 mm x 1200 mm	

8.16.3.2 ***Thickness:*** The thickness of plywood board shall be 3 mm, 4 mm, 6 mm, 9 mm, 12 mm, 19 mm and 25 mm.

Note: Any other dimensions (length, width and thickness) as agreed to between the manufacturer and the purchaser may also be used.

8.16.3.3 ***Tolerances:*** Tolerances on the nominal sizes of finished boards shall be as follows:

Dimension	*Tolerance*
Length	*+6 mm-0*
Width	*+3 mm-0 mm*
Thickness *(i) Less than 6 mm*	+ 10 per cent
(ii) 6 mm and above	+ 5 per cent
Edge straightness	2 mm per 1000 mm Or 0.2 per cent
Squareness	2 mm per 1000 mm Or 0.2 per cent

Note: Edge straightness and squareness shall be tested as per Appendix I of CPWD Specifications.

8.16.4 ***Finish :***The decorative plywood shall be uniform in thickness within the tolerances limits specified. The ends shall be trimmed straight and square edge straightness and squareness when tested as per Appendix I shall be within the tolerance specified in 8.16.3.3

8.16.5 ***Sampling and Criteria for Conformity :***The method for drawing representative samples and criteria for conformity shall be as per IS 7638.

8.16.6 ***Tests :***Boards shall be subjected to following tests :

(i) Moisture content: Decorative veneered plywood of either type when tested in accordance with IS1734 (Pt. I) shall have moisture content not less than 5 per cent and not more than 15 percent.

(ii) Water Resistance Test : Three test specimen of size 250 mm x 100 mm shall be prepared for each of the boards selected and submerged in water at 62 +2^{0}C for a period of 3 hours and dried for 8 hours at a temperature of 65 + 2^{0}C and then followed by two more cycles of soaking and drying under same conditions described above. Decorative Veneered plywood of either type shall not show delamination or blister formation.

8.16.7 ***Marking :***Each plywood bound shall be legibly and indelibly marked or stamped with the following on the face of board near one corner.

(a) Indication of the source of manufacture

(b) Year of manufacture

(c) Batch no.

(d) Type of plywood

(e) Criteria for which the plywood has been labelled as ECO mark

The decorative veneered plywood may also be marked with standard BIS certification mark.

8.16.8 Measurement:- Length and width of the decorative veneer shall be measured in square metres to nearest two places of decimal.

8.16.9 Rates:-The rate includes the cost of material and labour involved in all the operations described above except the hold fasts or metallic fasteners which shall be paid separately.

8.17 COIR VENEER BOARD FOR GENERAL PURPOSES

8.17.1 Coir veneer board is manufactured with a combination of coconut fibre needled felt, veneer and jute fibres with craft paper coconut fibre. Needled felt can be used as core cross bands or as outer skin formed with jute fibres and craft paper. However, the composite ply should be a balanced construction on either side of central ply. The blended mass of glued fibres is laid to form a mat which is pre needled.

8.17.2 Coir veneer board generally shall conform to IS 14842.

Grades

Coir veneer board for general purposes shall be of two grades:

(a) Boiling water resistant (BWR) grade

(b) Moisture resistant (MR) grade

8.17.3 ***Material***

*(a) Coconut Fibre :*Coconut fibre layer used in the manufacture of coir veneer board shall be uniform with minimum of 600 gm/m^2.

*(b) Jute :*Jute fibre layer used in the manufacture of coir veneer board shall be uniform with minimum of 60 gm/m^2.

*(c) Adhesive :*Adhesive for manufacture of coir veneer board shall be conform to BWR/MR of IS 848for BWR/MR grade boards respectively.

(d) Veneer : Any species of timber may be used for the manufacture of veneers.

*(e) Kraft Paper :*Kraft paper used in manufacture of coir veneer board shall be uniform with minimum of 40 gm/m^2.

8.17.4 Permissible Defects: Gap in cores and cross band shall not be permitted. Splits in cores and cross bands may be permitted to an extent of 2 per core or cross band and overlap shall be permitted in core/cross bands only.

8.17.5 The Dimensions and Tolerances: The dimensions and tolerances of coir veneer board shall be quoted in following order. The first dimension shall represent the length, the second dimension the width and the third dimension the thickness. The dimensions and tolerances shall be as per IS 12049.

Thickness of coir veneer board shall be 3 mm, 4 mm, 5 mm, 6 mm, 9 mm, 12 mm, 16 mm, 18 mm,20 mm and 25 mm.

The following tolerance on nominal thickness shall be permissible.

(a) Less than 6 mm + 10%
(b) 6 mm and above + 5%

8.17.6 Workmanship and Finish: Coir veneer board shall be of uniform thickness and density throughout the length and width of board. The squareness and edge straightness of the board shall be as per para 9 of IS 12842 and Appendix J.

8.17.7 Sampling: The method of drawing representative samples and criteria for conformity shall be as prescribed in IS 7638.

8.17.8 Tests: The tests shall be carried out as specified in IS 14842 – Appendix K.

8.17.9 Moisture Content: Coir veneer board when tested in accordance with IS 3734 (Part-I) shall have a moisture content not less than 5 percent and not more than 15 percent.

8.17.10 Marking: Each coir veneer board shall be legibly and indelibly marked or stamped with the following near one corner.

(a) Identification of source
(b) Year of manufacturing
(c) Batch no.
(d) The grade and type as follows.
    (i) Boiling water resistant (BWR) and
    (ii) Moisture resistant (MR)

8.17.11 *BIS Certification Marking :* Coir veneer board may also be marked with the standard mark governed by the BIS Act, 1986.

8.17.12 Measurement:- Length and width of the decorative veneer shall be measured in square metres to nearest two places of decimal.

8.17.13 Rates:- The rate includes the cost of material and labour involved in all the operations described above except the hold fasts or metallic fasteners which will be paid for separately.

8.18 PRELAMINATED PARTICLE BOARDS

8.18.1 Pre-laminated particle boards are available in two grades namely Grade I and II as per IS 12823. Each grade is further classified in four types; namely Type –I, II, III, IV.

8.18.2 Material

8.18.2.1 Particle Board Pre-laminated particle board Grade-1 (FPT–I or graded wood particle board FPT-I) bonded with BWP type synthetic resin and pre-laminated conforming to IS 12823 Grade-I, type II or I shall be used.

8.18.2.2 *Impregnated Base Paper* : Printed or plain coloured absorbent base paper having a weight of60-140 g/m^2 impregnated in a suitable synthetic resin and dried to a volatile content of 4-8 per cent shall be used for pre-lamination on both surfaces of particle board.

8.18.2.3 *Impregnant Overlay :*An absorbent tissue paper having a weight of 18-40 gm/m^2 impregnated in a suitable synthetic resin and dried to volatile content of 4-8 per cent.

8.18.3 ***Dimension and Tolerances***

8.18.3.1 Dimensions of pre-laminated particle boards shall be as follows:

Length : The length of pre-laminated particle boards shall be 4.8, 3.6, 3.0, 2.7, 2.4, 2.1,1.8, 1.5, 1.2, 1.0 and 0.9 metres.

Width : The width of pre-laminated particle boards shall 1.8, 1.5, 1.2, 1.0, 0.9, 0.6 and0.45 metres.

Thickness : The thickness of pre-laminated particle boards shall be 6, 9, 12, 15, 20, 25, 30,35, 40 and 45 mm.

8.18.3.2 ***Tolerances:*** Tolerances on the nominal sizes of finished boards shall be as given below :

Dimension	Tolerance
Length	+ 6 mm - 0
Width	+ 3 mm - 0
Thickness	5 per cent
Edge straightness	2 mm per 1000 mm or 0.2 per cent
Squareness	2 mm per 1000 mm or 0.2 per cent

Note : Edge straightness and squareness shall be tested as per IS 12823.

8.18.4 ***Sampling and Inspection*** **:** The number of pre-laminated particle board to be selected from a lot shall be in accordance with the Table 8.4 given below:

TABLE 8.4

Lot Size	Number of pre-laminated boards to be selected
Upto 50	**2**
51 to 100	**3**
101 to 200	**4**
201 to 300	**5**
301 to 500	**7**
501 and above	**10**

8.18.4.1 The pre-laminated particle boards shall be selected at random (ref. IS 4903). In order to ensure randomness of selection, all the pre-laminated particle boards in the lot may be arranged in a serial order and every pre-laminated particle board may be selected till the required number is obtained, 'r' being the integral part of N/n, where N is the lot size and n is the sample size.

8.18.4.2 All board selected as given in para 8.18.4.1 shall be tested as specified in IS 2380 (part-2) for length, width, thickness, edge straightness and squareness shall comply with the requirements specified under para 8.18.3.2.

8.18.4.3 ***Testing and Number of Tests :*** For each of particle board selected as per para8.18.4 Test specimens shall be cut out from portion 150 mm away from the edges for tests and tests shall be carried out as per IS 12823.

8.18.4.4 ***Criteria for Conformity:*** A lot shall be considered as in conformity to the requirements of the specification if no group of specimens for any of the characteristics fails to meet the conditions as prescribed in para 8.18.4 & 8.18.4.3 of this specification.

In case of a failure, double sample shall be taken from the lot for testing. The lot shall be consideredas passed, if all these samples conform to the specified requirement.

8.18.4.5 ***Marking :*** Each pre-laminated particle board shall be legibly and indelibly marked on any of its edges with following :

(a) Indication of source of manufacturer

(b) Grade and type of pre-laminated particle board

(c) Thickness

(d) Batch number and year of manufacture

8.18.5 Measurement:- Length and width of the decorative veneer shall be measured in square metres to nearest two places of decimal.

8.18.6 Rates:-The rate includes the cost of material and labour involved in all the operations described above except the hold fasts or metallic fasteners which will be paid for separately.

8.19 PRESSED CERAMIC TILES IN SKIRTING AND DADO

8.19.1 The tiles shall be of approved make and shall generally conform to IS 15622. The tiles shall be pressed ceramic covered by a glaze thoroughly matured and fitted to the body. The tiles shall be sound, true to shape, flat and free from flaws and other manufacturing defects affecting their utility.

The top surface of the tiles shall be glazed. The underside of the tiles shall not have glaze on more than 5% of the area in order that the tile may adhere properly to the base. The edges of the tiles shall be free from glaze, however, any glaze if unavoidable shall be permissible on only upto 50 per cent of the surface area of edges.

The glaze shall be free from welts, chips, craze, specks, crawlings or other imperfections detracting from the appearance when viewed from a distance of one metre. The glaze shall be either glossy or matt as specified. The glaze shall be white in colour except in the case of coloured tiles when colours shall be specified by the Engineer-in-Charge. There may be more than one colour on a tile.

8.19.1 (a) Dimensions and Tolerances

Glazed pressed cramic tiles shall be made square or rectangular in sizes Table 1, 3, 5 & 7 of IS 15622 give the modular sizes and table 2, 4, 6 & 8 of IS 15622 gives the sizes of non modular tiles. The tiles shall conform to IS 15622 for dimensional tolerance, physical and chemical properties.

Half tiles for use as full tiles shall have dimensions which shall be such as to make the half tiles when jointed together (with 1 mm joint) match with dimensions of full tiles. Tiles may be manufactured in sizes other than those specified. above.

The thickness of the tiles shall be 5 mm or 6 mm or as specified.

The dimensions of fittings associated with the glazed tiles namely cover base, round edge tile, angles corner cups, ridge and legs, cronices and capping beads shall be of the shape and dimensions as required and the thickness of fittings shall be the same as the thickness of tiles given above.

8.19.2 Preparation of Surfaces

The joints shall be raked out to a depth of at least 15 mm in masonry walls.

In case of concrete walls, the surface shall be hacked and roughened with wire brushes. The surface shall be cleaned thoroughly, washed with water and kept wet before skirting is commenced.

8.19.3 Laying

12 mm thick plaster of cement mortar 1:3 (1 cement : 3 coarse sand) mix of as specified shall be applied and allowed to harden. The plaster shall be roughened with wire brushes or by scratching diagonal at closed intervals.

The tiles should be soaked in water, washed clean, and a coat of cement slurry applied liberally at the back of tiles and set in the bedding mortar. The tiles shall be tamped and corrected to proper plane and lines. The tiles shall be set in the required pattern and jointed. The joints shall be as fine as possible. Top of skirting or dado shall be truly horizontal and joints truly vertical except where otherwise indicated. Odd size/cut size of tile shall be adjusted at bottom to take care of slope of the flooring. Skirting and dado shall rest on the top of the flooring. Where full size tiles cannot be fixed these shall be cut (sawn) to the required size and their edges rubbed smooth. Skirting /dado shall not project from the finished "surface of wall" by more than the tile thickness, undulations if any shall be adjusted in wall.

8.19.4 Curing and Finishing

The joints shall be cleaned off the grey cement grout with wire/coir brush or trowel to a depth of 2 mm to 3 mm and all dust and loose mortar removed. Joints shall then be flush pointed with white cement added with pigments if required to match the colour of tiles. The work shall then be kept wet for 7 days.

After curing, the surface shall be washed and finished clean. The finished work shall not sound hollow when tapped with a wooden mallet.

8.19.5 Measurements

Length shall be measured correct to a cm. Height shall be measured correct to a cm in the case of dado and 5 mm in the case of riser and skirting. The area shall be calculated in square metre, correct to two places of decimal. Length and height shall be measured along the finished face of the skirting or dado including curves where specials such as coves, internal and external angles and beads are used. Where cornices are used the area of dado shall be measured excluding the cornices. Nothing extra will be paid for cutting (sawn) the tiles to sizes.

Areas where coloured tiles or different types of decorative tiles are used will be measured separately to be paid extra over and above the normal rate for white tiles.

8.19.6 Rates

The rate shall include the cost of all material and labour involved in all the operations described above, for tiles of sizes upto 0.14 sqm. unless otherwise specified in the description of the item. The specials such as coves, internal and external angles and beading shall be measured and paid for separately. The rate shall not include cost of cornices which shall be measured and paid for in running meters separately.

Note : Clause 8.19 brought from Sub Head 11 (Flooring) clause 11.18

8.20 CURTAIN WALL WITH ALUMINIUM COMPOSITE PANELS (ACP) CLADDING

8.20.1 General

1. All composite aluminum panels shall have a thickness of 4.00mm.
2. The composite cladding panels shall be of cassette type, framed with an extrude aluminum profile.
3. All fasteners shall be concealed within the panel joints. All fixing and joint details shall be designed to provide for the expected thermal expansion and contraction. The fixing of these panels shall accommodate the expected structural movements in the building.

4. With a gloss of 30% according to Gardner Scale, the installed composite panel surface shall not have irregularities such as oil canning, waves, buckles, and other irregularities when viewed at any position not less than 15 degrees to the true plane of the panel.
5. All fasteners, anchors, brackets and similar attachments used for the fixing and erection of these panels shall be of aluminum, non-magnetic stainless steel, or hot dip galvanized steel.

8.20.2 Materials

Aluminium Composite Panel (ACP) cladding in pan shape in metallic colour of approved shade, made of Aluminium Composite Material (ACM), made out of 4 mm thick aluminium composite panel consisting of 3 mm thick fire retardant (FR) grade mineral filled thermoplastic inorganic core of grade B1 sandwiched between two thin coil coated aluminium sheets(Top i.e. face # 1& rear i.e. face # 2) of alloy, Grade 3003 and H-16 temper and minimum thickness of 0.5 mm each as specified in the nomenclature of item. The ACPs are used for the external cladding surface like column, wall, jambs, sills, projected area, ceiling, decorative cladding on any surface to any profile and shape (pan shape) at horizontally / vertically / sloped / curved / circular etc.(linear as well as curvilinear shape).

The ACP fire retardant core of B1 grade contain 70% of Non-Combustible Inorganic compound & 30% of virgin LDPE. The main ingredient of the non-combustible compound are Aluminum Oxide (AlO) and Magnesium Oxide (MgO), when this ACP are put on fire at self ignition temperature of 460º C, it can be catched on fire after 5 minutes and when the fire leave the panels, the fire on the wall extinguish after 10 seconds.

The ACP top face (exposed surface) coil should have Kynar 500 PVDF(Polyvinylidene fluoride)/ Lumiflon based fluropolymer resin (high surface energy) coating of approved colour and shade of 30 microns to ensure corrosion resistance and weather proof and thus shall confirm to relevant ASTM or DIN or EN or BS code.The back face (rear side) of the cladding penal surface facing to the wall shall have polyester based wash (service) coating of 7 microns preferably grey in colour to protect against possible corrosion problems. The finished surface (Top face) shall be protected with a self adhesive peel off film with two layers of white & black tested to with stand local weather conditions without losing the original peel off characteristic or causing stains or other damages.

The weight of the Aluminum Composite Panel (ACP) should not be less than 7.50 Kg/Sqm. The ACP shall confirm to ASTM E84-08 or EN13501-1 or DIN4102 resulting in fire resistant properties.

The complete system shall be designed to with stand the design wind pressure as per relevant IS code or international code (Test pressure shall be 1.5 times of the design wind pressure).

Necessary pull out test of anchor fastener shall be carried out on the masonry wall /RCC structure to check the load carrying capacity of the bolt designed under suction pressure for designing the supporting and anchoring system.

8.20.3 Movement

System shall be designed to accommodate movement due to any force including the movement resulting from the exterior skin temperature ranging from 15°C to 85°C and also to accommodate the horizontal building movement of 10 mm per panel & vertical movement of 20 mm between floors on the aluminium framing system with support brackets, glass, gaskets and fastening devices. System shall be designed to accommodate the size and shape of the Laminated sandwiched composite panel as per the approved drawings including approved modifications as may be required during execution as well as all other incidental forces and stresses likely to be experienced under service conditions, i.e. Lateral force, Dead weight and Thermal expansion due to building movement both vertical and horizontal etc. Grooves shall be designed in such a way to accommodate weather silicon sealant/ Non staining sealant of approved make.

8.20.4 Testing

The mechanical properties of 4mm thick ACP or ACM with core and aluminium coil/sheet shall confirm to the requirement as given in table 8.5 below.

Table 8.5

Specification for Aluminium Composite Material (ACM)

S. No.	Description	Specification for 4mm	
A	**Physical Tests for ACM**	**Standard Test**	**Acceptable Value/Results**
1	Over all thickness of ACM	Measurement	4mm (Tolerance + 0.2mm)
2	Aluminium Skin thickness (each side)	Measurement	0.5mm (Tolerance +/- 0.03mm)
3	Panel weight (ACM)	Measurement	7.5 Kg/m^2 (+ 5%)
B	**Mechanical Properties of ACM**		
1	Peel off strength (Drum Peel Test)	ASTM D903	Min. 4 N/mm
2	Tensile strength	ASTM E8	Min. 40 N/mm^2
3	Yield strength	ASTM E8	Min. 40 N/mm^2
4	Elongation	ASTM E8	Min. 6%
5	Flexural strength	ASTM C393	Min. 130 N/mm^2
6	Shear strength with punch shear test	ASSTM D732	Min. 18 N/mm^2
C	**Properties of Aluminium skin**		
1	Tensile strength (Rm)	ASTM E8	Min. 150 N/mm^2
2	Modules of elasticity	ASTM E8	Min 70000 N/mm^2
3	Elongation	ASTM E8	Min. 2%
4	0.2% proof stress	ASTM E8	Min. 110 N/mm^2
5	Yield strength	ASTM E8	Min. 124 N/mm^2
6	Sound Transmission loss	ASTM E413	Max. 26 dB

8.20.5 Performance Certificate

Requisite performance certificate from the manufacturer of ACM stating compliance with ACM technical specification as per Table 5 above shall be submitted by the contractor to the Engineer-in-Charge before fixing at site of work.

The contractor shall provide curtain wall with aluminum composite panel cladding, having all the performance characteristics all complete as per the Architectural drawings, as per items description, as specified, as per the approved shop drawings and as directed by the Engineer-in-charge.

8.20.6 Marking

The ACP sheet should have a following laser marking and should be at repeated interval at the rear face of ACP sheet.

1. Total thickness with coil and core materials.
2. Size of ACP sheet.
3. Fire Retardant (FR) grade.
4. Date of manufacturing.
5. Batch number.
6. Make of manufacturer.

8.20.7 Installation

The installation system of ACP as external cladding with tray type (rout and return) panels and sealing joint is one of the most common method and it is available for a wide range of new buildings

and renovation projects. The ACP sheet under this system is first fixed on the substructure i.e. of steel members/RCC structures/brick walls with the help of base aluminium member frame work using necessary clamps, brackets, anchor fasteners, stainless screws, nuts and bolts, weather silicon sealant backer rods etc. as per approved design & drawing at all height and elevation which include all labours, materials, equipment's, handling, transportation, workmanship, design & preparation of working drawings, staging, scaffolding etc. all complete as per specification, drawings and instructions of the Engineer-in-Charge.

8.20.7.1 Frames: Providing and fixing Aluminium extruded members (Box Tube) designed to with stand design wind pressure and movement as specified as continuous member for cladding the Aluminium Composite Panel. Aluminium member shall be fixed into masonry wall / RCC member / steel structures with brackets / clamps and it shall be of chromicised finish aluminium. All fastening straps, nuts & bolts, rivets, washers/other fastening materials shall be of nonmagnetic stainless steel and aluminium brackets shall be considered for ACP cladding with standard dimension and after the site survey if any undulation is observed intern that doesn't allow to fix the aluminium bracket only in these areas the additional support with locally fabricated hot dip galvanized bracket can be considered. The bidder shall include the provision for these brackets also with in the quoted rate for ACP cladding works. Aluminium shim shall be used for level adjustment of bracket but more than 20 mm is not acceptable. If more than 20 mm, bracket shall be designed according to site condition.

Aluminium brackets / clamps shall be fixed with chemical injection technique threaded anchor rods of approved make to the base structure in the case of masonry wall / RCC members and SS anchor bolts in the case of steel structure. Extruded member shall be designed to accommodate laminated sandwiched composite panel as per the approved shop drawings and extruded aluminium member shall be 6063 T6 or 63400 (H9) grade conforming to BS 1467 or IS 8147, finished with transparent electrolytic colour anodic coating AC15 grade conforming to IS 1868.

8.20.7.2 Composite Panel: Aluminium composite panel cladding of approved make as specified in BOQ to be fixed on the framing system described above. Lamination process of Aluminium panel shall only be glue technology and the source of complete composite panel shall only be accepted.

The Laminated sandwiched composite panel suitably stiffened internally on the back side for preventing deformation due to design wind pressure beyond permissible limits by using aluminium flat 25 mm wide, 4 mm thick gloved with double adhesive tape in order to maintain panel flatness and to avoid permanent deformation over a period. Stiffener shall be provided at 600 mm c/c behind ACP panel irrespective of structural check of the panel against stability and deflection. Aluminium flat of size 25 mm wide and 3 mm thick shall be provided to a length 100 mm bent to shape, wherever the inner skin is cut to bend the ACP at the corners and as per approved shop drawing. Methodology of fixing the stiffener/flat in the corner panel shall be established in the drawing or to be glued to ACP on the backside of the panel in such a way the fixing mechanism of stiffener / flat shall not be visible on the elevation of the panel / outside.

8.20.7.3 Sealing: After fixing the ACP on the sub structure, then a suitable sealing materials i.e. Non structural weather silicon sealant/Non staining sealant filled to the joints of panel with baker rod of approved make to ensure water tightness to the panel. Sealing shall be carried out with Non-structural (weather) sealant / Non staining sealant with PE baker rods, wherever the system is interfacing with glazing, cladding groove and any other groove.

8.20.7.4 Flashing: Fixing flashing at terrace level as part of the system made to profile as shown in the approved shop drawings and the profile shall be made out of hot dip galvanized sheet 1.2 mm thick and galvanizing coating thickness shall be in accordance with IS 2629 & 4759. In general, the flashing shall be provided to the entire length of cladding horizontally at terrace level with necessary anchoring system with SS fastening devices of approved make. Also, the flashing shall be provided

at parapet top below the coping to drain the water during any seepage through the sealant joints with overlap of 100 to 125 mm in plan with sealant at joints to make sure that no water leakage through coping / flashing joints.

8.20.7.5 Field Test: Conduct field test at site on the installed system as per the criteria set out in the particular specification in the presence of Engineer in charge. Methodology for carrying out the test shall be submitted to Engineer-in Charge for approval prior to testing. Record the results and submit the report to the Engineer-in Charge for approval. If Field test fails, correct the defects revealed to the satisfaction of the performance data as set out in the technical specification with the prior approval of Engineer-in Charge on defects rectification methodology.

8.20.7.6 General Guideline: System design in total, including Aluminium extruded member, type & thickness of Aluminium composite panel, Aluminium sleeves at connections, inserts, Sealant, Supporting system/bracket including fastening and anchoring system & materials specified in the schedule and the system details as shown in the tender drawing are only tentative and is meant to set out a general outline of the proprietary system. Since the cladding system in terms of design, materials, all fixing details, methodology of execution are proprietary in nature, the onus of the design and performance requirements, shop drawing, execution etc. satisfying the design intent, particular specification and site conditions lies solely with the Contractor.

8.20.8 Precautions

1. Do unpacking and repacking of ACP sheet work in a clean place.
2. Remove dust and chips from ACP sheet and the packing paper.
3. Handle ACP sheet on a worktable. Do not handle it on the floor.
4. ACP sheets should always be handled by two people with external face upward to avoid possible rubbing of the ACP surface during handling.
5. Prior to fabrication, clean off the worktable, temporary stand and both side of ACP sheet.
6. Ensure that cutting chips generated from saws, routers and drills are completely removed from the interface between ACP sheet and tools.
7. The arrow should be followed as marked on the rear (back) face coil/ sheet to avoid the variation in colour.
8. Protective film of 75 microns should be removed within 45 days after the installation.
9. Do not use adhesive tapes made of PVC (Polyvinyl Chloride) on the surface of protective film or any time during storage, fabrication or installation.
10. Aluminum composite material (ACM) manufacturer shall provide warranty of ten years for any manufacturing defects.

8.20.9 Measurements

For the purpose of payment, only the actual area on the external face of the curtain wall with Aluminum Composite Panel cladding (including width of groove) shall be measured in square meters upto two places of decimal.

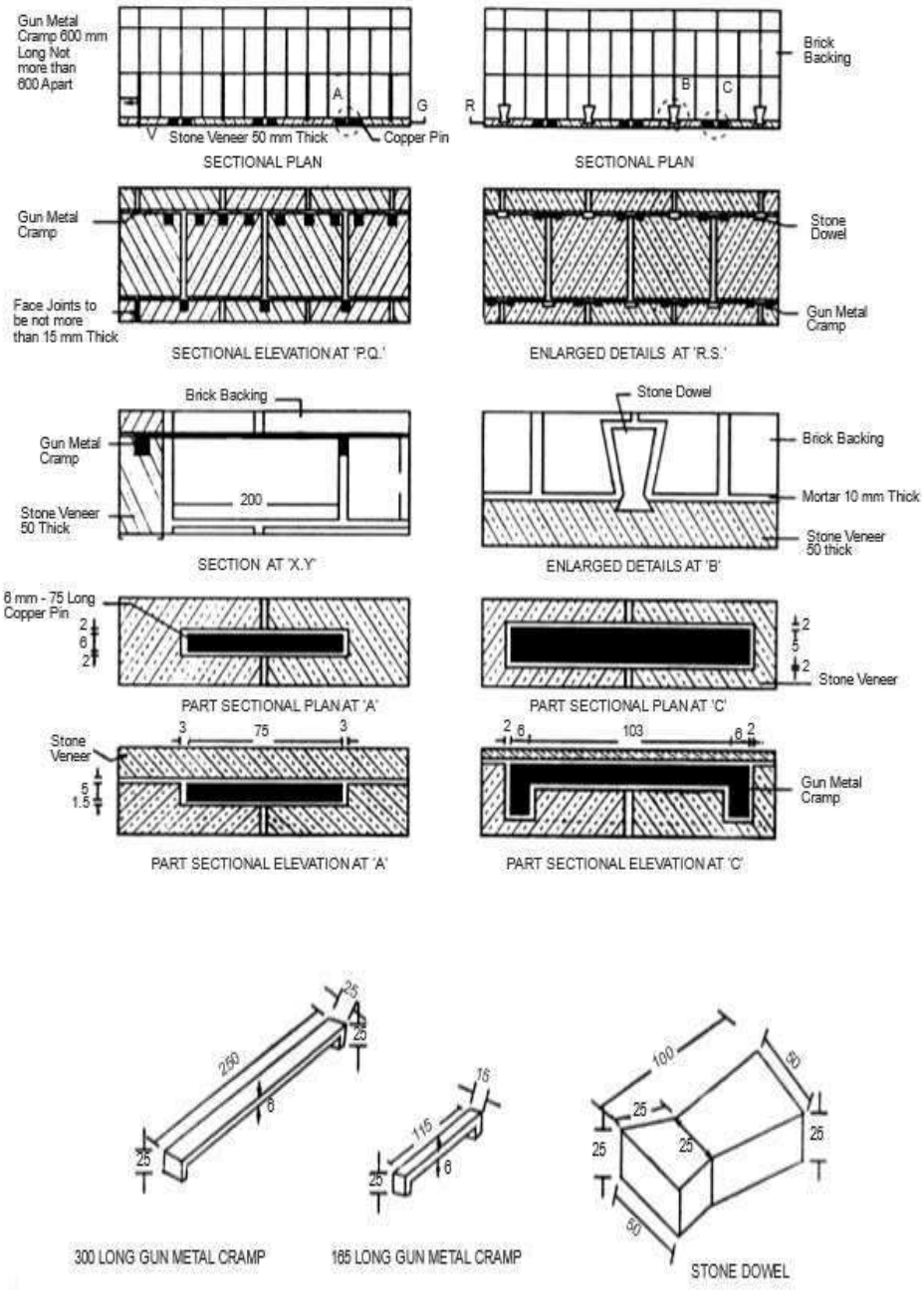
8.20.10 Rate

The rate includes the cost of all materials, labour, equipment's, design, shop drawing, fabricating, installation and fixing in position the curtain wall with Aluminum composite panels cladding for all height and all level etc. in all the operation described above and any other stipulations in the particular specification and agreement. Also, includes the cost of scaffolding, infrastructure facility and all other consumables to execute the work as specified above.

The cost of all mockups at site, testing charges, cost of all sample of the individual components for testing in an approved laboratories, field test on the assembled working curtain wall with aluminum composite panels claddings, cleaning and protection of the curtain wall with aluminum composite panel claddings till the handing over of the building for occupation. Base aluminum members frame work for ACP cladding is payable under the relevant aluminum items.

MARBLE STONE VENEERING

Sub Head : Marble Work
Clause : 8.6.2.2

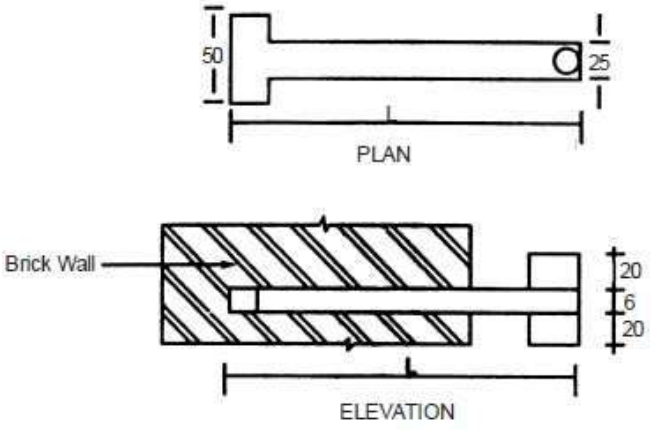


Drawing not to scale
All dimensions are in mm

Fig. 8.1 : Marble Stone Veneering (General Fixing Arrangement)

MARBLE STONE VENEERING
(Typical Fixing Arrangement)

Sub Head : Marble Work
Clause : 8.6.2.2



L=115 mm for half Brick Backing
L=150 mm for full Brick Backing

Fig. 8.2A : Cramp for Brick Backing

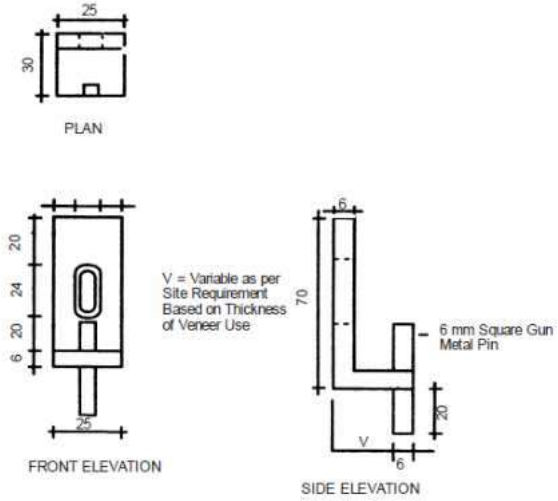


Fig. 8.2B : Cramp for R.C.C. Work Backing

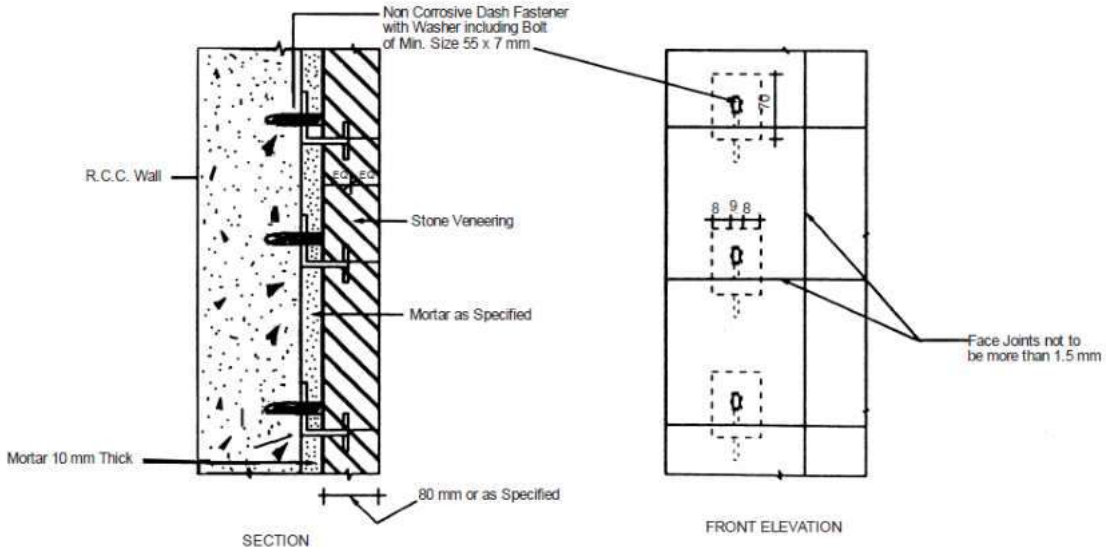


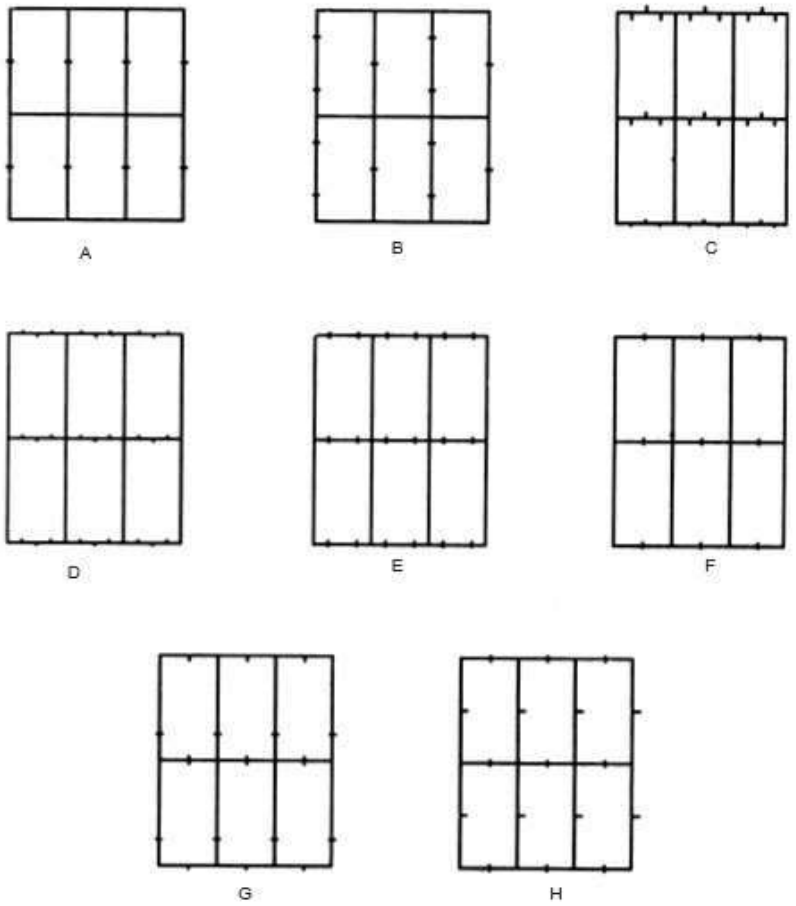
Fig. 8.2C :Typical Details of Cramps for R.C.C. Backing

Drawing not to scale
All dimensions in mm

Fig. 8.2 : Marble Stone Veneering (Typical Fixing Arrangement)

GENERAL ARRANGEMENTS OF CRAMPS

Sub Head : Marble Work
Clause : 8.6.2.3



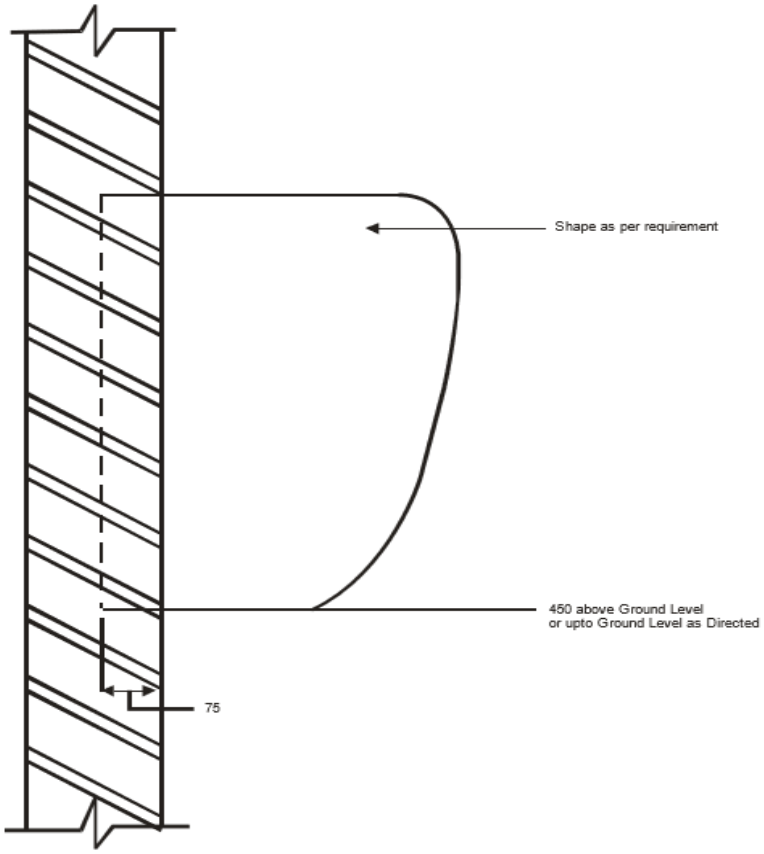
Note : Cramps arrangement is shown above for veneerings with longer sides vertical. For veneering having the longer sides horizontal cramps would be arranged to suit the altered positions.

Drawing not to Scale

Fig. 8.3 : General Arrangements of Cramps

MARBLE SLAB URINAL PARTITION

Sub Head : Marble Work
Clause : 8.7

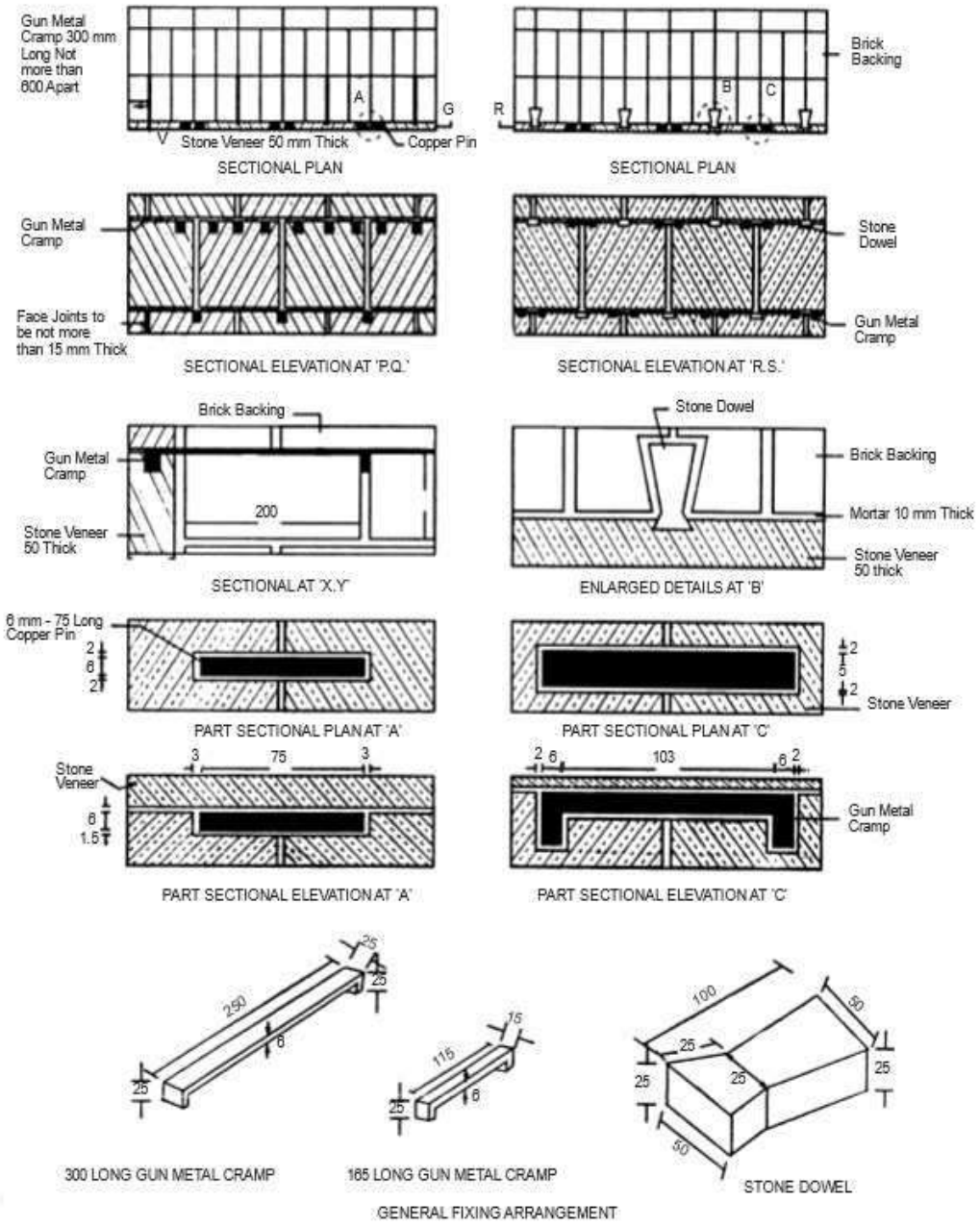


Drawing not to scale
All dimensions are in mm

Fig. 8.4 : Marble Slab Urinal Partition

STONE VENEERING

Sub Head : Stone Work
Clause : 8.8 & 8.8.4.2



Drawing not to scale
All dimensions are in mm

Fig. 8.5 : Stone Veneering

STONE VENEERING (Typical Fixing Arrangement)

Sub Head : Stone Work
Clause : 8.8.4.2 & 8.8.4.6

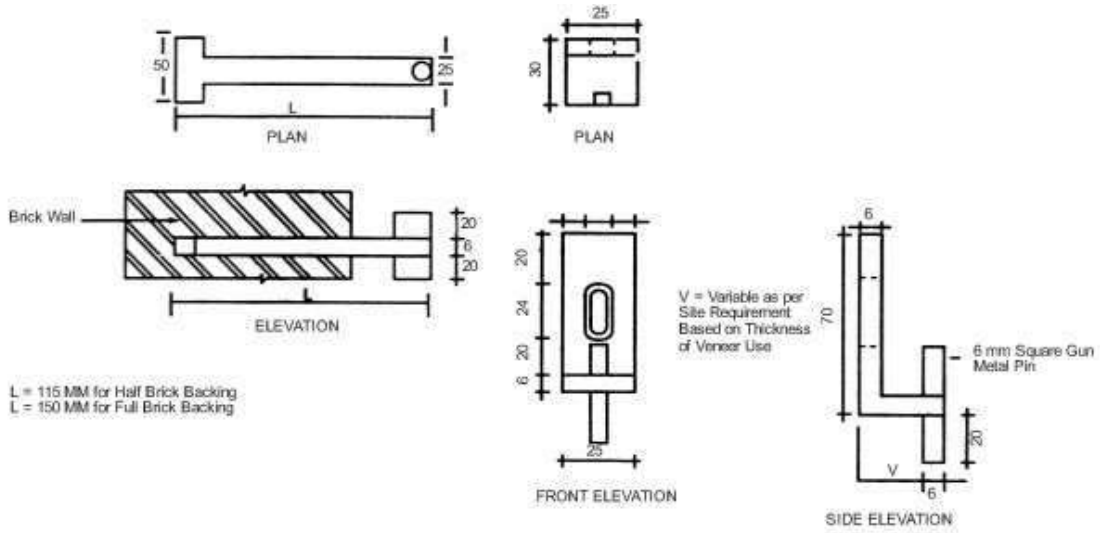


Fig. 7.15A : Cramp for Brick Backing **Fig. 7.15B : Cramp for R.C.C. Work Backing**

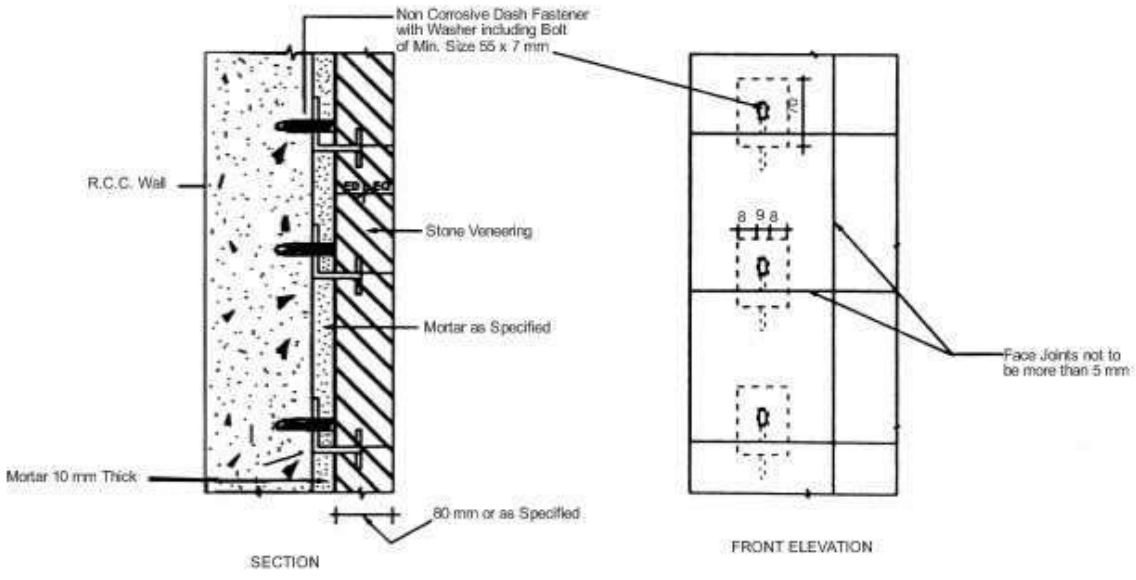
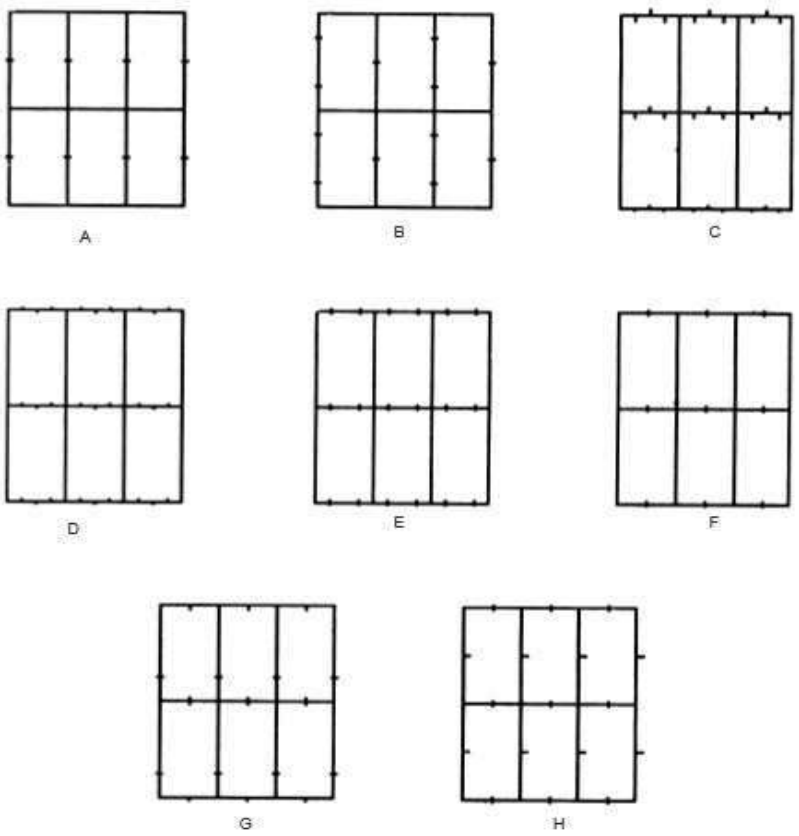


Fig. 8.6 : Stone Veneering (Typical Fixing Arrangement)

GENERAL ARRANGEMENT OF CRAMPS

Sub Head : Stone Work
Clause : 8.8.4.3



Note : Cramps arrangement is shown above for veneerings with longer sides vertical. For veneering having the longer sides horizontal, cramps would be arranged to suit the altered positions.

Drawing not to scale

Fig. 8.7 : General Arrangement of Cramps

Note: Fig. 8.5, 8.6 & 8.7 brought from Fig. 7.14, 7.15 & 7.16

SUB HEAD : 9.0

WOOD WORK AND P.V.C. WORK

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LIST OF MANDATORY TESTS

Material	*Clause*	*Test*	*Field/ Laboratory Test*	*Test Procedure*	*Min, Quantity of Material for carrying out the test*	*Frequency of Testing*
1	2	3	4	5	6	7
Timber	9.1.6	Moisture content	Field (by moisture meter) laboratory test as required by Engineer-in-Charge	Appendix 'C'	1 cum	Every one cum or part thereof.
Flush door	9.7.10	End immersion Test knife test Adhesion Test	Laboratory	IS 2202 Appendix 'F'	26 shutters	As per sampling and testing specified in clause 9.7.11
Mortice Locks	9.15.13	Testing of spring	Laboratory	IS 2209- Appendix 'G'	50 Nos	100 or part thereof.

LIST OF BUREAU OF INDIAN STANDARD CODES

S. No.	IS No.	Subject
1	IS 204 (Part I)	Specification for tower bolts (ferrous bolt)
2	IS 204 (Part II)	Specification for tower bolts (non ferrous metals)
3	IS 205	Specification for non ferrous metal butt hinges
4	IS 206	Specification for Tee and strap hinges
5	IS 207	Specification for Gate and shutter hook and eye
6	IS 208	Specification for door handles
7	IS 277	Galvanized steel sheets (Plain and Corrugated)
8	IS 281	Specification for mild steel door bolts for use with pad locks
9	IS 287	Recommendations for maximum permissible moisture contents of timber used for different purpose
10	IS 303	Specification for plywood for general purposes
11	IS 362	Specification for parliament hinges
12	IS 363	Specification for hasps and stapple
13	IS 364	Specification for fan light catch
14	IS 401	Code of practice for preservation of timber
15	IS 419	Putty for use on window frames
16	IS 451	Technical supply condition for wood screws
17	IS 452	Specification for door spring rat tail type
18	IS 453	Specification for double acting spring hinge
19	IS 707	Glossary of terms applicable to timber technology and utilization
20	IS 710	Specifications for Marine Plywood
21	IS 723	Specification for steel counter sunk head wire nails.
22	IS 729	Specification for drawer lock, cup board lock and box locks
23	IS 848	Specification for synthetic resin adhesive for plywood (phenoic and amino plastic)
24	IS 851	Specification for synthetic resin adhesive for const. work (non structural in wood)
25	IS 852	Specification for animal glue for general wood work purpose
26	IS 875 (Part-3)	Code for practice for design loads (other than Earthquake) for building and structures
27	IS 1003 (Part I)	Specification for timber panelled and glazed shutter Part I (door shutters)
28	IS 1003 (Part II)	Specification for timber panelled and glazed shutter Part II (window and ventilator shutter)
29	IS 1079	Hot rolled carbon steel sheet and strip

30	IS 1141	Specification for code of practice for seasoning of timber
31	IS 1200 Part XIV	Method of measurement of building and civil engg work glazing.
32	IS 1200 Part XII	Wood work and joinery
33	IS 1328	Specification for veneered decorative plywood
34	IS 1341	Specification for steel butt hinges
35	IS 1378	Specification for oxidized copper finishes
36	IS 1566	Specification for hard drawn steel wire fabric
37	IS 1568	Specification for wire cloth for general purpose
38	IS 1658	Specification for hard drawn steel wire fabric
39	IS 1659	Specification for block boards
40	IS 1708 (Part 1 to 18)	Testing of small clear specimen for timber
41	IS 1734	Determination of density and moisture content.
42	IS 1823	Specification for floor door stopper
43	IS 1868	Specification for anodic coating on aluminium and its alloy
44	IS 2046	-do- Decorative thermosetting synthetic resin bonded laminated sheet
45	IS 2095	Specification for gypsum plaster board
46	IS 2096	Specification for asbestos cement flat sheet.
47	IS 2202 (Pt I)	Specification for wooden flush door shutter, solid core type (plywood face panels)
48	IS 2202 (Part II)	-do- (Particle boards and hard board face panels)
49	IS 2209	Specification for mortice lock (Vertical Type)
50	IS 2380	Method of test for wood particle board and board for lignocelluloses material
51	IS 2547	Specification for gypsum plaster
52	IS 2753	Method for estimation of preservatives in treated timber and in treating solutions.
53	IS 2681	Specification for non-ferrous metal sliding door bolts use with pad locks
54	IS 3087	Specification for wood particle boards (Medium density) for general purpose.
55	IS 3097	Specification for veneered particle board
56	IS 3828	Specification for ventilator chain
57	IS 3400 (Part II)	Method of test for Vulcanized rubber (hardness)
58	IS 3400 (Part IV)	Accelerated aging
59	IS 3400 (Part IX)	Density
60	IS 3564	Specification for door closer (hydraulically regulated)

61	IS 3618	Phosphate treatment of iron and steel for protection against corrosion
62.	IS 3813	“C” hooks for use with swivels
63.	IS 3818	Specification for continuous (Piano) hinges
64.	IS 3847	Specification for mortice night latch
65.	IS 4351	Steel Door Frames - Specification
66	IS 4835	Specification for polyvinyl acetate dispersion based adhesive for wood
67.	IS 4948	Specification for welded steel wire fabric for general use
68.	IS 4985:2000	uPVC pipes for potable water supplies
69.	IS 4992	Specification for rebated mortice lock
70.	IS 5187	Specification for flush bolts
71.	IS 5509	Specification for Fire Retardant Plywood
72.	IS 5930	Specification for mortice latch
73.	IS 6318	Specification for plastic wire window fastners
74.	IS 6607	Specification for rebated mortice lock (Vertical type)
	IS 6760	Specification for sloted counter sunk head wood screws.
75.	IS 7196	Specification for hold fast
76.	IS 7534	Specification for sliding locking bolts for use with pad lock
77.	IS 7638	Wood/lignocellulosic based panel products – Method for sampling
78.	IS 8756	Specification for mortice ball catch for use in wooden almirah
79.	IS 9308 (Part II)	Specification for mechanically extracted coir fibres. (Mattress coir fibres)
80.	IS 9308 (Part III)	-do- Decorated coir fibre
81.	IS 11215	Moisture content of timber and timber products method of determination
82.	IS 12049	Dimensions and tolerance relating to wood based panel materials
83.	IS 12406	Specification for medium density fibre board
84.	IS 12817	Specification for stainless steel Butt Hinges
85.	IS 12823	Specification for wood products –Prelaminated particle Boards
86.	IS 14276	Cement Bonded Particle Boards - Specificaion
87.	IS 14616	Specifications for laminated veneer lumber
88.	IS 14842	Specification for coir veneer board for general purposes
89	IS 14856	Specification for glass fibre reinforced plastic (FRP) panel type door
90	IS 14862	Fibre Cement Flat Sheets - Specification
91	IS 14900	Specifications for transparent float glass

9.0 WOOD WORK AND P.V.C. WORK

9.0 TERMINOLOGY

Ballies : Thin round poles usually without bark.

Beam : A structural timber generally long in proportion to its width and thickness and used for supporting load primarily by its internal resistance to bending.

Block Board : A Board having a core made up of strips of wood, each not exceeding 25 mm in width, laid separately or glued or otherwise joined to form a slab which is glued between two or more outer veneers with the direction of the grain of the core blocks running at right angles to that of the adjacent outer veneers.

Core : The inner layers of a composite wood product.

Cross Band : A general term indicating a transverse layer of veneer or veneers in composite wood products.

Decorative Veneers : Veneers having attractive appearance due to figure, colour, grain, lusture, etc.

Hard Wood : A conventional term used to denote the wood obtained from broad-leaved trees. It has no relationship to the physical properties of hardness or strength. On account of the confusion this word might cause, its use is discouraged.

Freeze Rail : Horizontal member, mortised or otherwise secured to the stiles of a door, provided just below the freeze panel usually provided for decorative purposes in the uppermost portion of the door.

Joint : A prepared connection for joining adjacent pieces of wood, veneer, etc.

Dovetail Joint : A joint at the corner of two pieces in such a way that the notches made to one are fitted exactly into projections of corresponding size and shape made in the other. There are various kinds of dovetail joints for instance, lapped dovetail joint, wedge shaped dovetail joint, etc. joined in a way which will resist withdrawal except in the direction in which it was assembled (Fig. 9.1C).

Mitred Joint : A joint, between two members at an angle which bisects the joining angle usually the joining faces are cut at 45° to form a right angle (Fig. 9.1B).

Mortise and Tenon Joint : A joint in which the reduced end (tenon) of one member fits into the corresponding slot (mortise) in another member (Fig. 9.1D).

Tongue and Groove Joint : A joint in which a tongue is provided on edge of one member to fit into a corresponding groove on the other (Fig. 9.1A).

Knot : Base of a branch or limb embedded in the tree which becomes visible when it is cut.

Diameter of a Knot : The maximum distance between two points farthest apart on the periphery of a round knot, on the face where it becomes visible. In the case of a spike or splay knot, the maximum width of the knot visible on the face on which it appears shall be taken as its diameter.

Muntin : Small horizontal or vertical dividing bars within basic framework of a window, or door sub-dividing and supporting the glass panes or panels of doors.

Particle Board : A board manufactured from particles of wood or other lignocellulose material, for example, flakes, granules, shavings, slivers, splinter agglomerated, formed and pressed together by use of an organic binder together with one or more of the agents, such as heat, pressure, moisture and a catalyst.

Particle : Distinct particle or fraction of wood, or other lignocellulose material produced mechanically for use as the aggregate for making a particle board. This may be in the form of flake, granule, shaving, splinter and sliver.

Plywood : A board formed of three or more layers of veneers cemented or glued together, usually with the grain of adjacent veneers running at right angles to each other.

Rebate : A recess along the edge of a piece of timber to receive another piece or a door, sash or a frame.

Sapwood : The outer layers of the log, which in the growing tree contain living cells and feed material.

The sapwood is usually lighter in colour, and is readily attacked by insects and fungi.

Seasoning : A process involving the reduction of moisture content in timber under more or less controlled conditions towards or to an amount suitable for the purpose for which it is to be used.

Seasoned Timber : Timber whose moisture content has been reduced to the specified minimum, under more or less controlled processes of drying.

Structural Timber : Timber used in framing and load bearing structures or timber used or intended for use in buildings where strength is the primary consideration.

First Class Wood

Individual hard and sound knots shall not be more than 25 mm in diameter and the aggregate area of all the knots shall not exceed one per cent of the area of the piece.

Second Class Wood

Individual hard and sound knot shall not be more than 40 mm in diameter and aggregate of all the knots shall not exceed one and half per cent of the area of the piece. Wood shall be generally free from sapwood, but traces of sapwood may be allowed.

9.1 TIMBER

Timber is classified as under :

(i) Teak wood
(ii) Deodar wood
(iii) Non-coniferous timbers other than teak
(iv) Coniferous timber other than deodar.

The timber shall be free from decay, fungal growth, boxed heart, pitch pockets or streaks on the exposed edges, splits and cracks. The timber shall be graded as first grade and second grade on the basis of the permissible defects in the timber as given in Appendix 'A' of Chapter 9.0. For both the grades, knots should be avoided over a specified limit.

9.1.1 Teak Wood (Tectona Grandis)

It is of outstanding merit in retention of shape and durability. The heart wood is one of the most naturally durable woods of the world. It usually remains immune to white ant attack and insect attack for very long periods. It is, however, not always immune from fungus attack (rot). Taken as a whole, good quality teak is very durable, it is relatively easy to saw and work. It can be furnished to a fare surface and takes polish well. It is generally used for making furniture and all important timber construction.

9.1.1.1 ***Superior Class Teak Wood such as Balarsha, Malabar and Dandeli :*** Individual hard and sound knot shall not be more than 12 mm in diameter and the aggregate area of all the knots shall not exceed one half per cent of the area of the piece. It shall be close grained.

9.1.2 Deodar Wood (Cedrus Deodars)

It is the strongest of the Indian conifers. Its weight and strength is 20% per cent less than teak. It is easy to saw and works to a smooth finish. It is not, however, a suitable wood for polish or paint work as the oil in the wood and especially near knots, always seeps through such finishes and discolours them.

It is used for house building, furniture and other construction work. It is also suitable for beams, floors, boards, posts, window frames and light furniture etc.

9.1.3 Sal Wood (Shoera Robusta)

Sal is about 30 per cent heavier than teak, 50 per cent harder, and about 20 to 30 per cent stronger. In shock resistance it is about 45 per cent above teak. Its heart wood is a naturally durable wood, and usually remains immune to attack by white ants and fungi for a long period, while its sapwood is very perishable and should not be used. Well dried sal is not a really easy wood to saw and work. It is a rough constructional wood than a carpentary timber. No individual hard and sound knot shall exceed 25 mm in diameter and the aggregate area of all the knots shall not exceed 1% of the area of the piece.

It can be used for a variety of purposes, such as for beams, rafters, flooring, piles, bridging, tool handles, picker arms and tent pegs, etc.

9.1.4 Kail Wood (Pinus Roxburghie)

Kail Wood is not a very durable wood. But it is easy to saw and work and usually very popular in wokshops. It can be brought to a fine smooth surface, but is more suitable for paint and enamel finishes than for polish work. It is useful for joinery works, constructional work, light furniture and house fitments.

9.1.5 Other Species

The other species of timber as given in Table 9.1 of chapter 9.0 can also be used for various activities of building construction.

TABLE 9.1
Species of Timber

Sl. No.	*Botanical Name*	*Availability*						
		Trade Name	*Average Unit wt Kg/m^3*	*North Zone*	*East Zone*	*Central Zone*	*West Zone*	*South Zone*
1.	Tectone grandis linnf	Teak	640	—	Y	X	X	X
2.	Acacia Catechiu Willd	Khair	1010	X	X	X	Y	Y
3.	Acacia Arabica Willd	Babul	785	X	X	X	Y	Z
4.	Adina Cordifolia Roxb HK. f	Haldu	675	X	—	—	—	X
5.	Cedrus Deodara D Don	Deodar	545	X	—	Y	Y	—
6.	Magnifera Indica Linn	Mango	690	X	X	Y		X
7.	Pinus Roxburghie	Chir	575	X	—	—	—	—
8.	Pinus Excelsa Wall	Kail	515	X	—	—	—	—
9.	Shorea Robusta Gaertn.	Sal (U.P.)	881	X	X	X	—	—
10.	Terminalia Myrioecarpa. Heurcket Muell Arg.	Hollock	610	—	X	—	—	—
11.	Lagerstroemia Lanceolata Wall	Benteak	675	—	—	—	Y	X
12.	Gamelinc Arborea Ronb.	Gamari	515	Y	Y	Y	Z	Y
13.	Terminalia Bellirica Roxb.	Bahora	801	X	X	X	Y	X
14.	Pterocarpus Marsupium Roxb	Bijasal	800	—	X	X	Y	Y

Note : The Average unit wt. is at 12% moisture content.

NORTH ZONE	:	Jammu and Kashmir, Punjab, Himachal Pradesh, Delhi, Uttar Pradesh and Rajasthan.
EAST ZONE	:	Assam, Manipur, Tripura, West Bengal, Bihar, Orissa, Sikkim, Andamans, North East Frontier Agency and Nagaland.
CENTRAL ZONE	:	Madhya Pradesh, Vidharbha areas of Maharashtra State and the North East Part of Andhra Pradesh (Godavari delta area).
WEST ZONE	:	Maharashtra State (Except Vidharbha areas), Gujarat and North West part of Karnataka. Tamil Nadu, Andhra Pradesh (except the Godawari Delta area) Kerala and karnataka (except north west port)
SOUTH ZONE	:	Tamil Nadu, Andhra Pradesh (Except the Godawari delta area) Kerala and Karnataka (except North West part)

The availability of timbers is categorised under three classes as indicated below:

X - Most common, 1415 m^3 (1000 tonnes) and more per year.
Y - Common, 355 m^3 (250 tonnes) to 1415 m^3 (1000 tonnes) per year and
Z - Less common, below 355 m^3 (250 tonnes) per year.

9.1.6 Moisture Content

Control on moisture content of timber is necessary to ensure its proper utility in various climatic conditions. For specifying the permissible limit of moisture content in the timber the country has been divided into four climatic zones as per Appendix B of Chapter 9. In each of the zones, maximum permissible limit of moisture content of timber for different uses, when determined in accordance with the procedure laid down in Appendix 'C' shall be as per Table 9.2 of Chapter 9.

TABLE 9.2
Maximum Permissible Moisture Content of Timber

Sl.No.	*Use*	*Max Moisture Content Percent*			
		Zone I	*Zone II*	*Zone III*	*Zone IV*
1.	Beams, Rafters & Posts	12	14	17	20
2.	Doors and windows				
	(a) 50 mm and above thickness	10	12	14	16
	(b) Thinner than 50 mm	8	10	12	14
3.	Flooring strips	8	10	10	12
4.	Furniture & Cabinet making	10	12	14	15

9.1.6.1 ***Tolerance on Moisture Content :*** Average Moisture content of all the samples from a lot shall be within + 3 per cent and moisture content of individual samples within + 5 per cent of maximum permissible moisture content specified in Table 9.2. These tolerance are the absolute values over the percentage moisture content for Sl. No. 1 & 2 of Table 9.2. No tolerance on moisture content is permitted for Sl. No. 3 & 4 of Table 9.2.

9.1.7 Seasoning of Timber

The process of drying timber under controlled conditions is called seasoning of timber. Timber shall be either air seasoned or kiln seasoned and in both cases moisture content of the seasoned timber shall be as specified in Table 9. 2 of Chapter 9 unless otherwise specified, air seasoned timber shall be used. Kiln seasoning of timber, where specified, shall be done as per IS 1141 in a plant approved by Engineer-in-Charge.

9.1.8 Preservation of Timber

Preservative treatment does not improve basic properties of timber but gives varying degree of protection against deterioration due to attacks by fungi, termites, borers and marine organisms. Preservative treatment, where specified, shall be done using Oil type, Organic solvent type or Water-soluble type preservative. Oil type preservatives shall be used if the timber is not required to be polished or painted. Before preservative treatment, the timber shall be sawn and seasoned. All surfaces exposed after treatment, except due to planing, shall be thoroughly brushed with the preservation before jointing. Preservative treatment of timber shall be done as per IS 401 in a plant approved by the Engineer-in-Charge.

9.2 PANELLING MATERIAL

9.2.1 Timber

Timber panels shall be preferably made of timber of larger width. The minimum width and thickness of a panel shall be 150 mm and 15 mm respectively. When made from more than one piece, the pieces shall be joined with a continuous tongue and groove joint, glued together and reinforced with metal dowels. The grains of timber panels shall run along the longer dimensions of the panels. The panels shall be designed such that no single panel exceeds 0.5 square metre in area.

9.2.2 Plywood Boards

9.2.2.1 Plywood shall be of BWP grade or BWR grade as per IS 303.

9.2.2.2 Marine plywood confirming to IS 710.

9.2.2.3 Fire resistant plywood confirming to IS 5509.

9.2.2.4 ***Thickness :***Plywood boards are available in thickness ranging from 3 to 25 mm. Tolerance in thickness shall be ± 10% for boards upto and including 5 mm; ± 7% for boards from 6 to 9 mm and ± 5% for boards above 9 mm thickness. The boards shall be of uniform thickness and the surfaces of the boards shall be sanded to a smooth finish. Number of plys in plywood boards shall be as per Table 9.3.

TABLE 9. 3

Thickness in mm	*No. of ply*	*Thickness in mm*	*No. of ply*
3,4,5,6	3	12,15,16,19	9
5,6,8,9	5	19,22,25	11
9,12,15,16	7		(Above 11 Ply as ordered)

Note : Plywood of 9 mm thick of 5 or 7 ply may be used generally.

9.2.2.5 Moisture content of the plywood boards when tested in accordance with IS 1734 (Part 1) shall not be less than 5 per cent and not more than 15 per cent.

9.2.2.6 ***Testing :*** One sample for every 100 sqm or part thereof shall be taken and testing done as per IS 303. However, testing may not be done if the total requirement of plywood boards is less than 30 sqm. All the samples tested shall meet the requirements of physical and mechanical properties of plywood boards specified in Appendix D of Chapter 9.

9.2.3 Particle Boards

9.2.3.1 Particle boards shall be of medium density and manufactured from particles of agro waste, wood or lignocellulose i.e. material blended with adhesive and formed into solid panels under the influence of heat, moisture, pressure etc. The particle boards shall be flat pressed three layered or graded and of Grade-I as per Table 1 of IS 3087. Both surfaces of the boards shall be sanded to obtain a smooth finish and shall conform to IS 3087.

9.2.3.2 ***Adhesives :*** Adhesives used for bonding shall be BWP type synthetic resin conforming to IS 848.

9.2.3.3 ***Thickness and Tolerance :*** Thickness of particle boards shall be as specified. Tolerance in thickness shall be ± 5% for boards upto and including 25 mm thick and ± 2.5 per cent for boards above 25 mm thickness. Each board shall be of uniform thickness.

9.2.3.4 ***Testing :*** One sample for every 100 sqm or part thereof shall be taken and testing done as per IS 3087. However, testing may not be done if the total requirement of particle boards in a work is less than 30 sqm. All the samples tested shall meet the requirement of physical and mechanical properties of particle boards specified in Appendix E of Chapter 9.0.

9.2.4 Veneered Particle Boards

9.2.4.1 Veneered Particle Boards with core of FPT-1 or graded board Grade-I particle board (IS 3087) with commercial or general purpose veneer (Type-1) or decorative veneers on both faces or with decorative veneer on one face and commercial /general purpose veneers on the other Type-2. Face veneers are bonded using adhesives under the influence of heat and pressure.

9.2.4.2 ***Adhesives :*** The adhesive used for bonding veneers shall be BWP or BWR type conforming to IS 848 for grade I veneered particle board.

9.2.4.3 ***Thickness & Tolerance :*** Veneered particle boards are available in various thickness 6, 10, 12, 20, 25, 30, 35, 40, 45 & 50 mm.

Tolerance in thickness shall be ± 5%.

9.2.4.4 ***Testing :*** One sample for every 100 sqm or part thereof shall be taken and testing done as per IS 3097. However, testing may not be done if the total requirement of veneered particle boards in a work is less than 30 sqm. All the samples tested shall meet the requirements of physical and mechanical properties of veneered particle boards as under:

1.	Moisture Content	5-15%
2.	Water Absorption	
	(a) 2 hrs. soaking (b) 24 hrs. soaking	Not more than 25% Not more than 50%
3.	Water Resistance	No sign of disintegration or delamination after 3 hrs. boiling in water.
4.	Swelling in Water	
	(a) General absorption for 2 hrs. immersion	Not more than 7%
	(b) Surface absorption for 2 hrs.	Not more than 5%
5.	Adhesion of plies	Knife test

9.2.4.5 Type of face veneers, thickness of veneered particle boards and adhesive used for bonding shall be as specified. Unless otherwise stated, exterior grade veneered particle boards with BWP type synthetic resin adhesive shall be used.

9.2.5 Non-Asbestos Fibre Boards

9.2.5.1 Fibre boards shall be of medium density cement board reinforced with wood fibre, produced by fiberizing steamed wood under pressure, blended with adhesive and wax and formed into solid panels under controlled conditions of heat and pressure as per IS 14862.

9.2.5.2 ***Adhesives :*** The adhesive used for bonding shall be BWP type synthetic resin conforming to IS 848.

9.2.5.3 ***Thickness :*** Fibre boards are available in thickness 6, 9, 12, 15, 18, 22, 25, 30, 35 & 40 mm. The tolerance in thickness shall be ± 0.3 mm. Thickness of fibre boards and adhesive used for bonding shall be as specified. Unless otherwise stated, exterior grade fibre boards bonded with BWP type synthetic resin adhesive shall be used.

9.2.6 Float Glass, Frosted Glass

Float glass used shall be as specified in sub-head 21.0 of this specifications.

For panel exceeding 0.5 sqm in area, the nominal thickness of the glass to be used shall be as specified.

9.2.7 Wire Cloth (Wire Gauze)

9.2.7.1 Wire Cloth which shall generally conform to IS 1568 shall be regularly woven with equally spaced galvanised mild steel wires in both warp and weft directions. The wire cloth shall be properly selvedged by one or more wires in each edge.

9.2.7.2 ***Mesh :*** Average width of aperture and the nominal diameter of the wire shall be as under:

Average width of Aperture mm	*Nominal dia. of wire mm*
1.40	0.63
1.18	0.56
1.00	0.50

9.2.7.3 Width of aperture and dia of wire cloth shall be as specified. Unless otherwise stated, wire cloth of 1.40 mm average aperture width woven with 0.63 mm nominal dia galvanized mild steel wire shall be used.

9.2.7.4 Fly-proof wire cloth (aperture 1.40 mm) is generally provided in Kitchen and dining areas while wire cloth of smaller aperture is used in mosquito proof shutters.

9.2.8 Veneered Decorative Plywood

Decorative plywood shall be of two grades namely BWR and MR Decorative Plywood shall be of two types. Type I and type 2 and shall conform to IS 1328.

9.2.8.1 Requirement of Type-I Veneered decorative plywood shall be as under:

(a) Open slits checks or open joints not more than 150 mm in length and 0.5 mm in width shall be permissible provided the same are rectified with a veneer insert bounded with synthetic resin adhesive, as the case may be and further provided that the insert matches with the surrounding veneer in colour as well as figure.

(b) The decorative veneered surface shall be free from torn grain, dead knots discolourisation and sapwood.T

(c) he decorative veneered surface shall be selected for figure, texture, colour and grain etc. It shall be free from all manufacturing and wood defects except to the Engineer-in-charge permitted under para 9.2.8.1(a). All veneers shall be matched or mismatched to achieve a decorative effect in colour figure and grain.

9.2.8.2 ***Adhesive :*** The adhesive for bonding veneers shall be MR and BWR type synthetic resin adhesive conforming to IS 848 for MR and BWR grade veneered decorative plywood respectively.

9.2.8.3 ***Dimensions and Tolerances:***

9.2.8.3.1 The dimensions of plywood boards shall be as follows:

2400 mm x 1200 mm 2100 mm x 900 mm
2100 mm x 1200 mm 1800 mm x 900 mm
1800 mm x 1200 mm

9.2.8.3.2 *Thickness:* The thickness of plywood board shall be 3 mm, 4 mm, 6 mm, 9 mm, 12 mm, 19 mm and 25 mm.

Note: Any other dimensions (length, width and thickness) as agreed to between the manufacturer and the purchaser may also be used.

9.2.8.3.3 ***Tolerances:*** Tolerances on the nominal sizes of finished boards shall be as follows:

Dimension	*Tolerance*
Length	+6 mm - 0
Width	+3 mm -0 mm
Thickness:	
(i) Less than 6 mm	±10 per cent
(ii) 6 mm and above	+ 5 per cent
Edge straightness	2 mm per 1000 mm or 0.2 per cent
Squareness	2 mm per 1000 mm or 0.2 per cent

Note : Edge straightness and squareness shall be tested as per Appendix I.

9.2.8.4 ***Finish :*** The decorative plywood shall be uniform in thickness within the tolerances limits specified. The ends shall be trimmed straight and square edge straightness and squareness when tested as per Appendix I shall be within the tolerance specified in 9.2.8.3.3.

9.2.8.5 ***Sampling and Criteria for Conformity :*** The method for drawing representative samples and criteria for conformity shall be as per IS 7638.

9.2.8.6 ***Tests :*** Boards shall be subjected to following tests :

(i) *Moisture content:* Decorative veneered plywood of either type when tested in accordance with IS 1734 (Pt. I) shall have a moisture content not less than 5 per cent and not more than 15 per cent.

(ii) *Water Resistance Test* : Three test specimen of size 250 mm x 100 mm shall be prepared for each of the boards selected and submerged in water at 62 $\pm 2^{o}$ C for a period of 3 hours and dried for 8 hours at a temperature of 65 $\pm$ 2°C and then followed by two more cycles of soaking and drying under same conditions described above. Decorative Veneered plywood of either type shall not show delamination or blister formation.

9.2.8.7 ***Marking :*** Each plywood bound shall be legibly and indelibly marked or stamped with the following on the face of board near one corner.

(a) Indication of the source of manufacture
(b) Year of manufacture
(c) Batch no.
(d) Type of plywood
(e) Criteria for which the plywood has been lablled as ECO mark

The decorative veneered plywood may also be marked with standard BIS certification mark.

9.2.9 Prelaminated Particle Boards

9.2.9.1 Prelaminated particle boards are available in two grades namely Grade I and II as per IS 12823. Each grade is further classified in four types; namely Type –I, II, III, IV.

9.2.9.2 Material

9.2.9.2.1 Particle Board Prelaminated particle board Grade-1 (FPT–I or graded wood particle board FPT-I) bonded with BWP type synthetic resin and prelaminated conforming to IS 12823 Grade-I, type II or I shall be used.

9.2.9.2.2 *Impregnated Base Paper* : Printed or plain coloured absorbent base paper having a weight of 60 -140 g/m^2 impregnated in a suitable synthetic resin and dried to a volatile content of 4-8 per cent shall be used for prelamination on both surfaces of particle board.

9. 2.9.2.3 *Impregnant Overlay :* An absorbent tissue paper having a weight of 18-40 g/m^2 impregnated in a suitable synthetic resin and dried to volatile content of 4-8 per cent.

9.2.9.3 ***Dimension and Tolerances***

9.2.9.3.1 Dimensions of prelaminated particle boards shall be as follows:

Length : The length of prelaminated particle boards shall be 4.8, 3.6, 3.0, 2.7, 2.4, 2.1, 1.8, 1.5, 1.2, 1.0 and 0.9 metres.

Width : The width of prelaminated particle boards shall 1.8, 1.5, 1.2, 1.0, 0.9, 0.6 and 0.45 metres.

Thickness : The thickness of prelaminated particle boards shall be 6, 9, 12, 15, 20, 25, 30, 35, 40 and 45 mm.

9.2.9.3.2 ***Tolerances :*** Tolerances on the nominal sizes of finished boards shall be as given below :

Dimension	Tolerance
Length	+ 6 mm - 0
Width	+ 3 mm - 0
Thickness	5 per cent
Edge straightness	2 mm per 1000 mm or 0.2 per cent
Squareness	2 mm per 1000 mm or 0.2 per cent

Note : Edge straightness and squareness shall be tested as per IS 12823.

9.2.9.4 ***Sampling and Inspection*** **:** The number of prelaminated particle board to be selected from a lot shall be in accordance with the Table 9.4 given below:

TABLE 9.4

Lot Size	*Number of prelaminated boards to be selected*
Upto 50	2
51 to 100	3
101 to 200	4
201 to 300	5
301 to 500	7
501 and above	10

9.2.9.4.1 The prelaminated particle boards shall be selected at random (ref. IS 4903). In order to ensure randomness of selection, all the prelaminated particle boards in the lot may be arranged in a serial order and every rth prelaminated particle board may be selected till the required number is obtained, 'r' being the integral part of N/n, where N is the lot size and n is the sample size.

9.2.9.4.2 All board selected as given in para 9.2.9.4.1 shall be tested as specified in IS 2380 (part-2) for length, width, thickness, edge straightness and squareness shall comply with the requirements specified under para 9.2.9.3.2.

9.2.9.5 ***Testing and Number of Tests :*** For each of particle board selected as per para 9.2.9.4 Test specimens shall be cut out from portion 150 mm away from the edges for tests and tests shall be carried out as per IS 12823.

9.2.9.6 ***Criteria for Conformity:*** A lot shall be considered as in conformity to the requirements of the specification if no group of specimens for any of the characteristics fails to meet the conditions as prescribed in para 9.2.9.3 & 9.2.9.5 of this specification.

In case of a failure, double sample shall be taken from the lot for testing. The lot shall be considered as passed, if all these samples conform to the specified requirement.

9.2.9.7 ***Marking :*** Each prelaminated particle board shall be legibly and indelibly marked on any of its edges with following :

(a) Indication of source of manufacturer

(b) Grade and type of prelaminated particle board
(c) Thickness
(d) Batch number and year of manufacture

9.2.9A PRE-LAMINATED MEDIUM DENSITY FIBER BOARD

9.2.9A.1 Pre-laminated medium density fiber boards are available in two grades namely Grade I and II as per IS 14587:1998. Each grade is further classified in four types; namely Type –I, II, III, IV.

9.2.9A.2 Material

9.2.9A.2.1 A medium density fiber board laminated on both surfaces by synthetic resin impregnated base papers conforming to IS 14587:1998 Grade-I, type II or I shall be used.

9.2.9A.2.2 Impregnated Base Paper : Printed or plain coloured absorbent base paper having a weight of 60-140 g/m^2 impregnated in a suitable synthetic resin and dried to a volatile content of 4-8 per cent shall be used for pre-lamination on both surfaces of medium density fiber board.

9.2.9A.2.3 Impregnated Overlay : An absorbent tissue paper having a weight of 18-40 g/m^2 impregnated in a suitable synthetic resin and dried to volatile content of 4-8 per cent.

9.2.9A.3 Dimension and Tolerances

9.2.9A.3.1 Dimensions of pre-laminated medium density fiber boards shall be as follows:
Thickness : The thickness of pre-laminated medium density fibre boards shall be 6, 9, 12, 15, 18, 22, 25, 30, 35 and 40 mm.

9.2.9A.3.2 Tolerances : Tolerances on the nominal sizes of finished boards shall be as given below :

Dimension	Tolerance
Length	± 3 mm/metre
Width	± 3 mm/metre
Thickness	± 0.3 mm
Edge straightness	2 mm/metre
Squareness	2 mm/metre

9.2.9A.4 Sampling and Inspection: The number of pre-laminated medium density fibre board to be selected from a lot shall be in accordance with the Table 9.4A given below:

TABLE 9.4A

Lot Size	Number of pre-laminated boards to be selected
Upto 50	2
51 to 100	3
101 to 200	4
201 to 300	5
301 to 500	7
501 and above	10

9.2.9A.5 Marking : Each pre-laminated medium density fibre board shall be legibly and indelibly marked on any of its edges with following :
(a) Name of the manufacturer or trade mark.
(b) Grade and type of pre-laminated medium density fiber board.
(c) Thickness and
(d) Batch number and year of manufacture.

9.2.10 Coir Veneer Board for General Purposes

9.2.10.1 Coir veneer board is manufactured with a combination of coconut fibre needled felt, veneer and jute fibres with kraft paper coconut fibre. Needled felt can be used as core crossbands or as outer skin formed with jute fibres and kraft paper. However, the composite ply should be a balanced construction on either side of central ply. The blended mass of glued fibres is laid to form a mat which is pre needled.

9.2.10.2 Coir veneer board generally shall conform to IS 14842.

Grades

Coir veneer board for general purposes shall be of two grades:

(a) Boiling water resistant (BWR) grade
(b) Moisture resistant (MR) grade

9.2.10.3 ***Material***

(a) *Coconut Fibre :* Coconut fibre layer used in the manufacture of coir veneer board shall be uniform with minimum of 600 g/m^2.

(b) *Jute :* Jute fibre layer used in the manufacture of coir veneer board shall be uniform with minimum of 60 g/m^2.

(c) *Adhesive :* Adhesive for manufacture of coir veneer board shall be conform to BWR/MR of IS 848 for BWR/MR grade boards respectively.

(d) *Veneer* : Any species of timber may be used for the manufacture of veneers.

(e) *Kraft Paper :* Kraft paper used in manufacture of coir veneer board shall be uniform with minimum of 40 g/m^2 .

9.2.10.4 ***Permissible Defects :*** Gap in cores and crossband shall not be permitted. Splits in cores and crossbands may be permitted to an extent of 2 per core or crossband and overlap shall be permitted in core/crossbands only.

9.2.10.5 ***The Dimensions and Tolerances :*** The dimensions and tolerances of coir veneer board shall be quoted in following order. The first dimension shall represent the length, the second dimension the width and the third dimension the thickness. The dimensions and tolerances shall be as per IS 12049.

Thickness of coir veneer board shall be 3 mm, 4 mm, 5 mm, 6 mm, 9 mm, 12 mm, 16 mm, 18 mm, 20 mm and 25 mm.

The following tolerance on nominal thickness shall be permissible.

(a) Less than 6 mm $\pm$ 10%
(b) 6 mm and above $\pm$ 5%

9.2.10.6 ***Workmanship and Finish :*** Coir veneer board shall be of uniform thickness and density throughout the length and width of board. The squareness and edge straightness of the board shall be as per para 9 of IS 12842 and Appendix J.

9.2.10.7 *Sampling :* The method of drawing representative samples and criteria for conformity shall be as prescribed in IS 7638.

9.2.10.8 *Tests :* The tests shall be carried out as specified in IS 14842 – Appendix K.

9.2.10.9 *Moisture Content* : Coir veneer board when tested in accordance with IS 3734 (Part I) shall have a moisture content not less than 5 percent and not more than 15 percent.

9.2.10.10 *Marking:* Each coir veneer board shall be legibly and indelibly marked or stamped with the following near one corner.

(a) Identification of source
(b) Year of manufacturing
(c) Batch no.
(d) The grade and type as follows.
    (i) Boiling water resistant (BWR) and
    (ii) Moisture resistant (MR)

9.2.10.11 *BIS Certification Marking :* Coir veneer board may also be marked with the standard mark governed by the BIS Act, 1986.

9.2.11 Marine Plywood

9.2.11.1 Marine plywood shall be generally conforming to IS 710. Selection of timber species for manufacture of plywood shall be as prescribed in IS 710 and as far as possible a single species of timber shall be used.

9.2.11.2 *Adhesive :* The adhesive used for bonding the veneer shall be of the hot press synthetic resin, phenol formaldehyde type (BWP) and shall conform to IS 848. Extender shall not be added to the adhesive by the plywood manufactures. Fillers, if used, shall not exceed 10 percent by mass of solid content of the glue.

9.2.11.3 *Dimensions*

9.2.11.3.1 The dimensions of plywood boards shall be as stated in para 9.2.10.5.

9.2.11.3.2 The thickness of any board shall not exceed the number of pieces multiplied by 2.5 mm. The two face veneers in finished board shall be of the same nominal thickness.

9.2.11.4 *Tolerances :* The following tolerances in the nominal size of finished boards shall be permitted.

Dimension	*Nominal Size*	*Tolerance*
Length	Upto 120 cm.	+ 3 mm
	Above 120 cm.	+ 6 mm
Width	Upto 90 cm.	+ 3 mm
	Above 90 cm	+ 6 mm
Thickness	Upto 4 mm	±10 per cent
	Above 4 mm	±5 per cent

9.2.11.5 *Sampling :* The method of drawing representative samples and criteria for conformity shall be as prescribed in IS 7638.

9.2.11.6 ***Tests :*** Test pieces cut from each of board as specified at para 9.2.11.5 shall be subjected to following tests.

(a) Moisture content
(b) Glue adhesive in dry state
(c) Water resistance test.
(d) Tensile strength
(e) Mycological test
(f) Retension of preservative.

These tests shall be carried out as specified in IS 710.

9.2.11.7 ***Marking :*** Each plywood board shall be legibly and indelibly marked or stamped with following particulars along with such other marks as the purchaser may stipulate at the time of placing order.

(a) Manufacturer's name, initials or recognized trade mark, if any.
(b) Year of manufacturing.
(c) Abreviation indicating the species of timber used in each ply as indicated in col. 3 of Table – 1 and 2 of IS 710.
(d) Batch number

9.2.11.8 ***BIS Certification Marking :*** The plywood board may also be marked with the standard mark, governed by the BIS Act,1986.

9.2.11.9 ***Tender Sample, Inspection and Acceptance:*** Where samples are required to be tendered, three samples each not less than 90 x 60 mm in size shall be submitted by the supplier, and these samples, if the tender is accepted shall constitute the standard as regards the type of timber, quality and finish.

9.2.12 Fire Retardant Plywood

9.2.12.1 Fire retardant plywood shall generally conform to IS 5509. The plywood to be given fire retardant treatment shall conform to BWR grade of IS 303 to be able to stand pressure impregnation. Plywood for treatment shall be clean, free from oil or dirt patches on the surface and at a moisture content not exceeding 15 percent. In case of veneered decorative plywood care shall be taken that colour of the solution does not spoil to decorative surface.

For Eco-mark the plywood shall conform to the requirements of Eco-mark specified in IS 303.

9.2.12.2 ***Fire Retardant Treatment :*** This shall be either pressure impregnation or soaking treatment as per IS 5509.

9.2.12.3 ***Choice of Treatment :*** The choice of treatment may be left to the manufacturer of plywood as per fire resistant requirements prescribed in IS 5509. The purchaser should however, specify whether plywood is to be treated with fire retardants only or with fire retardants and preservatives.

The recommended retention of fire retardant chemicals for different hazards like interior or exterior use not subject to leaching by rain and water is of the order of 50 kg/m^3.

9.2.12.4 ***Conditioning after Treatment :*** The plywood after treatment shall be conditioned to suitable equilibrium moisture content of not more than 20 per cent.

9. 2.12.5 ***Dimension and Tolerances*** shall conform to IS 2049. The tolerance of thickness shall conform to IS 303.

9.2.12.6 *Sampling :* The method of drawing representative sample and the criteria of conformity shall be as prescribed in IS 7638.

9.2.12.*7 Test Specimen and Number of Tests:* From each of fire retardant plywood selected as above para 9.2.12.6, following test specimens shall be cut from portions 150 mm away from the edges for tests specified as under:

(a) *For Flammability :* Six test specimens 125 mm x 125 mm in full thickness of material from each sample.
(b) *For Flame Penetration :* Three test specimens 125 mm x 125 mm in full thickness of material from each sample.
(c) *For Rate of Burning :* Three test specimen 100 mm x 12.5 mm in full thickness of material from each sample.

9.2.12.8 *Test Requirements and Other Tests*

(i) *Moisture Content :* Shall not exceed 20%.
(ii) *Flammability :* When tested as per IS 1734, time taken for second ignition shall not be less than 30 minutes.
(iii) *Flame Penetration :* When tested as per IS 1734, time taken for flame penetration shall not be less than 15 minutes for every 6 mm thickness.
(iv) *Rate of Burning :* When tested as per IS 1734, the time taken to lose weight from 30 per cent to 70 per cent shall not be less than 20 minutes.

9.2.12.9 *Marking :* Each board shall be legibly and indelibly marked near the edge with the following:

(a) Manufacturer's name, his initials or his recognized trade mark, if any.
(b) Year of manufacture
(c) Type of treatment
(d) Criteria for which the plywood has been labeled as ECO mark.

9.2.12.10 *BIS Marking :* Each board may also be marked with standard mark governed by the BIS Act, 1986.

9.2.13 Decorative Thermosetting Synthetic Resin Bonded Laminated Sheets

9.2.13.1 *Scope :* Decorative thermosetting synthetic resin bonded laminated sheets shall generally conform to IS 2046. This material is intended for interior use and is not intended for load bearing applications.

9.2.13.2 *Terminology :* For the purpose of this standard, the definition given under para 2 of IS 1998 shall apply.

9.2.13.3 *Types :* The material shall be of two types namely:-

(a) *Type 1-* Having only one side bearing decorative surface the other side being roughened or given an appropriate treatment to promote adhesion to the base. This type shall generally be used, unless specified otherwise.

(b) *Type 2-* Having both sides bearing the decorative surface, the two sides may be different in colour or pattern or both.

9.2.13.4 *Requirements*

(i) *Appearance :* The types of surface finish of decorative and reverse side, edge finish, colour and pattern shall be as agreed to between the purchaser and the supplier. The sheets shall be reasonably free from local deformation.

Note : Since sheets may vary slightly in colour and appearance, it is recommended that sheets for any one scheme may be matched.

(ii) *Flatness :* For nominal thickness 1.5 mm – when a sheet is tested for flatness in accordance with the method given in Appendix –C of IS 2046, the height above the flat surface at the edge of full manufactured and trimmed width shall nowhere exceed 150 mm.

(iii) *Tolerance to nominal thickness :* The departure from nominal thickness of sheet at any point, shall not exceed the value given below:

Nominal Thickness	Tolerance
Upto 1.5 mm	± 0.25 mm

(iv) Straightness of edges of rectangular finished panels, resistance to dry heat, resistance to boiling water, resistance to staining, gross breaking strength, packing and marking, sampling and criteria for conformity etc. shall be as per IS 2046.

9.3 DOOR, WINDOW AND VENTILATOR FRAMES

9.3.1 Timber for door, window and ventilators frames shall be as specified. Timber shall be sawn in the direction of the grains. All members of a frame shall be of the same species of timber and shall be straight without any warp or bow. Frames shall have smooth, well-planed (wrought) surfaces except the surfaces touching the walls, lintels, sill etc., which may be left clean sawn. Rebates, rounding or moulding shall be done before the members are jointed into frames. The depth of the rebate for housing the shutters shall be 15 mm, and the width of the rebates shall be equal to the thickness of the shutters. A tolerance of ± 2 mm shall be permitted in the specified finished dimensions of timber sections in frames.

9.3.2 Joints

The Jamb posts shall be through tenoned in to the mortise of the transoms to the full thickness of the transoms and the thickness of the tenon shall be not less than 2.5 cm. The tenons shall closely fit into the mortise without any wedging or filling. The contact surface of tenon and mortise before putting together shall be glued with polyvinyl acetate dispersion based adhesive conforming to IS 4835 or adhesive conforming IS 851 and pinned with 10 mm dia hard wood dowels, or bamboo pins or star shaped metal pins. The joints shall be at right angles when checked from the inside surfaces of the respective members. The joints shall be pressed in position. Each assembled door frame shall be fitted with a temporary stretcher and a temporary diagonal brace on the rebated faces.

9.3.3 Fixing of Frames

The frames shall be got approved by the Engineer -in -Charge before being painted, oiled or otherwise treated and before fixing in position. The surface of the frames abutting masonry or concrete and the portions of the frames embedded in floors shall be given a coating of coal tar. Frames shall be fixed to the abutting masonry or concrete with holdfasts or metallic fasteners as specified. After fixing, the jamb posts of the frames shall be plugged suitably and finished neat. Vertical members of the door frames shall be embedded in the floor for the full thickness of the floor finish and shall be suitably strutted and wedged in order to prevent warping during construction. A minimum of three hold fasts shall be fixed on each side of door and window frames one at centre point and other two at 30 cm from the top and bottom of the frames. In case of window and ventilator frames of less than 1 m in height two hold fasts shall be fixed on each side at quarter point of the frames. Hold fasts and metallic fasteners shall be measured and paid for separately.

9.3.4 Measurements

Wood work wrought, framed and fixed shall be measured for finished dimension without any allowance for the wastage or for dimensions beyond specified dimension. However, in case of members having mouldings, roundings or rebates and members of circular or varying sections, finished dimensions shall be taken as the sides of the smallest square or rectangle from which such a section can be cut. Length of each member shall be measured over all to the nearest cm so as to include projection for tenons. Width and thickness shall be measured to the nearest mm and the quantity shall be worked out in unit of upto three places of decimal.

9.3.5 Rate

The rate shall include the cost of material and labour involved in all the operations described above except the hold fasts or metallic fasteners which will be paid for separately.

9.4 FALSE CEILING AND PARTITION FRAMES

This work shall be done as specified in 9.3 except that the scantlings need not be planed unless otherwise specified.

9.4.1 All screws shall be of stainless steel minimum grade 304 of required size.

9.4.2 Rate – The rate shall include cost of all materials including SS screws involved in all operations described above except the holdfast or metallic fastness which shall be paid for separately.

9.5 TRUSSES

9.5.0 The work shall be carried out as per detailed drawings and as directed by the Engineer-in-Charge specified timber shall be used. Sawing shall be truly straight and square, and in the direction of the grains. The scantlings shall be accurately planed smooth to the full dimensions and rebate roundings and mouldings shown in the drawings, before the same are framed. Patching or plugging of any kind shall not be permitted. A tolerance of +3 mm and -2 mm shall be allowed in the finished cross sectional dimension.

9.5.1 Joints

Joints shall be simple, neat and strong. All mortise and tenon joints, mitred joints, scarfs etc. shall fit in fully and accurately without wedging or fillings. The joints shall be as per detailed drawings. Holes of correct sizes shall be drilled before inserting screws/bolts. Driving in screws with hammer is prohibited. Holes for bolts shall be of uniform diameter. The screws, bolts and nails shall be dipped in oil before using. The heads of nails and screws shall be sunk and puttied or dealt with as instructed by Engineer-in-Charge. The gauge and length of nails, screws and bolts shall be approved by the Engineer-in-Charge before using on works.

9.5.2 Shaping Form and Cutting

The wood sections, as specified or required, shall be straightened, cut square and to correct lengths. A fine accuracy shall be ensured in the fabrication of various member so that these can be assembled without being unduly packed, strained or forced into position and when built up, shall be true to shape and free from twist, kinks, buckles or open joints.

9.5.3 Fabrication

As per drawing, a full size truss diagram shall first be drawn on a levelled platform. From this full size diagram, templates of all joints as for tenons, mortises, scarves etc. shall be made for use in the fabrication. The template shall be made to correspond to each member and plate holes for screws and bolts shall be marked accurately on them and drilled. The templates shall be laid on wooden members and the holes for screwing and bolting marked on them. The ends of the wooden members shall also be marked for cutting. The base of columns and the position of anchor bolts shall be carefully set out. Before fabrication of the truss individual members shall be assembled together to ensure close abutting or lapping of the surfaces of the different members and fitted close together as per drawing.

9.5.4 Hoisting and Placing in Position

The trusses shall be hoisted and placed in position carefully, without any damage to itself and other building work and injury to workman. The trusses shall be secured to walls by means of holding down bolts or as directed by the Engineer- in-Charge. The necessary mechanical appliances such as lifting tackel, winch etc. for hoisting the truss shall be used. The trusses shall be stayed temporarily till they are permanently secured in position and connected with each other by means of purlins. Holding down bolts cleats used for purlins and bottom plates used for tie and rafter member shall be paid for separately.

9.5.5 Surface Treatment

Wood work shall not be painted, oiled or otherwise treated before it has been approved by the Engineer- in-Charge. All portions of timber built into or against or close to masonry or concrete or burried in ground shall be given two coats of boiling coal tar. All junctions of rafters, purlins, beams and wall plates shall be painted with approved wood primer.

9.5.6 Measurements

Wood work shall be measured for finished dimensions. No allowance shall be made for dimensions supplied beyond those specified. Length of each piece shall be measured over all nearest to a cm, so as to include projections for tenons, scarves or mitres. Width and thickness shall be measured to the nearest mm. Cubical contents can be worked out in units cubic meters upto 3 places of decimal in whole numbers.

9.5.7 Rate

The rate includes the cost of materials and labour involved in all the operations described above. Unless otherwise specified, iron fixtures such as bolts and nuts, M.S. steel plates, holding down bolts and staining, priming, painting or polishing of the work shall be paid for separately.

9.6 PANELLED GLAZED OR PANELLED AND GLAZED SHUTTERS (FIG. 9.2)

9.6.0 Panelled or glazed shutters for doors, windows, ventilators and cupboards shall be constructed in the form of timber frame work of stiles and rails with panel inserts of timber, plywood, block board, veneered particle board, fibre board wire gauze or float glass. The shutters may be single or multipanelled, as shown in the drawings or as directed by the Engineer-in-Charge. Timber for frame work, material for panel inserts and thickness of shutters shall be as specified. All members of the shutters shall be straight without any warp or bow and shall have smooth well planed face at right angles to each other.

Any warp or bow shall not exceed 1.5 mm for door shutter and 1 mm for window and ventilator shutters The right angle for the shutter shall be checked by measuring the diagonals and the difference between the two diagonals should not be more than 3 mm. Generally panelled glazed or panelled and glazed shutter shall conform to IS 1003 (Pt. 1 & 2).

9.6.1 Frame Work

9.6.1.1 Timber for stiles and rails shall be of the same species and shall be sawn in the directions of grains. Sawing shall be truly straight and square. The timber shall be planed smooth and accurate to the required dimensions. The stiles and rails shall be joined to each other by plain or haunched mortise and tenon joints and the rails shall be inserted 25 mm short of the width of the stiles. The bottom rails shall have double tenon joints and for other rails single tenon joints shall be provided. The lock rails of door shutter shall have its centre line at a height of 800 mm from the bottom of the shutters unless otherwise specified. The thickness of each tenon shall be approximately one- third the finished thickness of the members and the width of each tenon shall not exceed three times its thickness.

9.6.1.2 ***Gluing of Joints :*** The contact surfaces of tenon and mortise shall be treated, before putting together, with bulk type synthetic resin adhesive conforming to IS 851 suitable for construction in wood or synthetic resin adhesive (Phenolic and aminoplastic) conforming to IS 848 or polyvinyl acetate dispersion based adheshive conforming to IS 4835 and pinned with 8-10 mm dia hardwood dowels or bamboopins or star shaped metal pins; after the frames are put together and pressed in position by means of press.

9.6.1.3 Stiles and bottom rail shall be made out of one piece of timber only. Intermediate rail exceeding 200 mm in width may be of one or more pieces of timber. The width of each piece shall be not less than 75 mm. Where more than one piece of timber is used for rails, they shall be joined with a continuous tongued and grooved joint glued together and reinforced with metal dowels at regular intervals not exceeding 200 mm.

9.6.1.4 ***Door Shutters***

9.6.1.4.1 Finished dimensions and tolerances of components of door shutters has been given in Table 9.5 below.

TABLE 9.5
Dimensions and Tolerances of Components of Door Shutters

Sl.	*Description*	*Width* *mm*	*Thickness* *mm*
(a)	Vertical Stile, top and freeze rail	100 ± 3	35 ± 1 or 40 ± 1
(b)	Lock rail	**150 ± 3**	35 ± 1 or 40 ± 1
(c)	Bottom rail	200 ± 3	35 ± 1 or 40 ± 1
(d)	Muntin	100 ± 3	35 ± 1 or 40 ± 1
(e)	Glazing bar	40 ± 3	35 ± 1 or 40 ± 1

9.6.1.4.2 *Size and Types :* Size and types of the timber panels and glazed shutters shall generally conform to modular sizes specified in Table 9.6 below.

TABLE 9.6
Dimension of Door Shutters

Sl. No.	*Designation of Doors*	*Width*	*Height*	
		mm	*mm*	
(1)	*(2)*	*(3)*	*(4)*	
(i)	8DS 20	700	1905	(1945)
(ii)	8DS 21	700	2005	(2045)
(iii)	9DS 20	800	1905	(1945)
(iv)	9DS 21	800	2005	(2045)
(v)	10 DS 20	900	1905	(1945)
(vi)	10 DS 21	900	2005	(2045)
(vii)	12 DT 20	1100[1)]	1905	(1945)
(viii)	12 DT 21	1100[1)]	2005	(2045)

Notes :

(1) The designation refers to modular sizes of door openings. First number stands for width and the last for height in modules (M = 100 mm). Alphabet D refers to doors, 'S' to single and 'T' to double leaf shutter.

(2) Standard sizes of door frames are covered in IS 4021 and IS 4351.

(3) The standard widths and heights for panel doors are arrived at as shown in Fig. 6 of IS 1003 (Pt. 1). In case the modular height is taken from the finished floor level, the height of the door shall be the one given in bracket. In the case of double leave shutters, the rebate in the shutter shall be as given in 6.15 of IS 1003 (Pt. 1).

9.6.1.5 ***Window and Ventilator Shutters :*** Window and ventilator shutters shall conform to IS 1003 (Part 2).

9.6.1.5.1 *Dimensional Sizes and Tolerances :* The finished dimensions and tolerances of different component shall be as given in Table 9.7.

TABLE 9.7
Dimensions and Tolerances of Components of Window and Ventilator Shutters

Description of components	*Window Shutters*		*Ventilator Shutters*	
	Width mm	**Thickness mm**	*Width mm*	**Thickness mm**
Stiles and rails	80 ± 3	25 ± 1	80 ± 3	20 ± 1
		30 ± 1		22.5 ± 1
				25 ± 1
				27.5 ± 1
				30 ± 1
Munting	60 ± 3	25 ± 1	60 ± 3	-do-
		30 ± 1		
Glazing bars	40 ± 1	25 ± 1	40 ± 1	-do-
		30 ± 1		

9.6.1.5.2 *Designation :* Window and ventilator shutters shall be designated by symbols denoting the width, type and height of window and ventilators in following manner.

(a) *Width :* It shall be indicated by the number of modules in the width of opening
(b) It shall be indicated by the following letters of alphabet: W- window, V- Ventilator , S-Single shutter, T-Double shutter
(c) Height : It shall be indicted by the number of modules in the height of opening.

Example : 10 WT 12 would mean a window shutter suitable for a double shutter window of 10 modules width and 12 modules height.

12 V 6 would mean ventilator shutter suitable for a ventilator of 12 modules width and 6 modules height.

9.6.1.5.3 *Sizes :* Sizes of window and ventilator shutters shall generally conform to the modular sizes specified in Tables 9.8 and 9.9 respectively. These sizes are derived after allowing the thickness of the frame and a margin of 5 mm all round based on 100 mm module.

9.6.1.5.4 Tolerances on the overall dimensions of window and ventilator shutter shall be ± 3 mm.

TABLE 9.8
Dimensions of Timber Window Shutters

Designation	*Width mm*	*Height mm*
(1)	*(2)*	*(3)*
6 WS 12	500	1100
10WT 12	460	1100
12 WT 12	560	1100
6 WS 13	500	1200
10 WT 13	460	1200
12 WT 13	560	1200

TABLE 9.9
Dimensions of Timber Ventilator Shutters

Designation	*Width mm*	*Height mm*
(1)	*(2)*	*(3)*
6 V 6	500	500
10 V 6	900	500
12 V 6	1100	500

9.6.2 Mounting and glazing bars where required shall be stubtenoned to the maximum depth which the size of the member would permit or to a depth of 25 mm whichever is less. Unless otherwise specified the finished dimensions of the components of frame work of shutters shall be as given in Table 9.7. The tolerance on width of styles and rail shall be ± 3 mm. The tolerance in thickness will be ± 1 mm. The thickness of all components of frame work shall be the same as the thickness of the shutter. Tolerance on over all dimensions of the shutter shall be ± 3 mm.

9.6.3 Rebating

The shutters shall be single-leaf or double leaved as shown in the drawings or as directed by the Engineer -in-Charge. In case of double leaved shutters, the meeting of the stiles shall be rebated by one-third the thickness of the shutter. The rebating shall be either splayed or square type as shown in Fig. 9.2.

9.6.4 Panelling

The panel inserts shall be either framed into the grooves or housed in the rebate of stiles and rails. Timber, plywood, and particle board panels as given in para 9.2 of this sub head and shall be fixed only with grooves. The depth of the groove shall be 12 mm and its width shall accommodate the panel inserts such that the faces are closely fitted to the sides of the groove. Panel inserts shall be framed into the grooves of stiles and rails to the full depth of the groove leaving space of 1.5 mm. Width and depth of the rebate shall be equal to half the thickness of stiles and rails. Glass panels, asbestos panels wire gauze panels and panel inserts of cupboard shutters shall be housed in the rebates of stiles and rails.

9.6.4.1 ***Timber Panels :*** Timber panels shall be preferably made of timber of large width; the minimum width and thickness of the panel shall be 100 mm, and 15 mm respectively. When made from more than one piece, the pieces shall be jointed with a continuous tongued and grooved joint glued together and reinforced with headless nails at regular intervals not exceeding 100 mm. Depth and thickness of such joint shall be equal to one-third of thickness of panel. The panels shall be designed such that no single panel exceeds 0.5 square metre in area. The grains of timber panels shall run along the longer dimensions of the panels. All panels shall be of the same species of timber unless otherwise specified.

9.6.4.2 ***Plywood Panels :*** Plywood boards used for panelling of shutters shall be BWP type or grade as specified in 9.2.2. Each panels shall be a single piece of thickness, 9 mm for two or more panel construction and 12 mm thickness for single panel construction unless otherwise specified.

9.6.4.3 ***Veneered Particle Board Panels :*** Veneered Particle board used for panelling of shutters shall be Exterior Grade bonded with BWP type synthetic resin adhesive as specified in 9.2.4.2. Each panel shall be a single piece of thickness 12 mm unless otherwise specified.

9.6.4.4 ***Fibre Board Panels :*** Fibre board used for panelling of shutters shall be Exterior Grade bonded with BWP type synthetic resin adhesive Each fibre board panel shall be a single piece unless otherwise specified.

9.6.4.5 ***Wire Gauze Panels:*** Wire Gauze used for panelling of shutters shall be woven with 0.63 mm dia galvanised mild steel wire to form average aperture size of 1.40 mm as specified in 9.2.7. Wire gauze shall be securely housed into the rebates of stiles and rails by giving right angles bend turned back and fixed by means of suitable staples at intervals of 75 mm and over this wooden beading shall be fixed. The space between the rebate and the beading shall be fixed with putty to give a neat finish. Each wire gauze panel shall be a single piece, and the panels shall be so designed that no single panels exceeds 0.5 sqm in area. However, care shall be taken to prevent sagging of wire gauge, of panel by providing and fixing 20 x 20 mm square or equivalent beading to the external face to the required patterns as decided by the Engineer-in-Charge.

9.6.4.6 ***Glass Panels :*** Glass panelling (Glazing) shall be done as specified in 9.2.6. Glazing in the shutters of doors, windows and ventilators of bath, WC and Lavatories shall be provided with frosted glass the weight of which shall be not less than 10 kg/sqm. **For making the glass of frosted look, suitable fill as per direction of the Engineer-in-Charge shall also be accepted and nothing shall be paid extra**. Frosted/ Filmed glass panes shall be fixed with frosted face on the inside. Glass panels shall be fixed by providing a thin layer of putty conforming to IS 419 applied between glass pane and all along the length of the rebate and also between glass panes and wooden beading.

9.6.4.7 Putty can be prepared by mixing one part of white lead with three parts of finely powdered chalk and then adding boiled linseed oil to the mixture to form a stiff paste and adding varnish to the paste at the rate of 1 litre of varnish to 18 kg of paste. Fixing of glass panes without beading shall not be permitted. Glazing shall be done after the shutters have been primed and prepared for painting, so that wood may not draw oil out of putty.

9.6.4.8 ***Finish :*** Panels of shutters shall be flat and well sanded to a smooth and level surface.

9.6.5 Beading

Beadings in panelled shutter shall be provided where specified in architectural drawings or directed by the Engineer-in-Charge. Each length of beading shall be single piece. Joints at the corners shall be mitred and exposed edges shall be rounded. Beading shall be fixed with headless nails at 75 mm intervals. For external shutters, the beading shall be fixed on the outside face.

9.6.6 Machine/Factory made Shutters

Machine made shutters, where specified, shall be procured from an approved factory. For machine made shutters, operations like sawing, planning, making tongue and tenons, cutting grooves, mortises and rebates, drilling holes and pressing of joints shall be done by suitable machines. Machines made shutters shall be brought to the site fully assembled but without any priming coat. Panel inserts of sheet glass and wire gauze may, however, be fixed at site.

9.6.7 Fixing of Shutters

For side hung shutters of height upto 1.2 m **and width up to 0.9 m** each leaf shall be hung on two hinges at quarter points and for shutter of height more than 1.2 m **and width up to 0.9 m** each leaf shall be hung on three hinges one at the centre and the other two at 200 mm from the top and bottom of the shutters. **One additional hinge shall be provided for width exceeding 0.9m for 0.3 m or part thereof.** Top hung and bottom hung shutters shall be hung on two hinges fixed at quarter points of top rail or bottom rail. Centre hung shutter shall be suspended on a suitable pivot in the centre of the frame. Size and type of hinges and pivots shall be as specified. Flap of hinges shall be neatly counter sunk into the recesses cut to the exact dimensions of flap. Screws for fixing the hinges shall be screwed in with screw driver and not hammered in. Unless otherwise specified, shutters of height more than 1.2 mm shall be hung on butt hinges of size 100 mm and for all other shutters of lesser height butt hinges of size 75 mm shall be used. For shutter of more than 40 mm thickness butt hinges of size 125 × 90 × 4 mm shall be used. Continuous (piano) hinges shall be used for fixing cup-board shutters where specified.

9.6.8 Fittings

Fittings shall be provided as per schedule of fittings as shown in drawings or as decided by Engineer- in-Charge. The schedule of fittings and screws for door & windows contained in Appendix 'H' is for guidance only. All fittings shall be paid for separately. The fittings shall conform to specifications laid down in 9.15. All screws shall be of stainless steel of minimum grade 304.

9.6.9 Wooden Cleats and Blocks

Wooden cleats and blocks shall be fixed to doors and windows as directed by Engineer-in-Charge, as per size and shape approved by him. These are included in the cost of providing and fixing the shutters.

9.6.10 Measurements

Framework and panelling shall be measured separately.

9.6.10.1 ***Framework of Shutters :*** The overall length and width of the framework of the shutters shall be measured nearest to a cm in fixed position (overlaps not to be measured in case of double leaved shutters) and the area calculated in square metres correct to two places of decimal. No deduction shall be made to form panel openings or louvers. No extra payments shall be made for shape, joints and labour involved in all operations described above.

9.6.10.2 For panelling of each type or for glazed panel length and width of opening for panels inserts or glazed panels shall be measured correct to a cm before fixing the beading and the area shall be calculated to the nearest 0.01 sq.m. The portions of the panel inserts or glazed panel inside the grooves or rebates shall not be measured for payment.

9.6.11 Rate

Rate includes the cost of materials and labour involved in all the operations described above. The framework and panelling of each type or glazed panels shall be paid separately. The rate for framework includes the cost of butt hinges and necessary screws as specified in 9.6.7. However, extra shall be paid for providing moulded beading where specified. Nothing extra shall be paid for plain beading as stated in 9.6.5 when specified in drawing.

9.7 FLUSH DOOR SHUTTERS (Fig. 9.3)

9.7.0 Flush door shutters shall have a solid core and may be of the decorative or non-decorative (Paintable type as per IS 2202 (Part I). Nominal thickness of shutters may be 25, 30 or 35 mm. Thickness and type of shutters shall be as specified.

9.7.1 Width and height of the shutters shall be as shown in the drawings or as indicated by the Engineer-in- Charge. All four edges of the shutters shall be square. The shutter shall be free from twist or warp in its plane. The moisture content in timbers used in the manufacture of flush door shutters shall be not more than 12 per cent when tested according to IS 1708.

9.7.2 Core

The core of the flush door shutters shall be a block board having wooden strips held in a frame constructed of stiles and rails. Each stile and rail shall be a single piece without any joint. The width of the stiles and rails including lipping, where provided shall not be less than 45 mm and not more than 75 mm. The width of each wooden strip shall not exceed 30 mm. Stiles, rails and wooden strips forming the core of a shutter shall be of equal and uniform thickness. Wooden strips shall be parallel to the stiles.

End joints of the pieces of wooden strips of small lengths shall be staggered. In a shutter, stiles and rails shall be of one species of timber. Wooden strips shall also be of one species only but it may or may not be of the same species as that of the stiles and rails. Any species of timber may be used for core of flush door. However, any non-coniferous (Hard wood) timber shall be used for stiles, rails and lipping.

9.7.3 Face Panel

The face panel shall be formed by gluing, by the hot-press process on both faces of the core, either plywood or cross -bands and face veneers. The thickness of the cross bands as such or in the plywood shall be between 1.0 mm and 3.0 mm. The thickness of the face veneers as such or in the plywood shall be between 0.5 mm and 1.5 mm for commercial veneers and between 0.4 mm and 1.0 mm for decorative veneers, provided that the combined thickness of both is not less than 2.2 mm. The direction of the veneers adjacent to the core shall be at right angles to the direction of the wooden strips. Finished faces shall be sanded to smooth even texture. Commercial face veneers shall conform to marine grade plywood and decorative face veneers shall conform to type I decorative plywood in IS 1328.

9.7.4 Lipping

Lipping, where specified, shall be provided internally on all edges of the shutters. Lipping shall be done with battens of first class hardwood or as specified of depth not less than 25 mm. For double leaved shutters, depth of the lipping at meeting of stiles shall be not less than 35 mm. Joints shall not be permitted in the lipping.

9.7.5 Rebating

In the case of double leaves shutters the meeting of stiles shall be rebated by 8 mm to 10 mm. The rebating shall be either splayed or square type as shown in drawing where lipping is provided. The depth of lipping at the meeting of stiles shall not be less than 30 mm.

9.7.6 Opening for Glazing

When required by the purchaser opening for glazing shall be provided and unless otherwise specified the opening for glazing shall be 250 mm in height and 150 mm or 200 mm in width unless directed otherwise. The bottom of the opening shall be at a height of 1.4 m from the bottom of the shutter. Opening for glazing shall be lipped internally with wooden batten of width not less than 25 mm. Opening for glazing shall be provided where specified or shown in the drawing.

9.7.7 Venetian Opening

Where specified the height of the venetian opening shall be 350 mm from the bottom of the shutter. The width of the opening shall be as directed but shall provide for a clear space of 75 mm between the edge of the door and venetian opening but in no case the opening shall extend beyond the stiles of the shutter. The top edge of the opening shall be lipped internally with wooden battens of width not less than 25 mm. Venetian opening shall be provided where specified or shown in the drawing.

9.7.8 Tolerance

Tolerance on width and height shall be + 3 mm and tolerance on nominal thickness shall be ± 1.2 mm. The thickness of the door shutter shall be uniform throughout with a permissible variation of not more than 0.8 mm when measured at any two points.

9.7.9 Adhesive

Adhesive used for bonding various components of flush door shutters namely, core, core frame, lipping, cross-bands, face veneers, plywood etc. and for bonding plywood shall conform to BWP type, phenol formaldehyde synthetic resin adhesive conforming to IS 848.

9.7.10 Tests

Samples of flush door shutters shall be subjected to the following tests:

(a) End Immersion Test
(b) Knife Test
(c) Glue Adhesion Test

One end of each sample shutter shall be tested for End Immersion Test. Two specimens of 150 x 150 mm size shall be cut from the two corners at the other end of each sample shutter for carrying out Glue Adhesion Test. Knife Test shall be done on the remaining portion of each sample shutter. Test shall be done as laid down in Appendix F of Chapter 9.

9.7.11 Sample Size

Shutters of decorative and non-decorative type from each manufacturer, irrespective of their thickness, shall be grouped separately and each group shall constitute a lot. The number of shutters (sample size) to be selected at random from each lot for testing shall be as specified in Table 9.10. If the total number of shutters of each type in a work (and not the lot) is less than twenty five, testing may be done at the discretion of the Engineer-in-Charge and in such cases extra payment shall be made for the sample shutter provided the sample does not fail in any of the test specified in 9.7.10.

For knife test, glue adhesive test, slamming test, the end immersion test, the number of shutters shall be as per col. 4 of Table 9.10.

TABLE 9.10
Sample Size and Criteria for Conformity

Lot Size	*Sample Size*	*Permissible no. of defective*		*Sub. Sample size*
(1)	*(2)*	*(3)*		*(4)*
Upto 26 to 50	8	0		1
51 – 100	13	1		2
101 – 150	20	1		2
151 – 300	32	1		3
301 – 500	50	2		4
501 and above	80	2		5

9.7.12 Criteria for Conformity

All the sample shutters when tested shall satisfy the requirements of the tests laid down in Appendix F of Chapter 9. The lot shall be declared as conforming to the requirements when numbers of defective sample does not exceed the permissible number given in col. 3 of Table 9.10. If the number of sample shutters found unsatisfactory for a test is one, twice the number of samples initially tested shall be selected and tested for the test. All sample shutters so tested shall satisfy the requirement of the test. If the number of samples found unsatisfactory for a test is two or more, the entire lot shall be considered unsatisfactory.

9.7.13 Fixing

This shall be as specified in 9.6.7.

9.7.14 Measurements

Length and width of the shutters shall be measured to the nearest cm in closed position covering the rebates of the frames but excluding the gap between the shutter and the frame. Overlap of two shutters shall not be measured.

All work shall be measured net as fixed and area calculated in square metres to nearest two places of decimal. No deduction shall be made for providing venetian opening and opening for glazing.

9.7.15 Rates

The rate includes the cost of material and labour involved in all the operations described above. Extra rate shall be payable for providing rebates in double leaved shutters. Glazing when provided shall be measured & paid for separately as specified in 9.6.10.2.

9.7A CUP BOARD SHUTTER

9.7A.0 Cup Board Shutter shall be with pre-laminated flat pressed three layers particle board or with Veneered particle board.

9.7A.1 Width and height of the shutters shall be as shown in the drawings or as indicated by the Engineer in-Charge. All four edges of the shutters shall be square. The shutter shall be free from twist or warp in its plane. The moisture content in timbers used in the manufacture of cupboard shutters shall be not more than 12 per cent when tested according to IS 1708.

9.7A.2 Material :- Pre laminated flat presses three layer shall conform to IS 12823. Venereal particleboard shall conform to IS 3087. The boards with BIS Certificate marks shall only be accepted. Nominal thickness of shutter may be 25, 30 or 35 mm thickness and of type of shutter shall be as specified.

9.7A.3 Lipping

Lipping, where specified, shall be provided internally on all edges of the shutters. Lipping shall be done with battens of first class hardwood or as specified of depth not less than 25 mm. For double leaved shutters, depth of the lipping at meeting of stiles shall be not less than 35 mm. Joints shall not be permitted in the lipping.

9.7A.4 Rebating

In the case of double leaves shutters the meeting of stiles shall be rebated by 8 mm to 10 mm. The rebating shall be either splayed or square type as shown in drawing where lipping is provided. The depth of lipping at the meeting of stiles shall not be less than 20 mm.

9.7A.5 Tolerance

Tolerance on width and height shall be + 3 mm and tolerance on nominal thickness shall be ± 1.2 mm. Tolerance in respect of Edge straightness and squareness shall be as per relevant BIS standard.

9.7A.6 Tests

All relevant tests as specified India standards shall be done or as directed by Engineer-in-Charge.

9.7A.7 Fixing of Shutter

Continuous (piano) hinges shall be used for fixing cupboard shutter where specified. Only stainless steel of minimum grade 304 shall be used.

9.7A.8 Measurements

Length and width of the shutters shall be measured to the nearest cm in closed position covering the rebates of the frames but excluding the gap between the shutter and the frame. Overlap of two shutters shall not be measured.

All work shall be measured net as fixed and area calculated in square meters to nearest two places of decimal.

9.7A.9 Rate

The rate includes the cost of material and labour involved in all the operations described above. Extra rate shall be payable for providing rebates in double leaved shutters.

9.8 WIRE GAUZE FLY PROOF SHUTTERS

9.8.0 Specified timber shall be used, and it shall be sawn in the direction of the grains. Sawing shall be truly straight and square. The timber shall be planed smooth and accurate to the full dimensions, rebates, roundings and mouldings as shown in the drawings made, before assembly. Patching or plugging of any kind shall not be permitted except as provided.

9.8.1 Stile and Rails

The Specifications shall be as described under 9.6.1.3. The stiles and rails shall be given a rebate to receive the wire gauze which shall form the panels.

9.8.2 Wire Gauze

This shall be unless specified otherwise conform to para 9.2.7 and 9.6.4.5. The wire gauze shall be bent at right angles in the rebates of stiles and rails, turned back and fixed tight with blue tacks at about 75 mm centres, fixed alternately in the two faces of the rebates. Over this, wooden beading shall be fixed with brads or small screws at about 75 mm centres.

The space between the beading and rebates, where the wire gauze is bent, shall be neatly finished with putty, so that the end of the wire gauze may not be visible.

9.8.3 Fixing Fittings, Wooden cleats, blocks and Measurement shall be as specified under 9.6.

9.8.4 Rate

This includes the cost of materials and labour involved in all the operations described above, and as specified under 9.6.

9.9 Clause shifted to Sub Head 8 (Cladding work) as clause no 8.15

9.10 SHELVES

9.10.0 Shelves and vertical partitions of cupboards shall be of timber planks fibre board, particle board, block board or veneered particle board as specified. Thickness and type of planks or boards shall be as specified. Each shelf shall be a single piece and vertical partitions between two consecutive shelves shall be without any joint. Exposed edges of boards having particle board core shall be sealed with 3 mm thick single piece teak wood strips of width equal to the thickness of board with headless pins. The arrangement of shelves and vertical partitions shall be as per drawings or as directed by the Engineer-in-Charge.

9.10.1 Fixing

Planks for shelves shall be planed on all faces and edges. In case of boards they shall be sawn to the required size truly straight and square. Timber battens 25 x 40 mm unless otherwise specified shall be planed smooth and fixed inside the cupboard with wooden plugs and screws. Shelves shall be fixed to the battens and vertical portions shall be held in position by fixing them to the battens and shelves using screws. Teakwood strips for edge sealing of the boards shall be planed smooth and fixed with headless nails. Tolerance in width shall be ± 1.5 mm and in thickness 1 mm.

9.10.2 Measurements

Length and width of shelves and vertical partitions shall be measured correct to a cm. separately for each type of board stating its thickness. Area shall be calculated correct to 0.01 sqm.

9.10.3 Rate

It includes the cost of materials and labour required for all the operations described above.

9.10.A Lipping in pelmet –

Lipping shall be provided on all edges of the pelmets. The timber shall be as specified.

9.11 TRELLIS (JAFFRI) WORK

9.11.0 Specified timber shall be sawn/cut in the direction of the grains. Sawing / cutting shall be truly straight and square. The timber shall be planed smooth and accurate to the full dimensions, rebates, roundings, and mouldings as shown in the drawings made, before assembly. Patching or plugging of any kind shall not be permitted except as provided. **The case of Bamboo Jaffri the bamboo of minimum 25 via shall be of cut in the length dimension.**

9.11.1 Plain Trellis (Jaffri)

This shall consist of wooden strips or laths 35 x 10 mm section unless otherwise specified planed and nailed together at every alternate crossing. The strips shall cross each other at right angle and shall be spaced 35 mm apart, so as to form 35 × 35 mm square opening or as shown in the drawing. These shall be fixed with nails to the frame. To cover the ends of strips, 50 × 12 mm beading shall be fixed to the frame with screws. The finished work with a tolerance of ± 1 mm may be accepted.

9.11.2 Bamboo Trellis (Jaffri)

This shall consist of half cut bamboos of 25mm (minimum parameter). The bamboo strips shall be fixed with 3 numbers Hollack Wood Scantling of size 50mm x 50 mm and shall be fixed with nails of required size. The finished work with a tolerance of ± 1 mm may be accepted.

9.11.3 Measurements

Width and height of plain trellis work and trellis shutters shall be measured overall correct to a cm.

The area shall be calculated in square metres nearest to two places of decimal.

9.11.4 Rate

It includes the cost of materials and labour required in all the operations described above.

9.12 PELMETS

9.12.0 Planks and curtain rods of specified timber shall be used, and it shall be sawn in the direction of the grains. Sawing shall be truly straight and square. The timber shall be planed smooth and accurate to the full dimensions, rebates, roundings, and mouldings as shown in the drawings made, before assembly. Patching or plugging of any kind shall not be permitted.

9.12.1 Sides, front and top of the pelmets shall be of 12 mm planks or boards of specified quality and width unless otherwise stated. These shall project from the wall face by 15 cm or as specified, and shall be securely fixed to walls with wood screws by means of wooden plugs and 10 cm long 25 × 3 mm M.S. flat bent in the form of angle or by any other device approved by the Engineer-in-Charge. The pelmets shall be provided with curtain rods and brackets or curtain rails with rollers, stop ends and brackets wooden, brass or chromium plated brass as specified. Intermediate wooden brackets shall be provided, if the front length of pelmet exceeds 1.5 metres.

9.12.2 Measurements

The pelmets box shall be measured along the sides and front planking correct to a centimetre.

9.12.3 Rate

The rate includes the cost of sides, front and top planking curtain rods with brackets or curtain rails with rollers labour and materials required for all the operations described above.

9.13 HOLD FASTS

9.13.0 These shall be made from mild steel flat 40 × 5 mm size conforming to IS 7196 without any burns or dents. 5 cm length of M.S. flat at one end shall be bent at right angle and one hole 11 mm dia shall be made in it for fixing to wooden frame with 10 mm dia nut bolt. The bolt head shall be sunk into the wooden frame, 10 mm deep and pluged with wooden plug. At the other end 10 cm length of the hold fast flat shall be forked and bent of length as specified at right angle in opposite direction and embedded in cement concrete block of size 30 x 10 x 15 cm of mix 1:3:6 (1 cement : 3 coarse sand : 6 graded stone aggregate, 20 mm nominal size) or as specified (see Fig. 9.4).

9.13.1 Measurements

Measurements for the hold fasts shall be in number.

9.13.2 Rate

It includes the cost of labour and material involved in all the operations described above including fixing bolt and cement concrete blocks.

9.14 EXPANDED METAL, HARD DRAWN STEEL WIRE FABRIC AND WIRE GAUZE IN WOODEN FRAMES

9.14.0 Expanded metal, hard drawn steel wire fabric or wire gauge or weld mesh as described in the item of work shall be fixed to the window frames on the outside or inside as per detailed drawings or as directed by the Engineer-in-Charge. These shall be free from rust and other defects.

Expanded Metal

This shall be in the form of rhombus with its opening diagonals 20 × 60 mm and strands 3.25 mm wide and 1.6 mm thick weighing 3.633 kg/m^2 unless otherwise specified.

Welded Steel Drawn Wire Fabric

This shall conform to IS 4948 and shall have rectangular mesh of 75 × 25 mm size with wires of diameter not less than 5 mm longitudinally and 3.15 mm transversely. Its weight shall be not less than 7.75 kg/m^2 unless otherwise specified.

Wire-Gauze

This shall be as per clause 9.2.7.

9.14.1 Fixing

Expanded metal, hard drawn steel wire fabric and wire gauze shall be cut in one piece to the size of the frame (out to out). Expanded metal and hard drawn steel wire fabric shall be fixed on to the frame with staples, over which wooden beading 60 x 20 mm shall be fixed with wood screws.

9.14.2 Measurements

The length and breadth shall be measured correct to a cm, the area from outside to outside of beading shall be calculated in square metre nearest to two places of decimal.

9.14.3 Rate

It includes the cost of labour and materials required for all the operations described above.

9.15 FITTINGS

9.15.0 Fitting shall be of mild steel brass, aluminium or as specified. Some mild steel fittings may have components of cast iron. These shall be well made, reasonably smooth, and free from sharp edges and corners, flaws and other defects. Screw holes shall be counter sunk to suit the head of specified wood screws. These shall be of the following types according to the material used.

(a) **Mild Steel Fittings :** These shall be bright finish black stone enamelled or copper oxidised (black finish), nickel chromium plated or as specified.

(b) **Brass Fittings :** These shall be finished bright satin finish or nickel chromium plated or copper oxidised or as specified.

(c) **Aluminium Fittings :** These shall be anodised to natural matt finish or dyed anodic coating not less than grade AC 10 of IS 1868.

The fittings generally used for different type of doors and windows are indicated in Appendix H attached. The fittings to be actually provided in a particular work shall, however, be decided by the Engineer-in-Charge.

Screws used for fittings shall be of the same metal, and finish as the fittings. However, chromium plated brass screws or stainless steel screws shall be used for fixing aluminium fittings. These shall be of the size as indicated in respective figures.

Fittings shall be fixed in proper position as shown in the drawings or as directed by the Engineer-in-Charge. These shall be truly vertical or horizontal as the case may be. Screws shall be driven home with

screw driver and not hammered in. Recesses shall be cut to the exact size and depth for the counter sunking of hinges.

9.15.1 Butt Hinges (Fig. 9.5A)

These shall be of the following types according to the material used.

(a) Mild steel butt hinges (Medium).
(b) Cast brass butt hinges light/ordinary or heavy.
(c) Extruded aluminium alloy butt hinges.

9.15.1.1 ***Mild Steel (Medium) (Fig. 9.5A) :*** These shall be medium type manufactured from M.S. sheet. These shall be well made and shall be free from flaws and defects of all kinds. All hinges shall be cut clean and square and all sharp edges and corners shall be removed. These shall generally conform to IS 1341.

Hinge Pin : Hinge pin shall be made of mild steel wire. It shall fit inside the knuckles firmly and rivetted head shall be well formed so as not to allow any play or shake, and shall allow easy movement of the hinge, but shall not cause looseness.

Knuckles : The number of knuckles in the hinges of different sizes shall be as per IS 1341. The size of knuckles shall be straight and at right angle to the flap. The movement of the hinges shall be free and easy and working shall not have any play or shake.

Screw Holes : The screw holes shall be clean and counter sunk. These shall be suitable for counter sunk head wood screws and of the specified size for different types, and sizes of hinges. The size of the holes shall be such that when it is counter sunk it shall be able to accommodate the full depth of counter sunk head of the wood screws. The nos. of screw holes shall as specified in IS 1341.

9.15.1.1.1 *Sampling and Criteria for Conformity :* The number of butt hinges to be selected from a lot shall be depend on size of lot and shall be in accordance with Table 9.11 below. Butt hinges for testing shall be selected at random from at least 10 per cent of the randomly selected packages subjected to minimum of three equal number of hinges being selected from each package. All butt hinges selected shall be checked for dimensions and tolerance requirements. Defects in manufacture and finish shall also be checked and lot shall be considered conforming to the requirement of this specifications, if the number of defective hinges among those tested does not exceed the corresponding number given in Table 9.11.

TABLE 9.11
Scale of Sampling and Criteria for Conformity

Sl. No.	*Lot size*	*Sample Size*	*Permissible No. of Defective hinges*
1	*2*	*3*	*4*
1.	Upto 150	5	0
2.	151 to 300	20	1
3.	301 to 500	32	2
4.	501 to 1000	50	3
5.	1001 and above	80	5

9.15.1.2 ***Cast Brass :*** These shall be light/ordinary or heavy as specified. These shall be well made and shall be free from flaws and defects of all kinds. These shall be finished bright or chromium plated or oxidised or as specified. These shall generally conform to IS 205.

Hinge Pin : Hinge pin shall be made of brass or of stainless steel. The hinge pins shall be firmly rivetted and shall be properly finished. The movement of the hinge pin shall be free, easy and square and shall not have any play or shake.

Knuckles : The number of knuckles in each hinge shall not be less than five. The number of knuckles in case of sizes less than 40 mm shall be three. The sides of the knuckles shall be straight and at right angle to the flap. The movement of the hinge pin shall be free and easy and working shall not have any play or shake.

Screw Holes : The screw holes shall be clean and counter sunk and of the specified size for differen types and size of hinges. The size of the holes shall be such that when it is counter sunk it shall be able to accommodate the full depth of counter sunk head of wood screw specified.

9.15.1.3 ***Extruded Aluminium Alloy :*** These shall be manufactured from extruded sections. These shall be well made and free from flaws and defects of all kinds. These shall generally conform to IS 205.

Hinge Pin : Hinge pin shall be made of mild steel (galvanised or aluminium alloy). The aluminium alloy hinge pin shall be anodised. The hinge pin shall be finally rivetted and shall be properly finished. The movement of hinges shall be free easy and square and shall not have any play or shake.

Knuckles : Number of knuckles in each hinge pin shall not be less than 5. The number of knuckles in case of sizes less than 40 mm be straight and at right angle to the flap. The movement of the hinge pin shall be free and easy and working shall not have any play or shake.

Screw Holes : The screw holes shall be suitable for counter sunk head wood screws, and of specified sizes for different type of hinges. The size of the holes shall be such that when it is counter sunk it shall be able to accommodate the full depth of counter sunk head of wood screw specified.

9.15.1.4 ***Sampling and Criteria for Conformity :*** The number of butt hinges to be selected from a lot shall depend on the size of lot and shall be in accordance with Table 9.12. Butt hinges for testing shall be taken at random from at least 10 per cent of the package subject to a minimum of three, equal number of hinges being selected from each package. All butt hinges selected from the lot shall be checked for dimensional and tolerance requirements. Defects in manufacture and finish shall also be checked. A lot shall be considered conforming to the requirements of this specification if the number of defective hinges among those tested does not exceed the corresponding number given in Table 9.12.

TABLE 9.12
Scale of Sampling and Criteria for Conformity

Sl. No.	*Lot size*	*Sample size*	*Permissible No. of defective hinges*
1	Upto 200	15	0
2	201 to 300	20	1
3	301 to 500	30	2
4	501 to 800	40	2
5	801 and above	55	3

Note: Any hinge which fails to satisfy the requirements of any one or more of the characteristics shall be considered as defective hinge.

9.15.2 Parliament Hinges (Fig. 9.5B)

9.15.2.1 These shall be of mild steel cast brass or as specified, and shall generally conform to IS 362. The size of parliament hinges shall be taken as the width between open flanges. Mild steel parliament hinges shall be copper oxidised (thick finish) or as specified. The brass parliament hinges shall be finished bright, chromium plated or oxidised or as specified.

9.15.2.2 The hinge pin shall be made of mild steel in the case of brass hinges. The hinge pin shall be mild steel (galvanised) in the case of aluminium alloy hinges. The hinge pin shall be firmly rivetted and shall be properly finished. The movement of the hinges shall be free, easy and square, and shall not have any play or shake.

All screw holes shall be clean and counter sunk to suit the counter sunk head of wood screws specified.

9.15.2.3 ***Sampling Criteria for and Conformity :*** The number of parliament hinges to be selected from a lot shall depend on the size of lot and shall be in accordance with Table 9.13. Parliament hinges for testing shall be taken at random. All hinges selected from the lot shall be checked for dimensional and tolerance requirements. Defects in manufacture and finish shall also be checked. A lot shall be

considered conforming to the requirements of this specification if the number of defective hinges among those tested does not exceed the corresponding number given in Table 9.13.

TABLE 9.13

Lot Size	*Sample Size*	*Permissible No. of Defective hinges*
Upto 150	13	0
151 to 300	20	1
301 to 500	32	2
501 to 1000	50	3
1001 and above	80	5

Note: Any hinge which fails to satisfy the requirements of any one or more of the characteristics shall be considered as defective hinge.

9.15.3 Spring Hinges (Single or double acting)

9.15.3.1 These shall be single acting when the shutter is to open on one side only or double acting when the shutter opens on both sides. These shall be made of M.S. or brass as specified, and shall generally conform to IS 453.

Hinges shall work smoothly and shall hold the door shutter truly vertical in closed position. Each double-acting spring hinge shall withstand the following tests which shall be carried out after fixing it to a swing door in the normal manner.

(a) When the door is pushed through 90° and released 2000 times on each side in quick succession the hinge shall show no sign of damage or any appreciable deterioration of the components during or on completion of the test.

(b) The door shall require a force of 2.0 ± 0.5 kg for 100 mm hinges and 3.0 ± 0.5 kg for 125 mm and 150 mm hinges at a distance of 45 cm from the hinge pin to move the door through 90º.

The size of spring hinge shall be taken as the length of the plate.

9.15.3.2 These shall be of the following type:

(a) *Mild Steel :* The cylindrical casing shall be made either from M.S. sheet of 1.60 mm thickness, lap jointed and brazed, welded and rivetted, or from solid drawn tube of thickness not less than 1.60 mm; or from mild sheet of 1.60 mm thickness pressed to from the two casing and the distance piece. It shall be stove enamelled black or copper oxidized or as specified.

(b) *Cast Brass :* The cylindrical casing shall be made either from brass sheet of 1.60 mm thickness, lap jointed and brazed, or from solid drawn brass tube of not less than 1.60 mm thickness. It shall be satin, bright nickle plated or copper oxidized or as specified.

9.15.3.3 ***Sampling :*** The number of spring hinges shall be selected from the lot and this number shall depend on the size of the lot and shall be in accordance with Table 9.14.

TABLE 9.14

Lot size	*Sample size*	*Permissible No. of defective spring hinges*
Upto 100	13	0
101 to 300	20	1
301 to 500	32	2
501 to 1000	50	3
1001 and above	80	5

9.15.4 Rising Hinges

These shall be made of brass, finished bright or chromium plated or oxidised or as specified. Its shape and pattern shall be approved by the Engineer-in-Charge. The size of the rising hinge shall be taken as the length of its plate.

9.15.5 Continuous Piano Hinges (Fig. 9.6B)

9.15.5.1 These shall be made from mild steel or aluminium alloy sheet, these shall generally conform to IS 3818. All screw holes shall be clean and counter sunk. Piano hinges shall be fixed in the entire length of the cup board shutters. Its size will be the width of the two flaps when open.

9.15.5.2 ***M.S. Piano Hinges :*** These shall be made from 1 mm or 0.80 mm thick M.S. sheets and shall be protected with anti-corrosive treatment, such as bright polished, chromium plated or oxidised finish.

Hinge pin shall be of galvanised mild steel. It shall fit in the knuckle firmly so as not to allow any play or shake and shall allow easy movement of hinge, but shall not cause looseness.

The sides of the knuckles shall be straight and at right angles to the flap. The movement of the hinge shall be free and easy and working shall not have any play and shake.

9.15.5.3 ***Aluminium Piano Hinges :*** These shall be made of aluminium alloy sheet and shall be anodised. The anodic coating shall not be less than the grade AC 15 of IS 1868.

Hinge pin shall be made of aluminium alloy with anodic coating not less than the grade of AC-15 of IS 1868. The hinge pin shall fit in the knuckle firmly so as not to allow any play or shake and shall allow easy movement of hinge but shall not cause looseness.

The sides of the knuckles shall be straight and at right angles to the flap. The movement of the hinge shall be free and easy, and working shall not have any play and shake.

9.15.5.4 ***Sampling and Criteria for Conformity :*** It shall be same as specified in clause 9.15.1.4.

9.15.6 Tee Hinges (Fig. 9.6A)

These shall be made from M.S. sheets and shall be either bright finished or stove enamelled black or as specified. These shall generally conform to IS 206 (Tee hinges shall be well made, free from burrs, flaws, and defects of any kind. The movement shall be square, and the working shall be free and easy without any play or shake. The hole for the hinge shall be central to the bore and shall be square.

The hinge pin shall be firm and rivetted over, so that the heads are well formed. All screw holes shall be clear and counter sunk and shall be suitable for the counter sunk head of wood screws.

9.15.6.1 ***Sampling and Criteria for Conformity :*** It shall be same as specified in clause 9.15.1.4.

9.15.7 Sliding Door Bolts (Aldrops) (Fig. 9.7)

9.15.7.1 These shall be of mild steel, cast brass, aluminium or as specified, and shall be capable of smooth sliding action.

9.15.7.2 ***M.S. Sliding Door Bolts :*** These shall be made of M.S. sheets and M.S. rods and shall generally conform to IS 281. M.S.sliding door bolts shall be copper oxidised (black finish) or as specified.

9.15.7.3 ***Cast Brass Sliding Door Bolts :*** These shall be made from rolled brass and shall generally conform to IS 2681. The hasp shall be of cast brass and secured to the bolt as shown in Fig. 9.7. Alternatively, the hasp and the bolt may be cast in one piece. The fixing and staple bolts shall be cast with 6 mm studs. Bolts shall be finished to shape and have threaded ends and provided with robs washers and nuts of square or hexagon type. All components shall be finished smooth and polished before assembly. Cast brass sliding bolts shall be finished bright or chromium plated or oxidised or as specified.

9.15.7.4 ***Aluminium Sliding Door Bolts :*** These shall be made of aluminium alloy and shall generally conform to IS 2681. Aluminium sliding door bolts shall be anodized. All screw holes shall be counter sunk to suit the counter sunk head of screws of specified sizes. All edges and corners shall be finished smooth. In case of single leaf door, when iron socket plate or a brass or aluminium fixing bolts (or sliding door bolt) cannot be fixed, hole of suitable size shall be drilled in the door frame and an iron or brass plate cut to shape shall be fixed at the face of the hole. The leading dimensions of the sliding door bolts are illustrated.

9.15.7.5 ***Sampling and Criteria for Conformity :*** The number of sliding door bolt to be selected from a lot shall depend on the size of lot and shall be in accordance with Table 9.15. For testing shall be taken at random from at least 10 percent of the package subject to a minimum of three, equal number of door bolts being selected from each package. All door bolts selected from the lot shall be checked for dimensional and tolerance requirements. Defects in manufacture and finish shall also be checked. A lot shall be considered conforming to the requirement of this specification if the number of defects sliding door bolts among those tested does not exceed the corresponding number given in Table 9.15.

TABLE 9.15

Lot. size	*Sample Size*	*Permissible speed Decorative sliding door bolts*
Upto 150	5	0
151 to 300	20	1
301 to 500	32	2
501 to 1000	50	3
1001 and above	81	5

9.15.8 Tower Bolts (Fig. 9.8)

9.15.8.0 These shall generally conform to IS 204 (Part. I) & IS 204 (Part. II). Tower bolts shall be well made and shall be free from defects. The bolts shall be finished to the correct shape and shall have a smooth action. All tower bolts made with sheet of 1.2 mm thickness and above shall have counter sunk screw holes to suit counter sunk head of wood screws. All sharp edges and corners shall be removed and finished smooth.

The height of knob of tower bolt when the door, window etc. is in closed position from the floor level shall be not more than 1.9 metre.

9.15.8.1 Tower bolts shall be of the following types:

(a) Aluminium barrel tower bolts with barrel and bolt of extruded sections of aluminium alloy. The knob shall be properly screwed to the bolt and rivetted at the back.

(b) Brass tower bolts with cast brass barrel and rolled or cast brass bolt.

or

Brass tower bolts with barrel of extruded sections of brass and rolled or drawn brass bolt.

The knobs of brass tower bolts shall be cast and the bolt fixed with knob, steel spring and ball shall be provided between the bolt and the barrel.

(c) Mild steel barrel tower bolts with mild steel barrel and mild steel bolt.

or

Mild steel tower bolts with mild steel barrel and cast iron bolts.

The plates and straps after assembly shall be firmly rivetted or spot welded. The rivet head shall be properly formed and the rivet back shall be flush with the plate. These shall be made in one piece.

9.15.8.2 Unless otherwise specified bolt shall have finish as given below :

(a) Mild steel tower bolts (Types 1 and 2) Bolts bright finished or plated as specified and barrel and socket stove enamelled black.

(b) Brass tower bolts (type 3 to 5) Bolt and barrel polished or plated as specified.

(c) Aluminium alloy tower bolts (type 6) Bolt and barrel anodized.

The anodic film may be either transparent or dyed as specified. The quality of anodized finish shall not be less than grade AC-10 of IS 1868.

9.15.8.3 ***Sampling and Criteria for Conformity :*** It shall be same as specified in clause 9.15.1.4.

9.15.9 M.S. Locking Bolt with Holes for Pad Locks

9.15.9.1 This shall conform to IS 7534.

9.15.9.2 This shall be of mild steel polished bright or copper oxidised batch electrogalvanised or stove enamelled. In case of stove enamelled locking bolts, the bolt may be finished bright.

9.15.10 Pull Bolt Locks (Fig. 9.9)

9.15.10.1 These shall be of M.S. cast brass or aluminium as specified. M.S. pull bolt locks shall be copper oxidized (black finish) or as specified.

9.15.10.2 Brass pull bolt locks shall be finished bright, chromium plated or oxidised as specified. Aluminium pull bolt locks shall be anodised and the anodic coating shall not be less than grade. A.C. 10 of IS 1868. The bolt shall be 10 mm in diameter and the fixing plate 3 mm thick. The stop block shall be screwed to the fixing plate by a small ball and spring over which the bolt shall slide.

9. 15.10.3 The fixing plate shall have four holes for fixing it to the door leaf, two of which shall be square to receive 6 mm dia. bolts with round heads, the remaining two shall receive machine screwed with lock nuts. The receiving plate shall be of the same width and thickness as the fixing plate and shall have 3 counter sunk holes.

Where the bolt slides into wooden members, like the chowkhat, which have a rebate, the receiving plate shall also be correspondingly shaped so as to fit into the rebate. The screws and bolts shall have the same finish as the main bolt. The leading dimensions of pull bolt locks are given in the drawing. The denominating size of the pull bolt locks shall be length of the fixing plate between guides plus the thickness of the guides.

9.15.11 Door Latch

9.15.11.1 This shall be of mild steel, cast brass, or as specified and shall be capable of smooth sliding action. In case, of mild steel latch, it shall be copper oxidized (black finish) or as specified and in case of brass, it shall be finished bright, chromium plated or oxidized or as specified. The size of door latch shall be taken as the length of the latch.

9.15.12 Indicating Bolt (Vacant/Engaged*)*

These shall be of cast brass finished bright chromium plated, or oxidized or as specified. The shape and pattern shall be approved by the Engineer-in-Charge.

9.15.13 Mortice Lock and Latch (Fig. 9.10)

9.15.13.0 This should generally conform to IS 2209.

9.15.13.1 The size of the mortice lock shall be denoted by the length of the body towards the face and it shall be 65 mm, 75 mm and 100 mm as specified. The measured length shall not vary more than 3 mm from the length specified.

9.15.13.2 ***Non-interchangeable Keys :*** Testing of non-interchangeable keys shall be as per IS 2209.

9. 15.13.3 The clear depth of the body shall not be more than 15 mm. The fore end shall be firmly fitted to the body suitably by counter sunk head screw. The latch bolt shall be of specified material and of section not less than 12 x 16 mm for all sizes of locks. If made of two piece construction both parts shall be rivetted. Ordinary lever mechanism with not less than two levers shall be provided. False levers shall not be used. Lever shall be fitted with one spring of phosphor bronze or steel wire and shall withstand the tests as provided in IS 2209.

9.15.13.4 Locking bolts, spring and strike plate shall conform to IS 2209.

9.15.13.5 ***Handles :*** These shall conform to IS 4992.

9.15.13.6 ***Keys :*** Each lock shall be provided with two keys.

9.15.13.7 ***Sampling, Criteria for Conformity :*** It shall be the same as specified in clause 9.15.1.4.

9.15.13.8 ***Tests :*** The finally assembled locks shall be tested as prescribed in Appendix 'G' of Chapter 9.

9.15.14 Mortice Latch (with Locking Bolt)

9.15.14.1 These are generally used in doors of bath rooms, WC's and private rooms.

9.15.14.2 Mortice latch shall, in respect of shape, design and mechanism of the latch and its components parts, generally conform to IS 5930. The material used for the different component parts of the latch shall comply with Tables 1 and 2 of IS 5930, unless otherwise specified.

9.15.14.3 The size of the latch shall be denoted by the length of the body towards the face and shall be 65 mm, 75 mm or 100 mm as specified. The depth of the body shall not be more than 15 mm.

9.15.14.4 The latch shall be of size 10 × 18 mm of shape as shown in Fig. 1 of IS 5930. The locking bolt shall be of section not less than 8 x 25 mm for all size of locks. The mechanism of the latch bolt, its spring, striking plate etc. shall be as described in IS 5930.

9.15.14.5 The handles provided shall conform to IS 4992.

9.15.14.6 Sampling, criteria for conformity shall be same as per clause 9.15.1.4.

9.15.15 Mortice Lock and Latch (Rebated)

9.15.15.1 These are slightly different from mortice lock described in 9.15.14 and are designed for use in double leaved doors. These should generally conform to IS 6607.

9.15.15.2 ***Handles, Keys, Sampling, Criteria for Conformity and Test :*** These shall be same as specified in clause 9.15.14.

9.15.16 Mortice Night Latch (Fig. 9.11)

9.15.16.1 This is a mortice lock having a single spring bolt withdrawn from the outside by using the key and from inside by turning the knob and with an arrangement whereby the lock can be prevented from being opened by its key from outside while the night latch is used from inside the room.

9.15.16.2 This should generally conform to IS 3847.

9.15.16.3 It shall be cast or sheet brass, cast or sheet aluminium alloy or Mild steel as specified and of best quality of approved make. These shall be bright finished or copper oxidised (black) finish as specified. Nominal size of the latch shall be denoted by the length of the face over the body in milli-metres. These shall have not less than two levers. False (Dummy) levers shall not be allowed.

9.15.16.4 ***Keys :*** Each latch shall be provided with two keys which should work smoothly and without any appreciable friction in the lock.

9.15.17 Cupboard or Wardrobe Lock

This should generally conform to IS 729. The size of the cupboard lock shall be 40, 50, 65 & 75 mm. This shall be made of cast brass and shall be of the best make of approved quality. These shall be finished bright or chromium plated or oxidised or as specified. The size of the lock shall be denoted by the length of the face across the body in mm.

These locks shall be fitted with four, five or six levers as specified. False (dummy) levers shall not be used.

9.15.18 Kicking Plates

9.15.18.1 This shall be of brass (finished bright or chromium plated or oxidised) bronze, stainless steel, aluminium or as specified. Aluminium kicking plates shall be anodised and the anodic coating shall not be less than grade AC-10 of IS 1868. It shall be made from a plate of minimum thickness 3.0 mm & 1.5 mm in case of stainless steel. Shape of the plate shall be as specified. This shall have bevelled or straight edges and shall be fixed by means of counter sunk or rounded screws of the same material and finish as that of the plate. The shape and pattern shall be according to the drawings and as approved by the Engineer-in-Charge.

9.15.19 Door Handles (Doors and Windows) (Fig. 9.12)

9.15.19.1 These should generally conform to IS 208. The door handles shall be well made and free from defects. These shall be finished correct to shape and dimensions. All edges and corners shall be removed and finished smooth so as to facilitate easy handling. Cast handle shall be free from casting defects. Where the grip portion of the handle is joined with the base piece by mechanical means, the arrangement shall be such that the assembled handle shall have adequate strength comparable to that of integrally cast type handles.

9.15.19.2 Door handles shall be of the following types according to the material used:

(a) ***Cast or Sheet Aluminium Alloy Handles :*** These shall be of aluminium of specified size, and of shape and pattern as approved by the Engineer-in-Charge. The size of the handle shall be determined by the inside grip of the handle. Door handles shall be of 100 mm size and window handles of 75 mm size unless, otherwise specified. These shall be fixed with 25 mm long wood screws of designation No. 6. Aluminium handles, shall be anodized and the anodic coating shall not be less than grade AC 15 - IS 1868 as specified. The finish can be bright natural, matt or satin or dyed as specified.

(b) Cast Brass Handles: These shall be of cast brass of specified size and of the shape and pattern as approved by the Engineer-in-Charge. The size of the handle shall be determined by the inside grip of the handle. Door handles shall be of 100 mm size and window handles of 75 mm size, unless otherwise specified. These shall be fixed with 25 mm long wood screws of designation No 6. Brass handles shall be finished bright satin or nickel chromium plated or copper oxidised or as specified.

(c) Mild Steel Handles : These shall be of mild steel sheet, pressed into oval section. The size of the handles will be determined by the inside grip of the handle. Door handles shall be 10 mm size and window handles of 75 mm size unless otherwise specified. These shall be fixed with 25 mm long wood screws of designation No. 6., Iron handles shall be copper oxidised (black finish) or stove enamelled black or as specified.

(d) Stainless Steel Handles:- These shall be of stainless steel of specified size, shape and pattern as approved by Engineer-in-Charge for using in doors, windows and kitchen cabinets. Doors handles shall be of 125 mm or 100 mm size and window handles of 75 mm size unless, otherwise specified. Kitchen cabinet handles shall of 125 mm, 100 mm or 75 mm as specified. These shall be fixed with stainless steel screws 20 mm long. Stainless steel handles shall not be less than grade 304. The finish can be bright or matt finish as specified.

9.15.19.3 ***Sampling and Criteria for Conformity :*** The number of handles to be selected from a lot shall depend on the size of lot and shall be in accordance with Table 9.16. Handles for testing shall be selected at random for at least 10 percent of packages. Subject to a minimum 3, equal number of door handles being selected from each such package. All door handles shall be checked for dimensional requirement and finish. Any door handle which fails to satisfy the requirement of dimensions or finish or both shall be considered as defective.

A lot shall be considered as conforming to requirement of this specification, if the number of defective handles among those tested does not exceed the corresponding number of defectives is greater than or equal to rejection number given in column 4 of Table 9.16, the lot shall be deemed as not meeting the requirements of this specification.

TABLE 9.16

Scale of Sampling and Criteria for Conformity

Lot size	*Sample size*	*Acceptance no.*	*Rejection no.*
(1)	*(2)*	*(3)*	*(4)*
Upto 50	8	0	1
51 to 90	13	1	2
91 to 150	20	1	2
151 to 280	32	2	3
281 to 500	50	3	4
501 to 1200	80	5	6
1201 and above	125	7	8

9.15.20 Floor Door Stopper (Fig. 9.13)

9.15.20.1 The floor door stopper shall conform to IS 1823. This shall be made of cast brass of overall size as specified and shall have rubber cushion. The shape and pattern of stopper shall be approved by the Engineer-in-Charge. It shall be of brass finished bright, chromium plated or oxidised or as specified. The size of floor stopper shall be determined by the length of its plate. It shall be well made and shall have four counter sunk holes for fixing the door stoppers to the floor by means of wood screws. The body for housing of the door stopper shall be cast in one piece and it shall be fixed to the cover plate by means of brass or mild steel screws and cover plate shall be of casting or of sheet metal. The spring shall be fixed firmly to the pin. Tongue which would be pressed while closing or opening of the door shall be connected to the lower part by means of copper pin. On the extreme end a rubber piece shall be attached to absorb shock. All parts of the door stopper shall be of good workmanship and finish, burrs and sharp edges removed. It shall be free from surface and casting defects. Aluminium stopper shall be anodised and anodic film shall not be less than grade AC-10 of IS 1868.

9.15.20.2 ***Sampling and Criteria for Conformity :*** The number of floor door stoppers to be selected from each lot shall depend on the size of the lot and shall be in accordance with col. 1 and 2 of Table 9.17. These stoppers shall be selected at random from at least 10 percent of the randomly selected packages subject to a maximum of three equal number of stoppers being selected from each such package.

All the floor stoppers selected shall be checked for dimensional requirement, material, manufacture and finish. Any of door stopper which fails to satisfy any one or more of these requirement shall be considered as defective door stopper.

A lot shall be considered as conforming to the requirements of this specifications if the number of defective floor door stoppers among these tested does not exceed the corresponding number given in col. 3 of Table 9.17. Otherwise it shall be considered as not conformity to the requirements of this specification.

TABLE 9.17
Scale of Sampling and Criteria for Conformity

Lot Size	*Sample Size*	*Permissible number of Decorative sliding door bolts*
(1)	*(2)*	*(3)*
Upto 100	5	0
101 to 300	0	1
301 to 500	32	2
501 to 1000	50	3
1001 and above	80	5

TABLE 9.18
Requirements for Rubber for Use in Floor Door Stoppers

Particulars	*Requirements*	*Testing Procedure*
Relative density Max.	1.3	IS 3400 (Part IX)
Hardness	60 ± 5	IS 3400 (Part II)
Ageing for 24 hours at $100_o \pm 1_oC$	(a) Change in initial hardness (b) Shall not develop brittleness + 5, – 0	IS 3400 (Part II)

9.15.21 Hanging Rubber Door Stopper

9.15.21.1 These shall be of cast brass, finished bright, chromium plated or as specified. Aluminium stopper shall be anodised and the anodic coating shall not be less than grade AC-10 of IS 1868. The size and pattern of the door stopper shall be approved by the Engineer-in-Charge. The size shall be determined by its length.

9.15.22 Universal Hydraulic Door Closer (Exposed Type)

9.15.22.1 These shall be made of cast iron/aluminium alloy/zinc alloy and of shape and pattern as approved by the Engineer-in-Charge.

9.15.22.2 These shall generally conform to IS Specifications for door closers (Hydraulically regulated) IS 3564.

9.15.22.3 The door closers may be polished or painted and finished with lacquer to desired colour. Aluminium alloy door closer shall be anodized and the anodic coating shall not be less than grade AC 15 of IS 1868. All dents, burrs and sharp edges shall be removed from various components and they shall be pickled, scrubbed and rinsed to remove greese, rust, scale or any other foreign elements. After pickling, all the M.S. parts shall be given phosphating treatment in accordance with IS 3618.

9.15.22.4 The nominal size of door closers in relation to the weight and the width of the door size to which it is intended to be fitted shall be given in Table 9.19.

TABLE 9.19
Type and Designation of Door Closers

Designation of closers	*Mass of the door (kg)*	*Width of the door (mm)*	*Remarks*
1.	Upto 35	Upto 700	For light doors such as double leaved and toilet doors.
2.	36 to 60	701 to 850	Interior doors, such as of bed rooms, kitchen and store
3.	61 to 80	851 to 1000	Main doors in a building, such as entrance doors

9.15.22.5 ***Sampling and Criteria for Conformity :*** All the door closer of the same nominal size and shape and from the same batch of manufacture, in one consignment shall constitute a lot. The number of door closers to be taken at random from a lot shall depend upon the size of the lot. (Table 9.20). The sample shall be tested for construction, finish, dimensions, interchangeability of parts and performance in accordance of Table 9.20. Any door closer failing in any one or more of these characteristics shall be considered as defective. If in the first sample, the number of defective door closer is less than or equal to corresponding acceptance number, the lot shall be declared as conforming to the requirement of these characteristics. If the number of defective door closer is greater than or equal to the rejection number, the acceptance number but less than the rejection number, lot shall be deemed as not meeting with requirements of these characteristics. If the number of defectives is greater than the acceptance number, but less than the rejction number, a second sample of the size equivalent to that of the first shall be taken to determine the conformity or otherwise of the lot. The number of defective door closers found in the first and the second sample shall be combined and if the combined number of defective thus obtained is less than or equal to the corresponding acceptance number, the lot shall be declared as conforming to the requirements of these characteristics.

Endurance Test- Two door closer in case of lot size 280 or less and five door closers in case of lot size more than 280 shall be selected from those already found satisfactory. These door closers shall be tested for the endurance test.

If all the door closers tested for endurance test satisfy the requirement of this standard, the lot shall be deemed as having satisfied the requirements of endurance test, otherwise not.

TABLE 9.20

No. of door closers in the lot	*Sample*	*Sample size*	*Commulative sample size*	*Acceptance Number*	*Rejection Number*
Upto 50	First	8	8	0	2
	Second	8	16	1	2
51 to 90	First	13	13	0	2
		13	26	1	2
91 to 150	Second	20	20	0	3
		20	40	3	4
151 to 280	First	32	32	1	4
		32	64	4	5
281 to 500	Second	50	50	2	5
		50	100	6	7
501 to 1200	First	80	80	3	7
		80	160	8	9
1201 to 3200	Second	125	125	5	9
		125	250	12	13
3201 and above	First	200	200	7	11
		200	400	18	19

9.15.22.6 ***Performance Requirements :*** After being fitted in its position when the door is opened through 90°, the same should swing back to angle of 20° ± 5° with nominal speed but thereafter, the speed should get automatically retarded and in case of doors with latches, it should be so regulated that in its final position the door smoothly negotiates with the latch.

9.15.23 Casement Brass Stays (Straight Peg Type) (Fig. 9.14)

9.15.23.1 These shall be made of mild steel, cast brass, aluminium (extruded section) or plastic (Polypropylene) as specified. Mild steel casement stays shall be a copper oxidised (black finish) or as specified. Cast brass stays shall be finished bright or chromium plated or as specified. Aluminium stays shall be anodised and the anodic coating shall not be less than grade AC-10 of IS 1868. Aluminium and M.S. stays shall be made from channel section. The stays shall not weigh less than that indicated below:

200 mm	0.24 kg each
250 mm	0.28 kg each
300 mm	0.33 kg each

9.15.23.2 The shape and pattern of the stays shall be approved by the Engineer-in-Charge. The size of stays shall be determined by its length as shown in the plate. The plastic (Polypropylene) stays shall conform to IS 6318.

9.15.24 Quadrant Stays 300 mm

These shall be made of cast brass and finished bright or chromium plated or as specified. The shape and pattern shall be approved by the Engineer-in-Charge. It shall not weigh less than 0.20 kg each.

9.15.25 Hasp and Staple Safety Type (Fig. 9.15)

9.15.25.1 This shall be made of mild steel, cast brass or aluminium as specified. This shall generally conform to IS 363. M.S. Hasp and staples shall be finished black enamelled, or copper oxidised (black finish) or as specified. Brass hasp and staples shall be finished bright chromium plated or oxidised or as specified. Aluminium hasp and staples shall be anodized and the anodic coating shall not be less than grade AC 15 of IS 1868.

9.15.25.2 M.S. hasp and staples shall be manufactured from M.S. sheet and brass hasp and staples by casting and Aluminium hasp and staples shall be made from dye section. The hinge pin which in all cases shall be of mild steel, shall be firm and its rivetted heads well formed. The movement of hasp shall be free, easy and square and shall not have any play or shake.

The hasp shall fit, in the staple correctly. The size shall be determined by the length of the bigger of the hasp.

9.15.25.3 The staple except in the case of cast one, shall be rivetted properly to its plate. The ends of the hinge pin for the safety type hasp shall be rivetted and properly finished. All screw holes shall be clean and counter sunk to suit counter sunk wood screw. All edges and corners shall be rounded.

9.15.26 P.T.M.T (Polytetra Methyline Tetraphthalate) Fittings

9.15.26.0 PTMT (Polytetra Methylene Tetraphthalate) is an engineering plastic (raw material imported) and have following physical properties:-

(i) Tensile Strength	:	500 Kg/cm²
(ii) Compressive Strength	:	900 Kg/ cm²
(iii) Rockwell hardness L-scale	:	75
(iv) Working temperature	:	-45º to 120ºC.
(v) E Value	:	85000 Kg/cm²
(vi) Density	:	1.3 gm/cc
(vii) Impact Strength	:	No Break

P.T.M.T. fitting shall be in different colours like White, Green, Blue, Derby Brown, Mushroom, Black, Gold, Silver & Broonze or any colours agreed by the manufactures and purchaser.

P.T.M.T. fittings are suitable for internal doors shutters kitchen, bath w.c. & cabinet etc. These shall not be used in external door and where security is concern.

Screws used for fittings shall be counter sunk cross head of chromium plated brass or stainless steel. Sizes of screws shall be of same size as used in case non ferrous material door/window fittings.

9.15.26.1 ***P.T.M.T. Butt Hinges :*** These shall of the material as mentioned in para 9.15.26.0 above. These shall be of required colour/shade ceramic look, glassy smooth surface. These shall be of required size and thickness.

9.15.26.1.1 *Hinge Pin:* Hinge pin shall be made of 5.5 mm dia stainless steel. It shall fit inside the knuckles firmly and riveted head (head covered with same material as of hinge) shall be well formed so as not to allow any play or shake and shall allow easy movement of the hinge, but shall not cause looseness.

9.15.26.1.2 *Knuckles :* The number of the knuckles in hinges shall be as per IS 1341. The shape of knuckles shall be straight and right angle to flap. The movement of the hinge shall be free and easy and working shall not have any play or shake.

9.15.26.1.3 *Screw Holes :* The screw holes shall be clean and counter sunk. These shall be suitable for counter sunk head cross head wood screws and of the specified sizes for different type and sizes of hinges. The size of the holes shall be such that when it counter sunk it shall be able to accommodate the full depth of counter sunk of screws.

9.15.26.2 ***P.T.M.T. Door Handles :*** The door handles shall be of material as mentioned in para 9.15.26.0 above moulded to required shape and size. The size & thickness etc. of the handle shall be determined by the inside grip of the handle. These shall be moulded as solid sections. The body of the handle shall not be hollow. Door handles shall be 100 mm size and window handles of 75 mm size unless, otherwise specified. These shall be fixed with 25 mm long wood. (Cross head) screws of designation No. 6.

9.15.26.3 ***PTMT Tower Bolt :*** The tower bolt shall be generally barrel type of material as mentioned in para 9.15.26.0 moulded to required shape and size. Size (length, dia, length of rod, number of holes) shall generally confirm to IS 204 PI & P-II. The rod shall be solid. If it in hollow it shall be provided with stainless steel rod of required dia. for its strength protective coat of wood primer, polish or varnish.

9.16 LAMINATED VENEER LUMBER (LVL)

9.16.1 Laminated Veneer Lumber door frames and shutters shall conform to IS 14616.

9.16.2 Material

9.16.2.1 ***Laminated Veneer Lumber (LVL)***

(a) Laminated Veneer Lumber is made of rubber wood silver oak, eucalyptus, Poplars, acacias etc. veneers glued together having grains of all the veneers in one direction under high temperature and pressure to develop high Modulus of Repture & Modulus of elasticity. Veneers for LVL shall be of thickness between 1.5 to 2.5 mm.

(b) Veneers shall be free from knot holes, decayed knots except pin knots, unfilled splits wider than 3 mm, concentrated borer holes, shakes, objectionable decay or termite attack, except that for the face veneers none of these defects nor cross grain exceeding 1 in 10 shall be permitted. The nominal thickness of all the veneers used shall be identical and uniform within a tolerance of $\pm$ 5 percent.

(c) *Adhesives :* Only BWP grade adhesive conforming to IS 848 shall be used for making LVL.

(d) *Preservatives :* Veneers used for LVL shall be given suitable perservative treatment before lamination, with a preservative that is compatible with the adhesive to be used. Only fixed type of water soluble preservatives, CCA or CCB, or non-leachable, solvent soluble preservatives as per IS 401 shall be used for treating the veneers. Retentions of preservatives shall be as per IS 401 depending upon the proposed end use.

All the Veneers shall be given preservative treatment by one of the water soluble fixed type treatment, Copper Chrome-Boron Composition. (CCB) as per IS 401. The treated Veneers shall then be dried having moisture content less than 6%. The Veneers shall be glued together, by keeping all the grains in one direction, with BWP grade synthetic resin adhesive conforming to IS 848. The Veneers having moisture content less than 6% so glued, shall be pressed in hot press at high temperature of 140 degree C to 180 degree C. and pressure 1.4 to 1.8 MPa. The net absorption of preservative in LVL when tested as per IS 2753 shall not be less than 8.0 kg/m^3 Veneers shall be scarf jointed only length wise and not in the direction of width with EWP type synthetic resin adhesive. However, the length of individual Veneer shall not be less than 600 mm.

9.16.3 Moisture Content

The average moisture content of three test specimens, when determined in accordance with IS 1734 (Part 1) shall be between 5 to 15%.

9.16.4 Tests

9.16.4.1 The tests as per Table-1 of IS 14616 shall be carried out by the manufacturer on the LVL (Laminated Veneer Lumber) sections on each batch.

9.16.4.2 The manufacturer shall get the tests done on at least three samples of each batch by the standard method of test to ensure quality and performance of the material as per para 8.2 of IS 14616.

9.16.4.3 The manufacturer shall provide a certificate with the delivery challan indicating that the material conforms to IS 14616 along with the copy of the test report of the relevant batch.

9.16.5 Laminated Veneer Lumber (LVL) Door Shutters (Fig. 9.16)

9.16.5.1 This specification lays down requirements regarding types, sizes, material, construction, workmanship and finish, performance evaluation, sampling, measurements, rates and testing of Laminated Veneer Lumber (LVL) door shutter for use in domestic buildings, offices, schools, hospitals etc. This specification does not cover large size door shutters for industrial and special buildings such as workshops, garages, godowns etc.

9.16.5.2 The material of each lot shall be supported by a certificate to that effect:

Each lot of LVL materials shall be accompanied by the test reports. Fabricator shall take up manufacturing of shutters only if provisions of clause 9.16.4 are fulfilled; failing which, shutters so manufactured are liable for rejection.

9.16.5.*3 Panelling Materials*

9.16.5.3.1 *Plain Particle Board:* Plain particle boards used for panels shall be FPT-1 conforming to IS 3087 and shall have been bonded with BWP type of synthetic resin adhesive as per IS 848. (Ref. para 9.2.3)

9.16.5.3.2 *Pre- laminated Particle Board:* Pre -laminated particle boards used for panels shall conform to IS 12823. The plain particle boards used in pre-laminated particle boards shall be as per para 9.2.11 above.

9.16.5.3.3 *Medium Density Fibre Board:* Medium density fibre board used for panels shall conform to exterior grade as per IS 12406 made from agro-forest products or agricultural wastes or natural fibers.

9.16.5.3.4 *Pre-laminated Medium Density Fibre Board:* Pre-lamination in pre-laminated medium density fiber board shall conform to the requirements such as Abrasion Resistance, Resistance to Steam, Crack Resistance, Resistance to Cigarette Burn and Resistance to Stain as specified in IS 12823. The medium density fibre board used in pre-laminated medium density fibre board shall be as per para 9.6.11 above.

9.16.5.3.5 *Glass:* Glass for glazing shall conform to IS 2835 or IS 2553. The use of other types of glass, such as frosted glass, wired glass and coloured glass may also be specified by the Engineer-in-Charge. (Ref.para 9.2.8).

9.16.5.3.6 *Wire Gauze:* Wire gauze shall generally conform to IS 1568 and shall be regularly woven with equally spaced galvanized mild steel wires of 0.63 mm nominal diameter in both warp and weft directions to form aperture of average width 1.40 mm. (Ref para 9.2.9)

9.16.6 Construction and Workmanship

9.16.6.1 Laminated Veneer Lumber (LVL) panelled, glazed and panelled and glazed shutter shall be constructed in the form of LVL framework of stiles and rails with panel inserts conforming to para 9.16.5 above of plain or perlaminated particle board, plain or prelaminated medium density fibre board, wire gauze or glass. The panels shall be fixed by either providing grooves in stiles and rails and beading as specified. The stiles, top rails, lock rails and bottom rails shall be jointed to each other by mortice and tenon joints (See Fig. 9.16A). Rails having width of 150 mm or more shall have plain double tenon joints as shown in Fig. 9.16B. Other rails shall have single tenon joints. The bottom lock and top rails shall be inserted 25+3 mm short of the width of stiles to form a stub mortice & tenon joint. After assembling shutter complete with panels, Bamboo pins of 6 mm dia shall be fitted on each tenon & mortice joint by drilling suitable size of holes (2 pins per joint for rail width upto 150 mm and 3 pins for rails of greater width). All the four edges of shutter shall be beaded with 12 mm thick rubberwood /plantation wood lipping (See Fig. 9.16). Lipping shall be seasoned and chemically treated as per clause 9.16.4. Lipping on top and bottom rails shall be of one piece and lipping on stiles may be in two pieces. All lippings shall be glued to shutter with water resisting glue (Synthetic rubber passed adhesive) at the rate of 0.15 kg/m^2.

9. 16.6.2 All members of the shutters shall be straight, smooth and with well planed faces at right angles to each other. Any warp or bow shall not exceed 1.5 mm. The right angle for the shutters shall be checked by measuring the two diagonals from one extreme corner to the opposite one and the difference between the two diagonals shall not be more than 3 mm.

9.16.6.3 ***Beading:*** All the panels except glass and wire gauze shall be fixed with grooves (see Fig. 9.16C) but additional beading may be provided either on one side or on both the sides, if so specified. In so far as glass and wire gauze panels are concerned, beading shall be provided without grooves. In such a case where beading is provided without the grooves, the beading shall be only on one side, the other side being supported by rebate from stiles. The beading shall have a size not less than 15 mm x 10 mm. It can be fixed by suitable headless nailing or screwing. The beading shall be of plantation timber section, preservative chemically treated of fixed type as per IS 401-1982.

9.16.6.4 Stiles, top rails, bottom rails and lock rails of shutters shall each be made in one piece of LVL, only.

Mullions and glazing bars shall be stubtenoned to the maximum depth which the size of the member would permit or to a depth of 25 mm, whichever is less.

Two common methods for jointing of panels with stiles/rails are shown in Fig. 9.16C. The minimum depth of grooves of stiles and rails shall be 12 mm for all types of panelling. The panels shall be framed into grooves to the full depth of groove leaving an air space of 1.5 mm and the faces shall be closely fitted to the sides of the groove.

LVL Shutters shall be manufactured in factories under controlled conditions.

9.16.7 Panelling

9.16.7.1 ***Plain and Prelaminated Particle Board Paneling:*** The panels shall be made of one piece of plain or prelaminated particle board of thickness 12 mm or more.

9.16.7.2 ***Wire Guaze Panelling :*** Wire guaze panel shall be so designed that no single panel shall exceed 0.5 sqm. in area.

9.16.8 Rebating

In case of double leaved shutters, the meeting of the stiles shall be rebated either splayed or square type as shown in Fig. 9.16 D as per clause 6.12 of IS 1003 (part-1).

9.16.9 Gluing of Joints

The contact surfaces of tenon and mortice shall be treated before putting together as per clause 6.13 of IS 1003 (Part -I). All the tenon and mortice joints should be glued together and pinned to full thickness of the door with Bamboo pins.

9.16.10 Dimensions, Sizes and Tolerances

9.16.10.1 ***Dimensions of Components and Tolerances:*** The finished dimensions and tolerances of the different components of door shutter shall be as per para 9.6.1.4.1.

Tolerances: Tolerance on the size of door shutter shall be + 3 mm and in thickness + 1.2 mm.

9.16.11 Locations of Fittings and Accessories

9.16.11.1 Each door shutter shall be fixed to the frame with four hinges, unless otherwise specified by the Engineer-in-Charge, of the type specified.

The lock rail of door shutters, where provided, shall be so placed that its centre line is at a height 850+5 mm from the bottom of the shutter. Hinges and other fixtures shall be fixed to shutter with full threaded steel screws after coating the screws with adhesive such as fevicol etc. For fixing of hinges, holes of 3.5 mm diameter and 52 mm length shall be bored and No. 10 full threaded parallel shank steel screws, 50 mm long, coated with adhesive shall be used. In no circumstances screws shall be hammered into board.

9.16.11.2 Cleats and blocks made of LVL wood shall be fixed to door shutter, if required, by the user as per size and shape approved. Pull bolt or sliding door bolt etc. shall be provided in the door shutter at a height of 850 mm from bottom of shutter. These shall be fixed to shutter as per method of fixing described in 9.16.11.

For rescrewing, a plastic sleeve of appropriate diameter shall be inserted into the hole and then fixing with full threaded screws shall be done. Fittings other than hinges shall be provided as per schedule of fittings decided by the user. The fittings shall conform to specifications as described in clause 9.15.

Panelled shutter may be provided with louvers of vision panels as specified. Where such a provision is made, the position, sizes and shape of louver or vision panel opening shall be as specified.

9.16.12 Finish

All the four edges of the shutter shall be square. The shutter shall be free from twist or warp in its plane. Panels of the door shutters shall be flat and well sanded to a smooth and level surface. All the surfaces shall be delivered without protective coat of wood primer polish or varnish.

9.16.13 Glazing

9.16.13.1 Glazing in the shutters of door and window shall be as per sub head 21.0 In specifying sizes of the openings or panels of glass, the first dimension shall be width. The glass shall be embedded in putty and secured to the rebate by the wooden beading of suitable size and shape.

9.16.14 Tests

9.16.14.1 ***Routine Tests:*** The following test shall be carried out by the fabricator on shutters during the process of fabrication in the factory's laboratory to be developed for this specific purpose before dispatch of shutters.

TABLE 9.21

Sl.No.	Name of Test	Acceptability Criteria
1	Dimensions and Defects of Squareness Test	As per IS 4020
2	General Flatness Test	As per IS 4020
3	Local Planeness Test	As per IS 4020
4	Flexure Test	As per IS 4020

9.16.14.2 ***Type Test :*** The manufacturer shall also have the performance of the shutters tested as per IS 4020 by the following tests as given in Table 9.22.

TABLE 9.22

Sl.No.	Name of Test	Acceptability Criteria
1	Impact indentation test	Not more than 0.2 mm
2	Screw withdrawal /Holding power test (a) Face (Min) (b) Edge (Min)	 2700 N 2300 N
3	Edge loading test (a) Deflection (b) Residual Deflection	 Not more than 5 mm Not more than 0.50 mm
4	Shock resistance test (a) Soft & light weight body impact (b) Soft and heavy weight body impact	 No visible damage observed -do-
5	Buckling test (a) Deflection/Deformation (b) Residual Deformation	 Not more than 50 mm Not more than 5 mm
6	Misuse test	Not be any permanent deformation observed
7	Slamming test	No visible damage observed

(i) All the tests to be carried under 9.16.14 shall be got done through approved/reputed lab on at least three samples to ensure the quality and performance of the door shutters on completing manufacturing of 5000 door shutters or once in 12 months whichever is earlier. Record of manufacturing of shutters shall be maintained to ensure the required frequency.

The fabricator shall also provide a certificate of shutters conforming to these specification along with each lot. The fabricator shall also provide test reports carried under para 9.16.14.1 and 9.16.14.2 with each lot of supply.

(ii) Tests to be conducted by field units : The Engineer-in-Charge shall also have options to get any or all other test covered in 9.16.14 done at his own cost. If the shutter fails to satisfy the test, cost will be borne by the supplier and consignment shall be rejected.

9.16.15 Measurement

Length and width of the shutter shall be measured to the nearest centimetre in closed position covering the rebates of the frames but excluding the gap between the shutter and the frame. Overlap of the two shutters shall not be measured. All work shall be measured net as fixed and area calculated in square metres to nearest two places of decimal. No deduction shall be made to form panel opening, louver Venetian opening and opening for glazing. No extra payment shall be made for shape, joints and labour involved in operations described above.

9.16.16 Rates

The rate includes the cost of material and labour involved in all the operations described above. Extra rate shall be payable for providing rebates in double leaf shutters. Fittings described in 9.16.11.2 shall be payable extra. Nothing extra shall be payable for complying with the provisions described in 9.16.14.1 & 9.16.14.2. Cost of tests as described in 9.16.14.2 shall be borne by Deptt. if test reports are found satisfactory. Rate shall include cost of material and labour involved in providing plain beading. Extra shall be paid for providing moulded/plain beading on panels where specified.

9.17 PARTITIONS

9.17.1 Materials

(i) Gypsum plaster Board conforming to IS 2095 (Pt.-I):1996 (Board with BIS Certifiction mark)
(ii) Glass Reinforced Gypsum (GRG) plaster board confirming to IS 2095 (Pt.-3):1996 (Board with BIS Certifiction mark)
(iii) Fiber cement flat sheet conforming to IS 14862-2000 (Reaffirmed 2009)
(iv) Cement bonded particle board confirming to IS 14276-1995 (Reaffirmed 2010)

Tapered Edge Calcium Silicate Board are manufactured from Siliceous and Calcareous materials reinforced with fibers. The boards are made in a laminar process and then autoclaved to give a stable crystalline structure. It is lightweight and can be fixed to either side of timber, aluminum or lightweight galvanized metal sections. The partitions are non-load bearing and can easily be assembled at site.

9.17.2 Installation

The G.I. frame and board partitions shall be fixed as per nomenclature of the item and directions of Engineer-in-Charge. (Fig. 9.17).

9.17.3 Jointing & Finishing

Joints of the boards are finished with specially formulated Jointing compound and fibre tape to provide seamless finish. Board surface can be decorated with any type of paint, wall paper, wood veneer & hard laminates. Services should be incorporated before commencement of board fixing.

9.17.4 Fitting and Fixtures

It is easy and simple to attach different fittings to wall panelling boards. Inclined nails can be fixed to the boards itself for light materials. For heavier materials the fastening should be centered on internal stud work or steel or wood frame behind the boards, fixed before boarding. Services should be incorporated before commencement of board fixing.

9.17.5 Tolerance

Tolerance in dimensions shall be $\pm$ 5 mm.

9.17.6 Measurements

9.17.6.1 Length and breadth of superficial area of the finished work shall be measured correct to a cm. Area shall be calculated in square meter correct to two places of decimal. No deduction will be made of openings of areas upto 0.40 sqm nor shall extra payment be made either for any extra material or labour involved in forming such openings.

9.17.6.2 For openings exceeding 0.40 sqm. in area, deduction in measurements shall be made but extra will be payable for any extra material or labour involved in making such openings.

9.17.7 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above including all scaffolding, staging etc.

9.17A Teak Wood Lipping

9.17A.0 Materials

2nd class Teak Wood or as specified shall be sawn / cut in the direction of grains to required size of lipping. Sawing / cutting shall be truly straight and shape.

9.17A.1 Fixing

The Lipping shall be fixed with head less nails to the base frame. No joint shall be permitted in one dimension of 2.5 meter or less. The joint shall be mitered in length as well as at corners.

9.17A.2 Measurements

The length of the Lipping shall be measured along the side correct to a centimeter.

9.17A.3 Rate

It includes the cost of labour and material involved in all the operations described above including fixing complete.

9.17B SKIRTING

9.17B.0 Material

Pre-laminated medium fiber density board as per IS 14587:1998

9.17B.1 Installation and joining

The board for skirting shall be cut in such a manner that the grains are in continuation of the grains of attached wall paneling or flooring. The edges of board shall be sealed with PVC edge bending tape 2.00 mm thick and width equal to thickness of board. Fixing shall be as per nomenclature of the item and direction of Engineer-in-Charge.

9.17B.2 Measurements

Length and breath of superficial area of the finished work shall be measured correct to a cm. Area shall be calculated in square meter correct to two places of decimal. No deduction will be made of openings of areas upto 0.40 Sqm nor shall extra payment be made either for any extra material or labour involved in forming such openings.

9.17B.3 Rate

The rate shall include the cost of all materials and labour involved in all operations described above.

9.18 PVC- DOOR FRAMES

9.18.0 Material

Polyvinyl chloride Resin suspension grade is the basic raw material for forming PVC compound. PVC resin then is mixed with chemicals like Calcium, Stearate, Hydrocarbon Wax, Titanium Dioxide, Calcium Carbonate, Acrylic processing aids. Further, additives like impact modifiers, pigments, epoxy plasticizer, UV stabilizer, lubricants, chemical blowing agent etc. are added. The purpose of adding the chemicals and additives is to impart cellular structure, strength, surface finish, colour and resistance to fading by light rays. These chemicals are mixed in the desired proportion and shall be used in the formulation of PVC material and for free and smooth extrusion of PVC profiles.

9.18.1 PVC Door Frame

PVC door frame shall be made of PVC material conforming to IS 10151. The door frame shall be made from extruded PVC section having overall dimensions of 48 x 40 mm or 42 x 50 mm having wall thickness of 2.0 mm $\pm$ 0.2 mm. Corners of the door frame to be jointed by M.S. galvanized brackets. Joints mitred and plastic welded. The hinge side vertical outer frames shall be reinforced by galvanized M.S. Tube of size 19 x 19 mm of wall thickness 1 mm $\pm$ 0.1 mm and a tie rod shall be provided at the bottom of the frame. The frame shall be fabricated in factory as per nomenclature of the item and directions of Engineer-in-Charge. (Fig. 9.18).

9.18.2 Fixing of Frames

The frames are to be fixed in prepared openings in the walls. All civil work and tiling should be completed before the fixing of the frames. The frames are to be fixed directly on the plastered wall. In case tiling is to be done in the place the frames are to be fitted, a 50 mm strip should be left untiled at the location where the frames are to be fitted. The frames are erected in the prepared opening such that the vertical members of the door frame are embedded 50 mm in the floor. The frame shall be fitted truly in plumb. A minimum of three anchor bolts or screws of size 65/100 shall be used to fix each vertical member. One bolt shall be fixed at 200 mm from the top member and one bolt shall be fixed at 200 mm from the floor. The third anchor bolt shall be fixed in the center. The top horizontal member shall be fixed using two 65/100 size anchor bolts or screws at a distance of 200 mm from both the corners.

9.18.3 Measurements

The outer length of the vertical and horizontal members of PVC door frame shall be measured in running metres including embedded length in floor corrected upto a cm.

9.18.4 Rate

The rate includes the cost of the materials and labour involved in all the operations described above. The cost of anchor bolts or screws for joining the frame is included in the rate. Any other hardware, which may be required, shall be paid for separately.

9.19 PVC DOOR SHUTTERS

The shutters shall be fabricated at factory as per nomenclature of the item and directions of Engineer-in-Charge. Shutter shall be made of PVC material conforming to IS 10151.

9.19.1 24 mm thick PVC Door Shutter (Fig. 9.19)

9.19.2 30 mm Thick PVC Door Shutters (Fig. 9.20)

9.19.3 Sampling and Criteria for Conformity

9.19.3.1 *General Precautions*

9.19.3.1.1 The test specimens shall not have been exposed to a temperature below 40°C for 24 hours immediately preceding the test and shall be free from all visible moisture. The specimen shall be inspected and any specimen with visible flaws shall be discarded.

9.19.3.1.2 If any test specimen fails because of mechanical reason, such as failure of testing equipment or improper specimen preparation, it shall be discarded and another specimen taken.

9.19.3.2 *Sampling*

9.19.3.2.1 Sampling criteria for conformity shall be in accordance with IS 4020 (Part –I)

9.19.3.2.2 Lot in any consignment of shutters shall be of the same grade and type and manufactured under similar conditions of production which shall be grouped together to form a lot.

9.19.3.2.3 The number of shutters to be selected at random from a lot shall depend upon its size and shall be in accordance with Col. 1 and Col. 2 of Table 9.23.

TABLE 9.23
No. of Sample and Criteria for Conformity

Sl. No.	*Sample size*	*Permissible No. of Defects*
(1)	*(2)*	*(3)*
26 to 50	8	1
51 to 100	13	1
101 to 150	20	1
151 to 300	32	1
301 to 500	50	2
501 and above	80	2

Note : For lot size 25 or less, number of samples to be taken for testing shall be as agreed to between the manufacturer & Engineer-in-Charge.

Number of Tests : The samples selected as in column 2 of Table 9.23 shall be as agreed to between the manufacturer & Engineer-in-Charge.

9.19.3.2.4 *Criteria for Conformity :* The lot shall be considered conforming to the requirements if the number of samples failing to satisfy the requirements of characteristics does not exceed the permissible number mentioned in col. 3.

9.19.4 Test

9.19.4.1 The door shutters shall be subjected to the following tests in accordance with IS 4020 (Part 1 to 16).

(a) *Dimension and Squareness Test :* Door shutters when tested in accordance with IS 4020 (Part 2) the dimensions of nominal width and height will be within a limit of $\pm$ 5 mm. The door shutter shall not deviate by more than 1 mm on a length of 500 mm. The thickness of the door shutter shall be uniform throughout with the permissible variation of not more than 0.8 mm between any two points. The nominal thickness of the shutter shall be within a limit of $\pm$ 1.5 mm.

(b) *General Flatness Test :* Door shutter, when tested in accordance with IS 4020 (Part 3) the twist, cupping and warping shall not exceed 6 mm.

(c) *Local Planeness Test :* Door shutters, when tested in accordance with IS 4020 (Part 4), the depth of deviation measured at any point shall not be more than 0.5 mm.

(d) *Impact Indentation Test :* Door shutters, when tested in accordance with IS 4020 (Part 5), shall have no defects such as cracking, tearing or delamination and the depth of indentation shall not be more than 0.2 mm.

(e) *Edge Loading Test :* Door shutters, when tested in accordance with IS 4020 (Part 7) the deflection of the edge at the maximum load shall not be more than 5 mm. On removal of the loads, the residual deflection shall not be more than 0.5 mm, failing which the test may be repeated on the other edge in the reverse direction. Also there shall be no lateral buckling by more than 2 mm during loaded condition and no residual lateral buckling after removal of the load.

(f) *Shock Resistance Test :* Door shutters, when tested in accordance with 2.1 of IS 4020 (Part 8) , there shall be no visible damage in any part of the door after twenty five blows on each end.

(g) *Buckling Test :* Door shutters, when tested in accordance with IS 4020 (Part 9), shall not show any deterioration and any residual deformation more than 5 mm after 15 min. of unloading and the initial deflection also shall not be more than 50 mm.

(h) *Slamming Test :* Door shutters, when tested in accordance with 2.1 of IS 4020 (Part 10), shall not have any damage in any part of the door at the end of successive impacts.

Door shutters, when tested in accordance with 3.1 of IS 4020 (Part 10), shall not have any visible damage in part of the door at the end of 100 successive impacts.

(i) *Misuse Test :* Door shutters, when tested in accordance with IS 4020 (Part 11), there shall not be any permanent deformation of the fixing or any other part of the door set in hindering its normal working after the test.

(j) *Screw Holding Test :* Door shutters, when tested in accordance with IS 4020- Part 16, the load shall not be less than 1000 N.

(k) *End Immersion Test :* Door shutters, when tested in accordance with IS 4020- Part 13, the shutter shall not show any delamination.

(l) *Knife Test :* Door shutter, when tested in accordance with IS 4020 – Part 14, the grading shall be standard & excellent.

(m) *Glue Adhesion Test :* Door shutters shall be tested in accordance with IS 4020 – Part 15. There should be no delamination.

9.19.5 Fixing of Shutters

PVC door shutter shall be side hung on three bolt hinges of size 100 mm, one at the centre and the other two at 200 mm from the top and bottom of the shutter. The flat of the hinges shall be neatly counter sunk in to the recesses cut out to the exact dimensions of the hinge flap. The door shall be drilled on the thickness to fit hinges. Screws for fixing the hinges shall be screwed in with screwdrivers and not hammered. The length of the screws should be 8 mm/30 mm. The hinges used should be of stainless steel.

9.19.6 Tolerance

The tolerance on the width and the height of the door shall be $\pm$ 5 mm and the tolerance on the nominal thickness of the door shall be $\pm$ 2 mm.

9.19.7 Fittings

Fittings shall be provided as per schedule of fittings decided by Engineer-in -Charge. In moisture prone areas M.S. fittings and screws should not be used. Hardware such as handles, tower bolt, stopper, buffer etc. should be directly screwed (not pre-drilled) and fitted on the door.

9.19.8 Measurements

Length and width of the shutters shall be measured to the nearest cm in closed position covering the rebates of the frames but excluding the gap between the shutter and the frame. Area is calculated to the nearest 0.01 sqm.

9.19.9 Rate

The specified rate include the cost of the door shutter and labour involved in fixing of the shutter. Fittings & fixtures on the door shutter except hinges & screws shall be paid extra as provided.

9.20 PVC DOOR FRAME

Solid PVC door frame and shutter shall be as per para 9.19.

9.20.1 Solid PVC Door Frames consisting of section 50 x 47 mm shall be fabricated from 5 mm PVC sheet having density of 600 kg./cum. The sheet used may be in plain colour, printed design or prelam veneer shade as approved by the Engineer-in-Charge. The weight per running metre of the door frame including reinforcement should be a minimum of 1.5 kg./sq. mtr. The depth of the rebate of door frame shall be 10 mm. Frames shall have smooth surface, without any warping or bending in any member. All the parts of the door frame are to be joined to each other using solvent adhesive conforming to IS 14182. A tolerance of $\pm$ 3 mm shall be permitted in the specified dimension of PVC section in the door frames. (Fig. 9.21)

The solid PVC door frames shall be fabricated in factory as per nomenclature of the item and directions of the Engineer-in-charge.

9.20.2 Fixing of Frames

As per clause 9.18.2.

9.20.3 Measurements

As per clause 9.18.3.

9.20.4 Rate

As per clause 9.18.4.

9.21 PANEL PVC DOOR SHUTTER

9.21.1 Panel PVC Shutters are factory made shutter and shall be brought to site fully assembled. The Solid Panel PVC Door shall be fabricated from 5 mm PVC sheet. The sheets used may be in plain colour, printed design or prelam veneer shade as approved by the Engineer-in -Charge. The shutters shall be fabricated at factory as per nomenclature of the item and directions of the Engineer-in-charge.

(a) 30 mm thick panel PVC door shutters (Figure 9.22).

9.21.2 Sampling and Criteria for Conformity

As per clause 9.19.3.

9.21.3 Tests

As per clause 9.19.4 except para (k), (l) & (m).

9.21.4 Fixing of Shutters

As per clause 9.19.5. In addition, it may be ensured that while fixing hinges the screws pass through the two opposites surfaces of the M.S. reinforcement.

9.21.5 Tolerance

As per clause 9.19.6.

9.21.6 Fittings

As per clause 9.19.7.

9.21.7 Measurements

As per clause 9.19.8.

9.21.8 Rate

As per clause 9.19.9.

9.22 FIBRE GLASS REINFORCED PLASTIC (FRP) DOOR FRAMES

9.22.0 Door Frames shall be three legged of cross section 90 mm x 45 mm having single rebate of size 32 mm x 15 mm to receive shutter of 30 mm thickness. The frame shall be made of laminate of thickness of 2 mm and shall be filled with wooden blocks of exterior grade MDF or seasoned and treated hard wood inside the laminate in all the three legs of the frame. The frame to be moulded by either hand lay up or resin transfer moulding process. The process shall consist of laying gelcoat at 1000 gms./m^2 and laid over with layer of FRP Mat (CSM mat) gelcoat and FRP (CSM Mat) are defined in IS 14856. The CSM mat shall be bonded with Isophatholic resin in the ratio not less than 1:2 (One part of Mat to two parts of Isopathlic resin and fillers & additives) by weight. The edge shall be sealed with gelcoat and FRP mat to obtain smooth finish. Sufficient roving shall be laid in the corner to have smooth curve while laying the CSM mat. (Fig. 9.23).

9.22.1 FRP door shall be manufcturred as per specifications laid down in IS 14856, nomenclature of items & direction of Engineer-in-Charge.

9.22.2 Tolerance

Tolerance of size of frame to be $\pm$ 2 mm and on size of rebate to be + 1 mm.

9.22.3 Finish

The surface of the moulded frame shall be free from any visible defects such as small pores, crazing, blistering, wrinkling, impurities, defective impregration, colour blots and aggregate defects, as mentioned in IS 14856. Scattered pin holes duly repaired and finished by applying resin and not noticeable shall be acceptable. Frame laminate shall be flat and shall have smooth and level surface. Laminate shall be finished in colour & shade as approved by Engineer-in-Charge.

9.22.4 Fixing of Frame

As per clause 9.18.2.

9.22.5 Measurement

As per clause 9.18.3.

9.22.6 Rate

As per clause 9.18.4.

9.23 FIBRE GLASS REINFORCED PLASTIC (F.R.P.) SHUTTERS

9.23.1 F.R.P. Shutters shall be manufactured conforming to the specifications as per IS 14856 and nomenclature of item & direction of Engineer-in-Charge. (Fig. 9.24A & 9.24B).

9.23.2 Blocks of any seasoned hardwood of bulk density not less than 450 kg./m^3 at 12 per cent moisture content or any other material of sufficient thickness and length shall be provided inside the shutter at suitable place to hold fittings and fixtures such as aldrops, tower bolt, handle, sliding door bolt, mortice lock etc. Blocks for hinges shall be provided at three locations, unless otherwise specified by the purchaser. One at the centre and other two at 200 mm from the top and the bottom of the shutter. Blocks shall be provided at predetermined places in the shutter so as to fix hinges mortice locks, tower bolts, aldrops, door closures, etc. The finished surface shall be buffed and polished with wax.

9.23.3 Location of Fittings and Accessories

The lock rail of door shutters shall be so placed that is centre line is at a height 850 + 5 mm from the bottom of the shutter. Door shutter shall be fixed to the frame with three hinges, unless otherwise specified by the purchaser, of the type specified. These locations shall be, one at centre and other two at 200 mm from the top and the bottom of the shutter, where blocks have already been provided and suitable indication by depressing the profile has been made. Screws for fixing the hinges shall be screwed in with screwdrivers & not hammered. The length of screw should be 8/30 mm. The hinges used shall be stainless steel or aluminum.

9.23.4 Sampling & Criteria for Conformity Shall be as per clause 9.19.3.

9.23.5 Finish

As per clause 9.22.3.

9.23.6 Tests

As per para 9.19.4 except clause (j), (k), (l) & (m).

9.23.7 Fixing of Shutter

As per clause 9.19.5.

9.23.8 Tolerance

As per clause 9.19.6.

9.23.9 Measurement

As per clause 9.19.8.

9.23.10 Rate

As per clause 9.19.9.

9.24 SOLID PVC FOAM PROFILE DOORS

9.24.1 Solid PVC Foam Profile Frame

Solid PVC foam profile frame doors are made from solid PVC foam profiles 60 x 30 mm with integral skin cut to required size. Doors are provided with naturally strong stiffener frame and sandwich panelled to offer sound and heat insulation with pressure laminate/infill panel to provide scratch resistance surface. (Fig. 9.25). Supporting bar at bottom side of frame shall be provided for maintaining frame in plumb. The frame shall be fabricated in factory as per nomenclature of the item and directions of the Engineer-in-charge. PVC door frame should have shore hardness more than 70.

9.24.2 Fixing of Frames

As per para 9.18.2.

9.24.3 Test in PVC Foam Profiles

Tests on PVC Foam Profiles shall be as per Table 9.24 below:

TABLE 9.24

Sl. No.	*Property*	*Test Method*	*Unit*	*Acceptable Value*
1	Density (at 27°C)	ASTM D 792	gm/cc	0.5-0.7
2	(a) Tensile strength at yield	ASTM D 638	PSI %	2000
	(b) Elongation at Break	ASTM D 638		20
3	Tensile Modulus (Modulus of Elasticity)	ASTM D 638	N/Sq.mm	200
4	Impact strength (charpy Unnotched)	ASTM D 256	ftlb/sq.In	7
5	Durometer Hardness	DIN 53505	Shore D	70
6	Vicat Softening Point (at 10N Load)	ASTM D 1525	C	75
7	Flammability	UL 94		Self Extinguishing

9.24.4 Measurements

As per clause 9.18.3.

9.24.5 Rate

As per clause 9.18.4.

9.25 SOLID PVC FOAM SHUTTERS

Solid PVC foam shutters are made from solid PVC foam profiles with integral skin. Doors are provided with naturally strong stiffener frame and sandwich panelled to offer sound and heat insulation with pressure laminate/infill panel provides scratch resistance surface. Door shutters can be nailed, screwed, drilled, glued, sawn lapped or welded just like wood and characterized by excellent screw holding strength (200 kgf.).

9.25.1 28 mm Thick Door Shutters

Profile is cut in required length to make vertical & horizontal stile. Mitered cut joint are made using solvent based PVC adhesive & epoxy solvent. GI 'C' stiffner 39 x 19 x 19 or 40 x 20 x 19g. M.S. Pipe is fixed in the grooves made in frame. Telescopic polymeric corners are provided at corners for better rigidity. Infill panel 3 mm thick HPL sheet is fixed with csk screws of required size to the profile frame as specified. Mirror image of shutter frame is joined using solvent based PVC adhesive as well as csk type sheet metal screws of required size at four corners at top & bottom. Additional bonding strength is provided by using silicone sealant epoxy sealant at joints. Lock rail is provided by using PVC profile & 'C' type GI stiffener 40 x 10 in the groove & fixed with adhesive to frame & infill. Decorative corner moulding is fixed to impart elegant look. (Fig. 9.26)

The fabrication shall be done in factory as per nomenclature of the item and directions of Engineer-in-Charge.

9.25.2 Sampling and Criteria for conformity
As per clause 9.19.3.

9.25.3 Tests
As per clause 9.19.4.

9.25.4 Fixing of Shutters
As per clause 9.19.5.

9.25.5 Tolerance
As per clause 9.19.6.

9.25.6 Fittings
As per clause 9.19.7.

9.24.7 Measurements
As per clause 9.19.8.

9.24.8 Rate
As per clause 9.19.9.

9.26 FACTORY MADE FIBRE GLASS REINFORCED PLASTIC CHAJJA

9.26.1 F.R.P. chajja shall be 4 mm thick of required colour/size, design and drawing as approved. The chaja shall have smooth gradual slope curvature for easy drainage of water & shall be factory manufactured as per nomenclature of item & directions of Engineer-in-Charge. (Fig. 9.27).

9.26.2 Material
(1) Glass Fibre (chopped strand mat) shall be as per IS 11551
(2) Unsaturated Polyester Resin shall be as per IS 6746
(3) Surface Burning Characteristics of Building Material – ASTM E 84-77a
(4) Unsaturated Polyester Resin Gel coat shall be as per IS 6746
(5) Curing Agents – Cobalt Napthanate and MEKP
(6) Test of products – IS 14425
(7) Glass Fiber Roving – IS 11320

The F.R.P. chajja laminate shall be water and chemical resistant and shall have very high transit strength to weight ratio and high modulus of elasticity, good textile processing and excellent fiber reinforcement properties. The laminate shall have low coefficient of thermal expansion and a high thermal conductivity and high dielectric constants. The F.R.P. laminate shall be diversionally stable, shall have moisture and corrosion resistance.

9.26.3 Tolerance
Tolerance of $\pm$ 10 mm in overall size of FRP chajja is permissible.

9.26.4 Finish
The F.R.P. laminate to be finished with polyurathene based or equivalent paint as final coat or gloss or mat followed by clear lacquer coat to get the shine of required shade.

9.26.5 Tests
Frequency of tests as per direction of Engineer-in-Charge & tests to be conducted as per para 9.19.4.

9.26.6 Measurement and Rate
The width and length to be measured in centimetres and area to be calculated as square metre correct upto two places of decimal. The rate includes cost of all the materials, labour scaffolding, fittings & fixing upto all heights etc. involved in operations described above, but excludes the cost of paint.

9.27 WALL PANELLING (Fig. 9.28)
All specification same as per clauses 9.17.1 to 9.17.7.

9.28 uPVC CASEMENT/SLIDING WINDOW & DOOR

9.28.1 Material

uPVC (un-plasticised polyvinyl chloride) is PVC resin blended with acrylic modifier, titanium dioxide and other chemicals. Then it is processed through machine and mould to produce required uPVC multi-chambered profiles.

The factory made uPVC white colour doors and windows shall be comprising of approved uPVC make multi-chambered frames, sash and mullion duly reinforced with appropriate thickness of galvanised iron section of required length, an appropriate dimension of uPVC glazing beads, EPDM gasket according to frame/sash profile and specified hardware and fittings of approved make having dimensions as per nomenclature of items. There are two type of uPVC extruded profile series which are used depending upon the size and design of window/door and wind load consideration and the agency shall also provide wind load calculation sheet duly approved by the Engineer-in-Charge as per IS 875 (Part-3) namely **Small Series** (small depth dimension) having wall thickness of 1.9±0.2 mm and **Big Series** (big depth dimension) having wall thickness of 2.3±0.2 mm of uPVC main profile i.e frame. Depth and width of the profile mentioned in the nomenclature of the item is as following.

(i) Depth of a profile (D)- Dimension which is measured at right angles to the glazing plane, between the front and back face surfaces of a profile.

(ii) Width of a profile (W)-Dimension, measured in the direction of the glazing plane, and perpendicular to the longitudinal axis of the profile.

Note :

(i) Profile size mentioned in the Delhi Schedule of Rate are in Depth (Base of Frame) x width format (visible elevation)

(ii) For building it is a must to use big series above 5th floor.

(iii) All uPVC profiles should be got approved by Engineer-in-charge before fixing at site of work.

9.28.1.1 Tolerance in profile dimension

For uPVC frame, sash and mullion extruded profile minus 5 % tolerance in dimension. i.e in depth and width of profile shall be accepted. Variation in profile dimension in higher side shall be accepted but no extra payment on this account shall be made.

9.28.2 Terminology

(a) Frame
Non movable or fixed portion of the window/door attached to the wall and to which the sash is assembled.

(b) Sash
Movable part in a window/door.

(c) Glazing Bead
Profile which holds the glass or any other partition materials.

(d) Transom (or Mullion)
Profile used within the frame, vertically or horizontally in a frame and/ or sash.

9.28.3 Marking

uPVC profiles shall be legibly and visibly marked in an unobtrusive position not visible when the window is closed at least once every one meter along the length of the profile and it should be visible when the window is open as well as shall contain the following minimum information on the main profile such as frame, sash and mullion/transom.

(i) The name of the trade mark or brand name of the manufacturer

(ii) Date of manufacturing and profile code

9.28.4 Testing (Criteria for conformity)

The uPVC extruded hollow profiles use in window and doors shall conform to the specification as per **EN 12608** and other standards as mentioned below:

S.No.	Name of the test	Test Method	Specified Parameter
1	Vicat Softening Temperature	EN ISO – 306	Shall not be < 75^0C
2	Charpy Impact Strength	EN ISO – 179-2	Shall not be < 20KJ/m^2
3	Flexural Modulus Elasticity	EN ISO – 178	Shall not be < 2200 N/mm^2
4	Tensile Impact Strength	EN ISO – 8256	Shall not be < 600 KJ/m^2
5	Mean Breaking Stress for welded corner		
	(a) For the tensile bending test	EN – 514	Shall not be < 25 N/mm^2
	(b) For the compression bending test		Shall not be < 30N/mm^2
6	Heat Reversion Test	IS:4985-2000	Shall not be > 2.0 %
7	Surface Spread of flame	BS : 476 - Part 7	Classification 1
8	Ignitability Evaluation	BS : 476 - Part 5	'P' Not easily ignitable
9	Tensile modulus	ASTM D 638	Shall not be < 35 MPa
10	Shear Modulus	ASTM D 732	Shall not be < 220 MPa
11	Tensile Strength	EN ISO 527	Shall not be < 30 MPa

For the determination of the weld ability of profiles, welded corners shall be tested for tests as mentioned above. The sample subjected to weld test shall not be finished by grooving and knifing etc. except for the outside edge of 90 degree angle, which shall be cleaned to permit the sample to sit fully on to the support.

Minimum percentage of **titanium dioxide** content in uPVC profiles shall not be less than **7.00 percent** and **calcium carbonate** content shall not be more than **10.00 percent**.

The uPVC casement / fixed / sliding windows and doors shall be factory fabricated by the approved manufacturer and installation work shall be carried out by them or their authorised vendor duly approved by the Engineer - in -charge.

9.28.5 Configuration

Indicative size and configuration of window& door (Casement/ sliding) are given in figure 9.29 to 9.38. In case a new configuration is to be provided, same shall be specified in the item and figure included in the tender document.

9.28.6 Fabrication

(i) According to the drawing, the required dimension and length of uPVC frame, sash and mullion profiles shall be mitred cut and reinforced with galvanised iron section of required length and thickness.

(ii) All frame and sash profiles of door and window shall be fusion welded at all corners. Mullion and Transom profiles shall also be fusion welded as per window / door design so as to prevent any ingress of water or air in the reinforcement chamber.

(i) Each corner and joints shall be neatly cleaned by removing all excess material. The weld shall be finished by grooving, knifing etc. at exposed welded portion only.

(iv) The minimum overlap of 6 mm shall be provided on frame and mullion to ensure effective seal between the sash and frame.

(v) The window / door shall be designed and provided water drainage/ventilation slots in profile of frame, sash, transom or mullion in order to permit the escape of entrapped water, moisture from the system. A minimum of 2 nos slots shall be provided at least at every 500 mm. The drainage shall be so designed as not to puncture the reinforcement chamber and prevent water running through the reinforcement chamber. The holes and slots shall offset between the inner and outer walls so as to prevent any back flow.

9.28.7 Reinforcement

(i) The reinforcement material should be non-hygroscopic and should have no adverse effect of the performance of the window/door and it shall confirm to any grade of IS 1079 or IS 513.

(ii) Mild steel section reinforcement made from Roll forming process and shall be hot dip zinc galvanised in accordance with IS 277 with a minimum coating mass of 120 gm/sqm.

(iii) The thickness of reinforcement shall be as such that the uPVC window and doors meet the design wind pressure in accordance with IS 875 (Part-3) and design of the reinforcement should be as per uPVC profile manufacturer recommendation and fix to ensure adequate fastener retention.

(iv) Galvanised mild steel reinforcement section is to be inserted in uPVC frame, sash and mullion profile of required length with in 6 to 15 mm distance from the face of the weld and then shall be screwed at 150mm from the end at every 400 mm (maximum) pitch to uPVC profile so that it does not move or rattle.

(v) Galvanised mild steel reinforcement section thickness shall be changed according to floor level keeping in consideration of wind load factor and minimum thickness should be as below :

(a)	From ground floor upto floor 5th level	=	1.60±0.2 mm
(b)	From floor 5th level onwards	=	2.20±0.2 mm

9.28.8 Glazing

(i) After fusion welding and cleaning of the corner of the sash prescribed glass panes shall be placed after fitting EPDM gasket and uPVC beading of approved quality and make.

(ii) Window sash shall be made in such a way that glazing or re-glazing is possible at site without the need to remove the outer frame.

(iii) The plastic spacer shall be used to provide to support the glass in sash/frame.

(iv) The following glass thickness shall be used in uPVC windows and doors but in no case less than 4mm.

(a)	For single glazing	-	4 to 6mm
(b)	For double glazing	-	20 mm or 24mm

Glazing supports shall be provided on frame or sash in order to distribute the load of the glass and to place the glass in the frame or sash. Spacers that would provide supports to the glass in the frame or sash shall be installed after the glazing support are installed. The supports and spacers shall be so placed as not block the drainage holes/slots.

9.28.9 Glazing gasket & Weather pile strip/ Wool pile

(i) Material for glazing gaskets shall be of EPDM (Ethylene propylene diene monomer) and shall be used on both side of glass panes in uPVC sash and glazing bead profiles.

(ii) Weather pile strip / Wool pile shall be used in uPVC sliding door and window to reduce air filtration and water penetration.

9.28.10 Window / Door Hardware and Fittings

Materials for all hardware except for fixing shall have at least the equivalent corrosion resistance of EN 1670-1988 grade 4 (240 hrs) when subjected to natural salt spray testing in accordance with EN ISO 9227. Testing shall be carried out on complete hardware items and also duly approved by the Engineer - in - charge before use at the site of work.

Hardware like hinges, rollers and locking devices which have been life cycle tested in accordance with EN 199 (Windows and Doors - Resistance to repeated opening and closing - Test method) and have achieved at least 10,000 operating cycles (i.e. opening and closing) without deterioration, failure or excessive wear.

These shall be provided as per nomenclature of item of approved make and duly approved by Engineer-in-Charge before fixing at site of work. Hardware / fittings such as handle, roller, touch lock, multipoint locking, 3D hinges, friction hinges etc. shall be directly screwed not pre-drilled or hammered.

9.28.10.1 For Casement windows

Approved quality stainless steel friction hinges (SS 304 grade) with SS screws shall be provided as per nomenclature of item and length of friction hinges should cover more than 60 percent width of the shutter and two number friction hinges required for each shutter one at top and one at bottom.

9.28.10.2 For Casement doors

Minimum three numbers of approved quality 3D hinges with necessary SS screws shall be provided in the casement door shutter up to 0.90 meter in width and 2.10 meter in height, for more than 2.10 metre height minimum four numbers 3D hinges to be used.

9.28.10.3 For Sliding windows/doors

(i) One pair of zinc alloy body with single nylon roller (weight bearing capacity to be 40 kg) upto 1.50m window height dimension and one pair stainless steel (SS 304 grade) body with adjustable double nylon roller (weight bearing capacity to be 120kg) above 1.50 m window height dimension of approved quality to each shutter of window shall be provided.

(ii) One pair of adjustable double nylon roller of approved quality to each shutter of door shall be provided.

(iii) In case of wire mesh, stainless steel fly proof wire mesh shall be provided as per nomenclature of item of approved make and manufactures duly approved by the Engineer-in-charge before fixing at site of work. SS wire mesh must be in the first track of the three track frame from the interior field of vision and that SS wire mesh must be fixed with EPDM gasket in a sash profile as the glass sash profile.

9.28.11 Tolerance

The tolerance in dimensions of finished window / door in size shall not be more than $\pm$ 5mm from the approved drawing dimension.

9.28.12 Installation

(i) There shall be a maximum gap of 3 to 5mm in between uPVC door / window frame and finished opening and the plastic packers shall be provided to maintain the level.

(ii) To maintain the exact dimension of door or window, the opening shall be checked for dimension and orthogonally using a prefabricated template. Any defect shall be made good by the agency at his own cost before fixing of door or window**.**

(iii) The uPVC frames are to be fixed in prepared opening in the walls. Window / door frame shall be fixed into the aperture by drilling through the outer frame to the existing structure and shall use 100x8mm fasteners of approved make.

(iv) The gap between uPVC window / door and adjacent RCC/Brick/Stone cladding work shall be filled with weatherproof Silicon sealant of approved make to maximum 5mm depth and 5mmin width to allow expansion/contraction of uPVC profiles. Silicon sealant of matching colour of uPVC profile shall be applied over backer rod.

9.28.13 Precautions taken before installation of uPVC Window &Door

(i) Jambs, sills and soffits of the opening shall be finished with plaster / stone / tiles according to agreement where uPVC window / door to be fixed.

(ii) Aperture shall be smooth in line and level as well as in plumb.

(iii) Flooring (where casement door is to be installed should be complete before installation of door).

(iv) The grill where to be installed in sliding / casement window should be provided after the installation of window.

(a) For sliding window – The grill shall be provided on the outer face of window.

(b) For casement window – The grill shall be provided on the inner face of window.

(v) Installation of uPVC door and window should be done before the last coat of the paint on the wall where window jambs, sills and soffits to be finished by paint. Atleast one coat of paint should be done before installation begins.

(vi) The colour of the profile shall be same and uniform on any surfaces or part of the surfaces which may be visible after installation of the window/door fabricated from the profile, when viewed by the normal vision.

(vii) The uPVC profiles manufacturer shall provide warranty of 10 years for colour fastness and any manufacturing defects in respect of uPVC profiles as well as water and air tightness in case of casement uPVC door/window unit.

(viii) uPVC door/windows hardware and fittings manufacturer shall provide warranty of 10 years for any manufacturing defects.

9.28.14 Mode of Measurement

The length and width of the window / door shall be measured from outer to outer face of the uPVC frame correct to a centimetre. Area shall be calculated in square meter nearest to 0.01 square metres.

9.28.15 Rate

The rate includes the cost of all labour, material and T&P involved in all the operations described above at all heights of the building. The cost of glass panes, wire mesh and silicon sealant shall be paid separately.

9.28A HARDWARE FITTINGS FOR UPVC DOORS & WINDOWS

9.28A.1 Hardware fittings such as zinc alloyed white powder coated casement handles, touch lock, steel roller, steel crescent lock (white powder coated) for uPVC doors/windows shall be of approved brand/make, size and manufacturer as described in nomenclature of item complete as per direction of Engineer-in-Charge.

9.28A.2 Measurement

uPVC doors & windows hardware fittings shall be measured in numbers.

9.28A.3 Rate

Rate shall include all the material and operation as described in the nomenclature of item.

9.29 FIRE RESISTANT GLAZED DOORS, WINDOWS & PARTITIONS

9.29.1 GENERAL

The Fire resistant Glazed Doors (hereinafter termed as FRGD), Fire resistant Glazed windows (hereinafter termed as FRGW) and Fire Resistant Glazed Partition (hereinafter termed as FRGP) shall not collapse during the rated period of fire under the specified fire conditions and shall provide safe access to the escape route.

9.29.2 CODES & SPECIFICATIONS

All materials, items, hardware etc. shall be subjected to approval by Engineer-In-Charge. Necessary documentation/ test certificates shall be furnished by the Contractor from the manufacturer before supply of material for approval by Engineer-in-charge. Each Door/Window and Partition shall be provided with a small metal identification plate in suitable location indicating Fire rating, name of the Manufacturer, date of installation and details of approved test house. Each Glazing pane shall carry a permanent stamp of the manufacturer.

The complete assembly of the doors i.e. frame, shutter, vision glass and hardware shall have fire rating as required and shall confirm to:

1. EN 1634-1	Fire resistance and smoke control tests for door and shutter assemblies, openable windows and elements of building hardware - Part 1: Fire resistance test for door and shutter assemblies and openable windows
2. EN 1364-1	Fire resistance tests for non-load bearing elements – Part 1: Walls
3. EN 410	Determination of luminous and solar characteristics of glazing.
4. EN 12600	Glass in Buildings – Pendulum test – Impact test and classification for flat glass

9.29.3 TESTING AND CERTIFICATION

The FRGD, FRGW & FRGP shall be supplemented with appropriate certification by fire test lab, for applicable or higher dimension with complete description of the architectural components and hardware for FRGD, FRGW and FRGP for which the approval is given. Along with the material tests, the complete system along with the framing shall be tested in accordance with the criteria of EN1634-1 for door/window and EN1364-1 for partition. The installation of the fire rated system shall confirm to requirement of test evidence. The choice of hardware and/or glazed accessories shall be as per test evidence.

9.29.4 Fire Resistant Doors/Windows and Partitions

9.29.4.1 Frame for Fire Resistant Glazed Door / Windows

Frame for Door/Window of 120 min fire rating shall be made of section 50 x 60 mm on horizontal side & 35 x 60 mm on vertical sides having built in rebate made out of 1.6 mm thick GI sheet (Zinc coating not less than 120gm/m^2) suitable for mounting 120 min Fire Rated Glazed Door Shutters. The frame shall be filled with Mineral wool Insulation having density min 96Kg/m^3 . The frame will have a provision of G.I. Anchor fastners 14 nos (5 each on vertical style & 4 on horizontal style of size M10 x 80) suitable for fixing in the opening along with Factory made Template for SS Ball Bearing Hinges of Size 100x89x3mm for fixing of fire rated glazed shutter . The frame shall be finished with a approved fire resistant primer or Powder coating of not less than 30 micron in desired shade as per the directions of Engineer - in- charge . (Cost of SS ball bearing hinges is excluded).

9.29.4.2 Frame for Fire Resistant Glazed Partitions

Frame for non load bearing fixed fire resistant glazed Partition for 120 min Fire Rating shall be made out to a profile of dimension 60mm x 70 mm of 1.6 mm thick galvanised steel sheet as per test evidence suitable for fixing fire rated glass for 120 min of both integrity & radiation control (EW120) & minimum 15 min of insulation (EI15).The profile has to be fixed to the supporting construction by means of anchor fasteners of size M10 x 80, every 150 mm from the edges and every 500 mm (approx) c/c. The frame shall be filled with mineral wool insulation of density min 96kg/m^3. and finished with a approved fire resistant primer or Powder coating of not less than 30 micron in desired shade as per the directions of Engineer - in- charge .

9.29.4.3 Shutter for Fire Resistant Doors/Windows

Glazed fire resistant door shutters 60 mm thick of 120 min Fire Rating shall be confirming to IS:3614 (Part II) or EN1634-1:1999, tested and certified as per laboratory approved by Engineer-in-charge, with suitable mounting on door frame, consisting of vertical styles, top rail & side rail 60 mm x 60 mm wide and bottom rail of 110 mm x 60 mm made out of 1.6mm thick G.I. sheet (zinc coating not less than 120gm/m^2) duly filled mineral wool insulation having density min 96 kg/m^3 and fixing with necessary stainless steel ball bearing hinges of size 100x89x3mm of approved make, including applying a coat of approved fire resistant primer or powder coating not less than 30 micron etc all complete as per direction of Engineer-in-charge (panelling to be paid for separately).

9.29.4.4 Fire Resistant Glass for Doors/Windows and Partitions

Glazing to be fixed in fire resistant doors/window shutters and fixed Partitions with G.I. beading made out of 1.6 mm thick G.I. sheet (zinc coating not less than 120 gm/m^2) of size 20 x 33 mm screwed with M4 x 38 mm SS screws at distance 75 mm from the edges and 150 mm c/c , including applying a coat of approved fire resistant primer/powder coating of not less than 30 micron on G.I. beading, & special ceramic tape of 5 x 20 mm size etc complete in all respect as per direction of Engineer-in-charge. The glass should be clear, toughened, interlayered, non-wired fire resistant having 11 mm minimum thickness of approved brand with 120 minutes of fire resistance both integrity & radiation control (EW120) and minimum 15 min of insulation (EI15) and having a sound reduction of more than 35dB and LT of 85%. Glass shall be compliant to class 2B2/1B1 category of Impact Resistance as per EN 12600. The glass should be manufactured in UL & TUV audited Facility and

including UL-EU Certification. The maximum glazing size cannot be more than 1100 mm x 2200 mm (w x h) or 2.42 sq mts in total area. The test report for the complete system (Glazed Door or Partition) will be considered valid only if it contains the stamp and signature of the authorized signatory from the glass manufacturer. (Actual glass size is to be measured at site for payments).

The complete assembly shall satisfy the given criteria of fire resistance - stability, fire integrity, radiation control and insulation as per above mentioned rating required.

9.29.5 Vision Panel For FRD

9.29.5.1 Vision Panel for Fire Door

Specifications for glass for Vision panels for Fire Rated Door shall be as per para C above. Minimum size of glass to be used for vision panels shall not be less than 350 mm x 350 mm.

9.29.6 DELIVERABLES BY THE CONTRACTOR

Following documentation/ drawings shall be furnished along with the Doors/window/partition.

(1) Prototype Test Certificate by national/international test house

(2) Shop drawings

(3) Specification/ Manufacturer's literature, Test certificates and other documentation for materials and items intended to be used.

(4) Certificate indicating that design and installation of Doors and hardware conforms to norm laid down by approved national/international test house.

(5) Test report to be attested by Fire rated glass manufacturer.

(6) The Fire rated glass applicator has to be approved by Fire rated Glass Manufacturer has to Submit the approved applicator certificate.

9.29.7 Measurements

9.29.7.1 Measurement of frame for door/window/partition

The outer length of the vertical and horizontal members of fire rated door/window frame shall be measured in running metres including embedded length in floor upto two decimal places.

The outer length of the vertical and horizontal members of fire rated partition frame shall be measured in running metres upto two decimal places.

9.29.7.2 Measurement of shutter for door/window

Length and width of the shutters shall be measured to the nearest cm in closed position covering the rebates of the frames but excluding the gap between the shutter and the frame. Area is calculated to the nearest 0.01 sqm.

9.29.8 Rate

The rate of frame includes the cost of the materials and labour involved in all the operations. The cost of SS ball bearing hinges and any other hardware which may be required, shall be paid for separately.

The specified rate for door/window shutter include the cost of the door/window shutter and labour involved in fixing of the shutter. Fittings, fixtures and paneling on the door shutter except hinges & screws shall be paid extra as provided.

9.30 NICKEL PLATED M.S. PIPE CURTAIN ROD WITH NICKEL PLATED M.S. BRACKETS :

9.30.1 20 MM DIA (HEAVY TYPE)

9.30.1.1 Materials

The nickel plated M.S. pipe for curtain rod (20 mm dia) shall be C.R. circular tube confirming to BIS code IS 1161-2014 of outer dia 20 mm, min. 1.25 mm thickness and weighing not less than 0.62 Kg/m. These pipe shall be coated with min. 20 microns nickel plating conforming to IS code 12393-1988.

Brackets for curtain rods are of two types (i) Flat type to be fixed at sideways (if door window opening are in corners) and (ii) Angle type (to be fixed just above openings of door/windows on wall away from corners).

These brackets are made of 1.25 mm thick strip and same grade of nickel plating. The weight of flat bracket shall not be less than 38 gms each piece and the weight of angle bracket shall not be less than 70 gms each.

Tolerances in thickness of CR strips for pipes may be (-) 0.05 mm and tolerance in weights may be specified weight as above (-) 10 gms/meter.

9.30.1.2 Fixing of curtain rods:-

For fixing the curtain rods, M.S. curtain pipe should be cut 30 cm longer than the door/window opening length. The pipe shall be cut and placed 15 cm above the finished soffit line. Positions of bracket holes are marked on lintle top/wall. Drilling the holes, fixing of brackets shall be done with PVC/polystyrene split expendable rawl plugs and 40 mm long fully threaded CSK headed screws.

9.30.1.3 Measurements

The running meter length of M.S. curtain rod only shall be measured correct to a centimeter.

9.30.1.4 Rates

It includes the cost of labour and all materials required for all the operations described above.

9.30.2 25 MM DIA (HEAVY TYPE)

9.30.2.1 Materials

The nickel plated M.S. pipe for curtain rod (25 mm dia) shall be C.R. circular tube confirming to BIS code IS 1161-2014 of outer dia 25 mm, min. 1.25 mm thickness and weighing not less than 0.77 Kg/m. These pipe shall be coated with min. 20 microns nickel plating conforming to IS code 12393-1988.

Brackets for curtain rods are of two types (i) Flat type to be fixed sideways (if door window opening are in corners) and (ii) Angle type (to be fixed just above openings of door/windows on wall away from corners). These brackets are made of 1.25 mm thick strip and same grade of nickel plating. The weight of flat bracket shall not be less than 50 gms each piece and the weight of angle bracket shall not be less than 85 gms each.

Tolerances in thickness of CR strips for pipes may be **(-)** 0.05 mm and tolerance in weights may be specified weight as above (-) 10 gms/meter**.**

9.30.2.2 Fixing of curtain rods:-

For fixing the curtain rods, M.S. curtain pipe should be cut 30 cm longer than the door/window opening length. The pipe shall be cut and placed 15 cm above the finished soffit line. Positions of bracket holes are marked on lintle top/wall. Drilling the holes, fixing of brackets shall be done with PVC/polystyrene split expendable rawl plugs and 40 mm long fully threaded CSK headed screws.

9.30.2.3 Measurements
The running meter length of M.S. curtain rod only shall be measured correct to a centimeter.

9.30.2.4 Rates
It includes the cost of labour and all materials required for all the operations described above.

9.31 M.S. GRILLS OF REQUIRED PATTERN IN FRAMES OF WINDOWS ETC. WITH M.S. FLATS, SQUARE OR ROUND BARS ETC. INCLUDING PRIMING COAT

9.31.1 FIXED TO STEEL WINDOWS BY WELDING.
9.31.1.1 Materials
The M.S. grill of required pattern/ as per drawing is made out of M.S. flats , square bars/ round bars of size as decided by engineer-in-charge or as per drawing by welding. The horizontal or vertical spacing of member should normally be 10 cm c/c or closer as per requirement. The steel including its grading should be as mentioned in 10.1.1 and the tolerances in weight shall be as mentioned in Table 10.3

9.31.1.2 Fabrication
Fabrication of grills shall conform to 10.3.2 (as specified in IS 800).

9.31.1.3 Fixing & installation to the steel window frame
The M.S. grill of require pattern as fabricated shall be properly welded to the sectional steel window frame with minimum 2 cm each weld length @ 10 to 12 cm c/c around the perimeter and on intermediate member of window if any. Priming coat with red oxide primer to grill must be done conforming to specifications of item no. 13.50.3 of CPWD specifications 2019 Vol. II.

9.31.1.4 Measurement
The mode of measurement shall be the same as specified in 10.2.4. The weight of welding materials shall not be added in the weight of members for payments.

9.31.1.5 Rates
The Rate is inclusive of cost of materials and labour i/c welding materials and labour for fixing all complete as described above.

9.31.2 FIXED TO OPENING/WOODEN FRAMES WITH RAWL PLUGS SCREWS ETC.
9.31.2.1 Specifications for this item are same as item No 9.31.1 with the only difference of fixing arrangement. For fixing this type of grill in a bare opening, the grill in opening (for perfectly plum and true level) shall be fixed by making holes of 6 mm dia by drilling in brick/concrete and fixing shall be done using PVC or polystyrene rawl plugs of size 6 mm dia & 50 mm long and with 50 mm size sunken headed steel Screws all complete as per directions of Engineer-in-Charge.

Alternately, if this type of grill is to be fixed to wooden frame of windows using 50 mm size sunken headed steel Screws all complete as per directions of Engineer-in-Charge.

9.31.2.2 Measurement:- Similar to item no. 9.48.1 above.

9.31.2.3 Rates:- Similar to item no. 9.48.1 above.

9.32 BAMBOO JAFFERY/ FENCING
9.32.1 Material
Bamboo sticks of required lengths upto 2.10 mm selected from the bundles, straight with least nos. of knots and average 25 mm dia with brown/dark yellow fully dried (not green soft bamboo) to be sorted out, split into two halfs each and cut to even lengths. Hollock wood battens of X-section 50 x 25 mm out of fully kiln-seasoned sleepers are to be cut out, properly planed and smoothened and sharp edges chamfered. Each 2.10 m high panel of bamboo fencing shall have minimum 3 nos. parallel battens across the height of fencing panel.

9.32.2 Making of bamboo fencing panel

Selected half cut bamboo battens of even length are placed over, 3 nos. hollock wood battens (kiln seasoned and chemically treated) placed equidistant with 20 cm, from the edges of fencing (top & bottom), M.S. nails M-3 size 75 mm long along with 1 mm thick 10 mm dia G.I. washers are hammered in upto bottom face of battens then the whole panel is turned upside down and then again hammering is done on the either side nail tip, once the nail tip ejects out of battens these are bent sideways into battens and to complete neatly as per direction of Engineer-in-Charge.

9.32.3 Priming coat

Pink wood primer shall be applied on either face of Bamboo fencing panel before fixing. (Specification same as that of item no. 13.50.1). This item is payable separately.

9.32.4 Fixing of bamboo fencing panel

Bamboo fencing panel of required height and required width are fixed to pre-existing angle iron posts of G.I. barbed wire/chain link/IRC fabric fencing or M.S. grills by properly tying with G.I. binding wire atleast three ties on each post. Bottom edges of bamboo fencing shall not rest directly on soil bed, but appropriately a minimum 150 mm high brick work base is necessary for longer life of bamboo fencing. (Brick work edging shall be payable separately under respective item.)

9.32.5 Measurement

Visible flat area of bamboo fencing i.e. length and height shall be measured correct to a cm and area shall be calculated up to two places of decimal.

9.32.6 Rates

The Rate includes the cost of materials like half cut bamboo sticks, hollock wood battens, nails with washers and G.I. binding wire and the labour involved in the operations described above.

9.33 WOODEN MOULDED CORNER BEADING OF TRIANGULAR SHAPE.

9.33.1 50X50 MM (BASE AND HEIGHT)

9.33.1.1 Materials

2nd class teak wood or as specified shall be sawn/cut in the direction of the grains to the required size of corner beading of triangular shape. Sawing/ cutting shall be truly straight and in shape.

9.33.1.2 Fixing

The moulded corner beading shall be fixed with headless nails to the base frame. No joint shall be permitted in one dimension of 2.50 meter. The joint shall be mitred in length as well as at corners.

9.33.1.3 Measurements

The length of the beading shall be measured along the side correct to a centimeter.

9.33.1.4 Rate

It includes the cost of labour and materials involved in all the operations described above including fixing complete.

9.34 MAGNETIC CATCHERS

Magnetic catchers for kitchen cabinets and cup-boards can be of slightly different sizes by different manufacturers with varied base materials for housing magnetic plates.

Main body can either be of stainless steel or HDGI steel or 1st grade virgin ABS plastic in which two or three galvanized steel magnetic strips with magnates placed vertically or horizontally in box type body .

Most commonly used magnetic catcher by standard manufacturers are of 1st grade virgin ABS plastic having two/three magnetic strips housed within box type case as described below.

(i) Triple strip magnetic catcher for fixing vertically on the door meeting side of the cabinet/cupboard box of size not less than 70x30x15 mm with three nos. galvanized steel M.S. magnetic strips housed

within the body and its attraction strip/plate of size not less than 60x15 mm . Both fixing of catcher and the alteration plates are to be fixed with 3-M, 15 mm long fully threaded sunken head screws complete.

(ii) Double strip magnetic catcher for fixing horizontally at top or bottom meeting edge of cabinet/cup board box of size not less than 50x30x12 mm with two nos. galvanized steel M.S. magnetic strips housed within the body and its attraction strip/plate of size not less than 50x12 mm. Both the catcher and the alteration plates are to fixed with 3-M, 15 mm long fully threaded sunken headed steel screws complete.

9.34.1 Measurements

It shall be counted in numbers.

9.34.2 Rate

Rate is inclusive of one set of magnetic catcher including its alteration strip and sunken headed steel screws and labour required for proper positioning and fixing in cabinets or cup boards.

9.35 POWDER COATED TELESCOPIC DRAWER CHANNEL 300 MM LONG

Telescopic drawer channels of standard length comprises of four components

(i) Outer fixed channel
(ii) Inner fixed channel
(iii) Intermediate movable channel and
(iv) High carbon high strength stainless steel balls in S.S ball cages.

Both outer and inner fixed channels are punched with holes/slots for fixing to cabinet box and drawer respectively.

The size of drawer channel is defined as length of outer fixed channel which is in this item is 300 mm. The inner fixed channel is of even smaller size in web depth and flange (which is detachable) by way of an ABS plastic clip mechanism and fixed to either sides of drawer wall and slides in the intermediate channel.

The telescopic drawer channels are always fixed in pair i.e. on either side of drawers and fixing to cabinet box using fully threaded M-4, 20 mm long sunken headed screws.

All the three channels are made of die pressed M.S. strips 1.5 mm thick with necessary holes and slots punched/cut and powder coated (minimum 30 microns) black/brown/chocolate color Virgin ABS plastic stopper cleats and clips are also housed/fixed. The standard weight of a pair (one set) of 300 mm long telescopic drawer channel shall not be less than 800 grams.

9.35.1 Measurements

It shall be counted in pair i.e. one set.

9.35.2 Rate

The rate for the item is inclusive of cost of a pair of telescopic drawer channel and sunken headed steel screws and labour for fixing to cabinets/drawer etc complete.

9.36 SLIDING ARRANGEMENT IN RACKS/CUP-BOARDS/CABINET SHUTTER

This sliding clamp is made of chrome plated (minimum 30 microns) M.S. strips to be pressed, cut and bend to form 'U' shaped clamps and 4 nos. 'V' shaped cuts, holes punched and bent inverse to form S.S. roller bearing axis tracks with two nos. S.S. roller bearings in each clamp.

This sliding clamps (1 pair each shutter panel) can be fixed to glass/plywood shutter panel of the cabinet by making inverse U shaped cut at the bottom in the said sliding shutter panel and using EPDM piece of required size & thickness push fixed to form firm grip to ply/glass sliding panel.

9.36.1 Measurements

It shall be counted in numbers.

9.36.2 Rates

The rate for each clamp is inclusive of the cost of clamp and labour charges for making the cuts in shutter panel and fixing of 'C' & E channels etc. all complete as per directions of Engineer-in-Charge.

APPENDIX A

TABLE FOR PERMISSIBLE DEFECTS FOR VARIOUS GRADES OF TIMBERS

(Clause 9.1)

Sl. No.	Defects	First Grade	Second Grade
(i)	Cross-grain	Not steeper than 1 in 15	Not steeper than 1 in 10
(ii)	Sound knots and live knots	(i) Stiles and Rails (a) Short Exposed Face: Not more than 15 mm size and not more than 1 knot/metre (b) Long Exposed Face- Not more than 15 mm size and not more than 1 knot/m. No knot shall occur within 20 mm of the edges (ii) Panels – Not more than 20 mm size and not more than 2 knots/m2 . No knot shall occur on edge of any component of a panel.	(a) Short exposed Face – Not more than 15 mm size and not more than 3 knots per stile and 1 knot per rail (b) Long Exposed Face- Not more than 20 mm size and not more than 3 knots per stile and 1 knot per rail
(iii)	Dead and loose knots (plugged)	(i) Stils and Rails – Not more than 10 mm size – centrally located and not more than 1 knot / m (ii) Panels – Not more than 15 mm size and not more than 2 knots/m2 . No knot shall occur on edges of any component of a panel.	(i) Stiles and Rails – Not more than 10 mm size, centrally located and not more than 3 knots per stile and 1 knot per rail. (ii) Panels – Not more than 15 mm size and not more than 4 knots/m2 . No knot shall occur on edge of any component of a panel.
(iv)	Pitch pockets or streaks	None	Permissible except on exposed edges provided that they are clean and filled up with suitable putty or filler when pitch pockets or streaks are located on the exposed edges of the core, they shall be cut out and filled with piece of wood of similar species with grain running in the same direction. The piece shall be well glued.
(v)	Sapwood	Total not exceeding 5 mm wide and 150 mm long per metre. (This restriction applies only to super group species).	Total not exceeding 10 mm wide and 300 mm long per metre. (This restriction applies only to super group species).
(vi)	Pin holes	Permitted provided they are not in cluster	Permitted.
(vii)	Worm holes	None	Permitted provided they are not more than 10 mm in diameter and not more than one per metre and provided such worm holes are plugged with similar timber in such a manner that the pluging merges with the surrounding area both as to colour and grain.

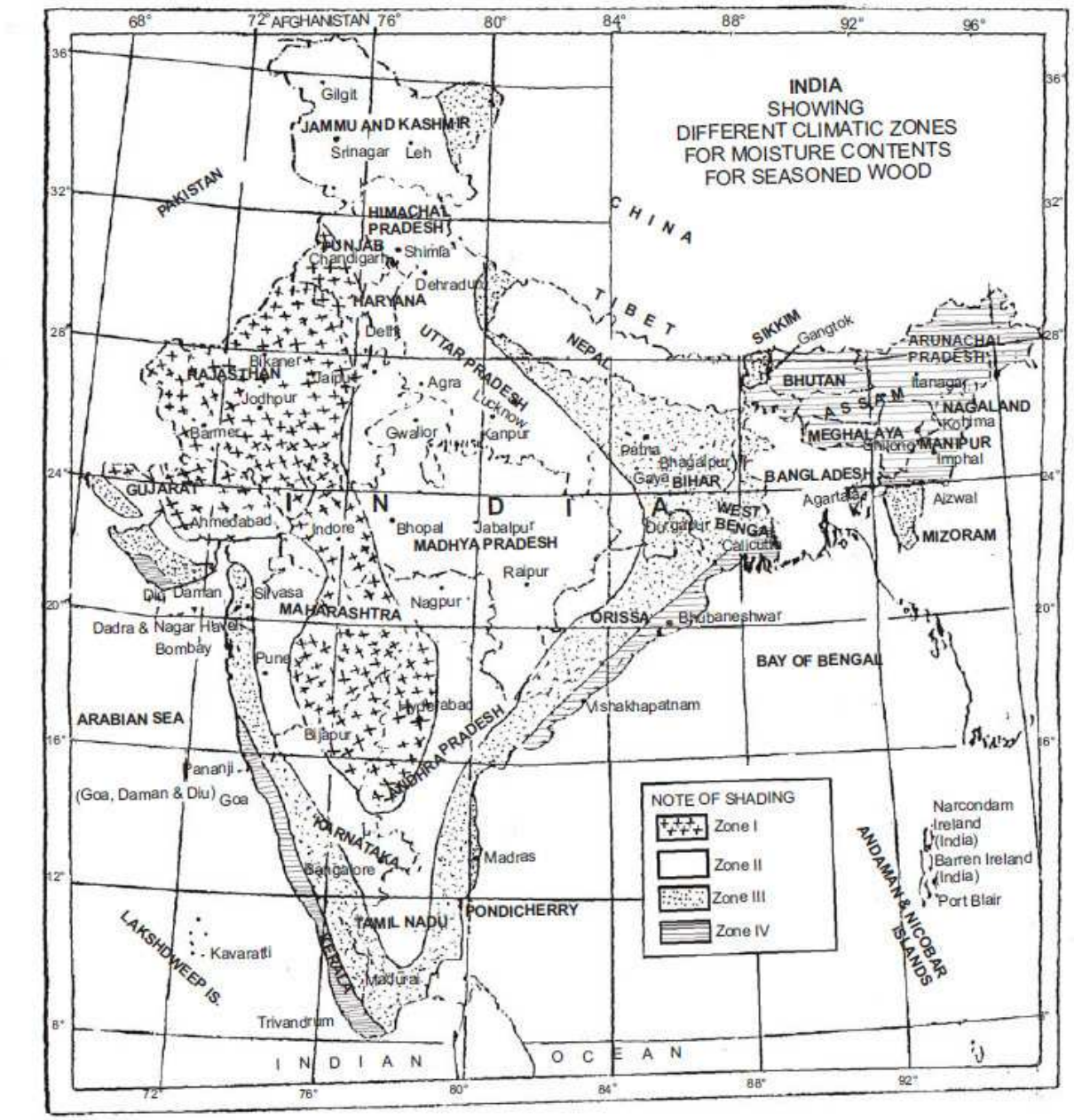
Note :

(i) Dead and loose knots are permitted only if they are suitably plugged.
(ii) Knot shall not occur where hinges or locks are to be fixed.

APPENDIX B

DIFFERENT CLIMATIC ZONES FOR MOISTURE CONTENT OF TIMBER

(Clause 9.1.6)



Note 1 : Based upon Survey of India map with the permission of the Surveyor General of India.
Note 2 : The territorial waters of India extend into the sea to a distance of twelve nautical miles measured from the appropriate base line.
Note 3 : The boundary of Meghalaya shown on this map is as interpreted from the North-Eastern Area (Reorganisation) Act, 1971, but has yet to be verified.
Note 4 : The administrative headquarters of Chandigarh, Haryana and Punjab are at Chandigarh.

APPENDIX C

MOISTURE CONTENT OF TIMBER

(Clause 9.1.6)

C-1 Moisture content of timber shall be checked for every 1 cum or part thereof by electrical moisture meters as per IS 287.

C-2 Electrical moisture meters are of resistance type and shall be used when the moisture content is within a range of 8 to 25 per cent. When checking moisture content with electrical moisture meter, it shall be ensured that :

(a) Timber is not hot or surface wet and the moisture gradient is not large due to wet cores.

(b) Electrode probes are of adequate depth (not less than one-fifth the thickness of the timber).

C-3 Sufficient number of reading at different positions are taken on each piece of timber to eliminate localised variations in surface moisture and species corrections are applied for the make of electrical resistance type moisture meter.

C-4 If for any reason, whatsoever, the result of electrical moisture are not to be relied upon the moisture content shall be checked by the oven drying method.

C-5 For checking moisture content by oven drying method, a complete test cross section, 12 to 19 mm long in the direction of timber grain, free from all defects shall be cut from each piece of timber selected for test as follows :

(a) If weighing can be done immediately, the test section shall be cut from a point at least 45 cm from one end of the piece or from its centre.

(b) In case cutting of test section from the piece is not permissible the moisture content in the whole section can also be determined by collecting a boring to a depth of half of the thickness of the piece by means of an auger, in a preweighed weighing bottle which should then be sealed properly.

C-6 The test sections obtained above shall be weighed, immediately after cutting, on a balance the sensitivity of which is not less than 10 mg. They shall be dried in a ventilated, and preferably thermostatically controlled, oven at a temperature of 100°C to 105°C untill the weight is constant. The weight of the test section shall be deemed to have become constant if successive weighing at intervals of 2 to 5 hours do not differ from one another by more than 50 mg. The test weight shall be taken to be the oven dry weight of the test section.

C-7 The percentage moisture content in the test section shall be calculated as follows :

$$\text{Moisture content (Per cent)} = \frac{W_1 - W_O}{W_O} \times 100$$

Where :

W_1 = initial weight of test section and

W_O = oven dry weight of test section

C-8 When moisture content of timber is checked by oven drying method, results of electrical moisture meter shall be ignored.

APPENDIX D

PHYSICAL AND MECHANICAL PROPERTIES OF PLYWOOD

(Clause 9.2.2.6)

D-1 Moisture content

5 to 15 per cent.

D-2 Shear Strength

	Dry State	*Resistance to Moisture*
Average	135	100
Individual	110	80

APPENDIX E

PHYSICAL AND MECHANICAL PROPERTIES OF FPT OR GRADED PARTICLE BOARD

(Clauses 9.2.3.4)

Sl. No.	Properties	Flat pressed Three layer multi layer and graded	
		Grade- I	Grade-II
(i)	Density variation, percent	± 10	± 10
(ii)	Water absorption, percent (a) 2 h soaking (b) 24 h soaking	 10 20	 40 80
(iii)	Linear expansion (swelling in water). 2 h soaking-percent (a) Length (b) Width	 0.5 0.5	 0.5 0.5
(iv)	Thickness, swelling, percent 2 h soaking	8	12
(v)	Swelling in thickness due to surface absorption, percent	6	9
(vi)	Modulus of rupture, N/mm2 (a) Average (b) Minimum	 15 13	 11 10
(vii)	Modulus of elasticity, N/mm2 (a) Average (b) Minimum	 2500 2250	 2000 1800
(viii)	Tensile strength perpendicular to surface, N/mm2 (a) Upto 20 mm thickness (b) Above 20 mm thickness	 0.45 0.40	 0.3 03
(ix)	Tensile strength perpendicular to surface, N/mm2 (a) After cyclic test (b) Accelerated water resistance test2)	 0.2 0.15	 - -
(x)	Screw withdrawal strength, N (a) Face (b) Edge (for thickness >12mm)	 1250 850	 1250 700

1) *Cyclic Test*— Specimen are immersed in water at 27 ± 2°C for a period of 72 h, followed by drying in air at 27 ± 2°C for 24 H and then heating in dry air at 70°C for 72 h. Three such cycles are to be followed and then the specimens are tested for tensile strength perpendicular to surface.

2) *Accelerated Water Resistance Test*— Specimen are immersed in water at 27 ± 2°C and water is brought to boiling and kept at boiling temperature for 2 h. Specimen are then cooled in water to 27 ± 2°C and then tested for tensile strength perpendicular to surface.

APPENDIX F

TESTS FOR FLUSH DOOR SHUTTERS

(Clause 9.7.1 to 9.7.10)

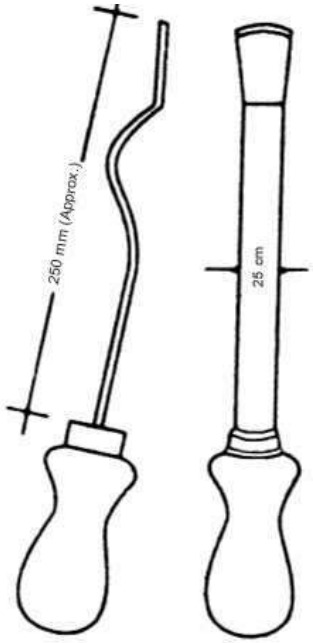
F-1. END IMMERSION TEST

Door shutters shall be tested for resistance of their base to immersion in water as follows :

The door shutter shall be immersed vertically to a height of 30 cm in water at room temperature for 24 hours and then allowed to dry for 24 hours at 27 ± 2°C and relative humidity of 65 ± 5 per cent. The cycle shall be repeated eight times. There shall be no delamination at the end of the test.

F-2. KNIFE TEST

(i) *Apparatus :* The type of knife required to be used in the test is given in Fig. below. It may be made from a 250 x 25 mm file. The cutting edge should be kept chiselsharp. The test shall be carried out on a stout table to which a wooden batten is screwed against which the edge of test piece is placed.



Drawing not to scale

KNIFE FOR TESTING PLYWOOD FOR ADHESION OF PLIES

(ii) *Procedure :* The knife is inserted with its cutting edge parallel to the grain of the outer veneer and worked into, or if possible along a glue line and the veneer is prised upwards. A hard and dense specie of plywood requires considerable force to effect entry and to prise and veneer. In a soft timber the knif tends to follow an easy course through the wood and in this case it is essential that the knife be firmly guided along the glue line.

The bond should just pass the requirement, it is judged by the relative amount of wood fibre left on the core veneer, and the area prised off. The grading is assessed chiefly on the appearance of the break. The force needed to effect separation is also an accompanying requirement.

The bond is 'excellent', when it is difficult to find the glue line and impossible to keep the tool within it for more than 6 mm without cutting adjacent wood. On prising upwards, the veneer usually breaks off over a width slightly greater than that of the tool.

The bond is ‘poor’ when knife meets little opposition in the glue line and the prise results in the easy removal of almost all the veneers from one side of the test piece. The separated veneers are usually almost free from adherent fibre.

(iii) *Reporting of test results :* The results shall be reported as ‘pass standard’ ‘excellent’ or ‘poor’.

F-3. GLUE ADHESION TEST

Four square sections, 150 x 150 mm shall be cut from the corners of the door. These four corner sections as cut from the door shall be immersed in boiling water for 4 hours, then dried at 27 ± 2°C and relative humidity of 65 ± 5 per cent for 24 hours. At the end of the drying period, the samples shall be examined for delamination. In the case of the glue lines in the plywood, all the four exposed edges of the plywood on both faces of a specimen shall be examined for delamination.

A specimen shall be considered to have passed the test if no delamination has occured in the glue lines in the plywood and if no single delamination more than 50 mm in length and more than 3 mm in depth has occured in the assembly glue lines between the plywood faces and the stile and rail. Delamination at the corner shall be measured continuously around the corner. Delamination at a knot, knot hole, a pitch pocket and worm hole or other permissible wood defects shall not be considered in assessing the sample. A door shall be deemed to have passed this test if three of the four specimens tested pass the test.

APPENDIX G

TEST FOR MORTICE LOCKS

(Clause 9.15.13)

The finally assembled lock shall withstand the test given as below :

The locking bolt shall be first locked in the forward position. A load of 40 kg. shall be applied without shock in the direction perpendicular to securing face as well as on both the locking faces of protruding bolt in turn. Then the load shall be applied by means of a fixed steel board 3 mm thick by rounded edge held in such a position that the centre line is approximately 3 mm from the fore end. A typical arrangement for the purpose of this test is shown in Fig. below :

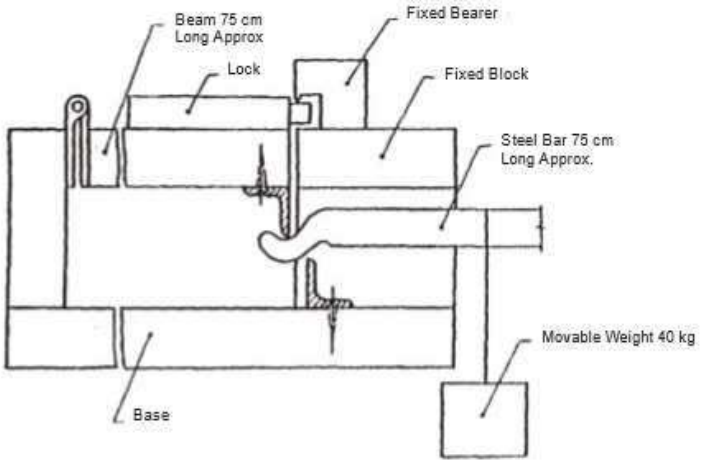


Fig. : Strength Test for Locking Bolt

When the spindle with handle is inserted into hole in the follower and turned, the latch bolt shall draw smoothly into the lock body and shall be within one millimetre from the face of the fore end.

When the latch bolt is pressed in to the lock body by pressure, the action shall be smooth and when fully pressed the latch bolt shall not project more than one millimetre from the face of the fore end.

When a key is inserted in key hole from one side of the lock and turned to withdraw the locking bolt the action shall be smooth and without impediment. When the direction of turn is reversed to lock the locking bolt then also the action shall be smooth and without impediment. In the locked position the locking bolt shall project 12 mm from the face of the fore end, although one millimetre free movement is permissible. In the withdrawn position the locking bolt shall not project more than one millimetre from the face of the fore end. The locking bolt shall be worked by turning key in both the direction 6000 times. At the end of the test, the lock shall continue to work smoothly.

The test shall be repeated with the key inserted from the other side of the lock.

Note : The clearance for levers while in the operating condition shall not exceed 0.25 mm.

When the key is turned to lock the locking bolt at the same time applying a reasonable pressure by finger on it, after completion of the key rotation the locking bolt shall be positively locked in the forward position. This test shall be repeated with the key inserted from the other side of the lock.

APPENDIX H

SCHEDULE OF FITTING FOR DOORS AND WINDOWS

(Clause 9.6.8)

Sl. No.	*Name of Fittings*	*Double leaf doors shutters panelled or glazed*	*Single leaf door shutters external panelled or glazed*	*Single leaf door shutters inter communicating panelled or glazed*	*Single leaf wire guaze door shutters*	*Single leaf wardrobe/ cupboard shutters*	*Single leaf window shutters panelled or glazed*	*Fan light/ clear storey window shutters*	*Designation no. of wood screw*	*Length in mm of wood screws IS 6760*	*Remarks*
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
1.	Butt Hinges 100 mm	6	3	3	3	-	-	-	9	40	
2	Butt Hinges 75 mm	-	-	-	-	-	2	2	8	20	
3	Butt Hinges 50 mm	-	-	-	-	1	1	-	6	20	For fixing wooden cleat
4	Piano Hinges	-	-	-	-	-	-	-	6	20	
5	Tower Bolt 250 mm	3	2	3	2	-	1	-	10	30	
6	Tower Bolt 150 mm	-	-	-	-	-	1	-	8	30	
7	Tower Bolt 100 mm	-	-	-	-	-	-	-	6	30	
8	Sliding door Bolt 300 mm	1	-	-	-	-	-	-	9	35	
9	Sliding door Bolt 250 mm	-	1	-	-	-	-	-	9	35	
10	Floor door stopper	2	1	1	-	1	-	-	9	30	
11	Door handle with plate 100 mm	2	2	2	1	-	-	-	6	25	
12	Window handle with plate 75 mm	-	-	-	-	-	1	-	6	20	
13	Casement stay 300 mm	-	-	-	-	-	1	-	6	30	
14	Helical door spring (Superior quality)	-	-	-	1	-	-	-	6	30	
15	Cupboard /Wardrobe Lock	-	-	-	1	1	-	-	6	20	
16	Fanlight Catch	-	-	-	-	-	-	1	8	30	

Notes :

A : Door Shutters

1. Door of room adjoining the verandah, corridor, lobby or hall, shall be considered as external door.
2. Where the height of the door leaf exceeds 2.15 metres above the floor level, one extra hinge shall be provided for every additional height of 0.50 metre, or part thereof and the length of top bolts shall be increased by the height of the leaf above 2.15 metres from floor level.
3. Single leaf door shutters of more than 0.80 m in width shall be provided with one extra hinge.
4. Fan light shutters of more than 0.80 metre width shall be provided with one extra hinge and extra quadrant stay.
5. In double leaf shutters of doors, two door bolts shall be fixed to the first shutter and one to the closing shutter at the top.
6. In case of single leaf inter communicating, panelled, glazed or panelled door shutter for bath and w.c. one tower bolts will be replaced by a bathroom latch.
7. For shutter exceeding 40 mm thickness, heavy type M.S. butt hinges of 125 x 90 x 4 mm shall be used.
8. In case of external door shutters, instead of sliding door ball mortice lock can be provided where specified.
9. Cupboard and wardrobe shutters will have ball catches where specified.
10. Finger plates shall be provided in case of bath and wc shutters in office buildings.

B : Window Shutters

11. In case of windows with double shutters, two tower bolts shall be fixed to the closing shutters and one tower bolt to the first shutter at the top.
12. In case of window shutters, hooks and eyes may be provided in lieu of casement stays where specified.
13. Where the height of window shutter exceeds 1.20 metres one extra hinge shall be provided and length of top bolts shall be increased by height of the leaf above 2.15 metres from the floor level.
14. Window shutter with steel frames shall be provided with six hinges in case of double leaf shutters and three hinges in case of single leaf shutters, irrespective of height and width of shutters.

C : Fanlight and Clerestory Window or Ventilator

15. Centrally hung and bottom hung CS windows and fan lights, will be provided with chain and hook bamboo pole with hook for opening ventilators shall be provided for each residence or for set of 4 rooms in case of office building.
16. Centrally hung clerestory windows or fan lights will have fan light pivots in lieu of hinges.

APPENDIX I

METHOD OF TEST FOR EDGE STRAIGHTNESS AND SQUARENESS OF PLYWOOD

(Clause No. 9.2.8.3)

I.1 PROCEDURE FOR EDGE STRAIGHTNESS

I.1.1 The straightness of the edge and ends of plywood shall be verified against a straight edge not less than the full length of the plywood. If the edge on the end of the plywood is convex, it shall be held against the straight edge in such a way as to give approximately equal gap at each end. The largest gap between the straight edge and the edge shall be measured to the nearest millimeter and recorded.

I.2 PROCEDURE FOR SQUARENESS

I.2.1 The squareness of plywood shall be checked with a 1200 mm x 1200 mm square by applying one arm of the square to the plywood. The maximum width of the gap shall be recorded.

APPENDIX J

METHOD FOR TEST FOR EDGE STRAIGHTNESS AND SQUARENESS OF COIR VENEER BOARD

(Clause 9.2.10.6)

J-1 PROCEDURE FOR EDGE STRAIGHTNESS

J-1.1 The straightness of the edges and ends of coir veneer board shall be verified against a straightedge not less than the full length of the coir veneer board. If the edge on the end of coir veneer board is convex, it shall be held against the straight edge in such a way as to give approximately equal gap at each end. The largest gap between the straightness and the edge shall be measured to the nearest millimeter and recorded.

J-2 PROCEDURE FOR SQUARENESS

J-2.1 The squareness of coir veneer board shall be checked with a 1200 mm x 1200 mm square, by applying one arm of the square to the coir veneer board. The maximum width of the gap shall be recorded.

APPENDIX K

METHOD OF TEST FOR COIR VENEER BOARD FOR DETERMINATION OF GLUE SHEAR STRENGTH

(Clause 9.2.10.8)

K-1 OBJECT

K-1.1 This test is intended to estimate the tenacity with which the bonding material holds the coir veneer board together.

K-2 TEST SPECIMEN

K-2.1 Six test specimens shall be cut from the coir veneer board from three locations separated by the greatest possible distance from each other.

K-2.2 The test specimens shall be prepared as shown in Fig. 1 below.

K-2.3 The test pieces for 3 ply coir veneer board shall be prepared by gluing an additional 3 ply coir veneer board as shown in Fig. 1A below. The test pieces for 5 ply shall be prepared as shown in Fig. 1B below. The test pieces for 7 ply coir veneer board shall be prepared as shown in Fig. 1C below.

The specimen is glued with room temperature setting epoxy resin and clamped/tied overnight.

Note - This method of preparation of specimen will avoid the failure on notches.

K-2.4 Before test, the specimen shall be conditioned to constant mass at relative humidity of 65 ± 5 per cent and at a temperature of 270° C ± 20°C.

K-3 PROCEDURE

K-3.1 Each test specimen shall be gripped symmetrically at two ends in the jaws of a suitable testing machine, and shall be pulled apart. The distance between the notches on the test specimen and the ends of the gripping jaws of the testing, machine shall be between 10 mm and 20 mm. The pull should be, as far as possible, in the centre line of the central veneer. The grain of the centre ply shall be perpendicular to the direction of application of load. The width of each specimen and distance between the notches shall be measured to nearest 0.025 cm. to determine the shear area.

K-3.2 During the test, the load shall be applied to the test specimens as uniformly as possible, and so adjusted as to have the traverse of the movable head of 1 mm/min.

K-3.3 The maximum load at the time of complete failure of each specimen shall be recorded. Record shall be made regarding the type of failure whether in ply or in glue by visual examination of the area under shear. In case of ply failure, the percentage ply failure shall also be recorded.

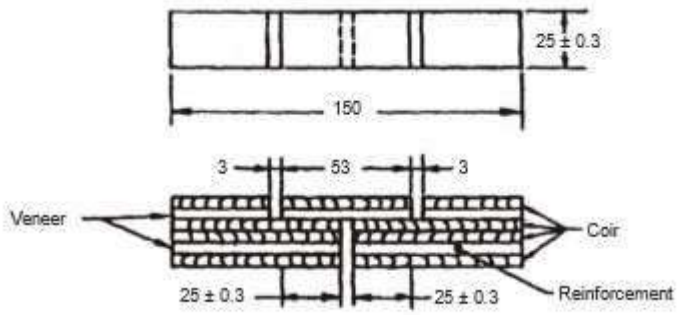
K-4 REPORT

K-4.1 Shear strength of the specimens determined in accordance with K-3 shall be straight averaged.

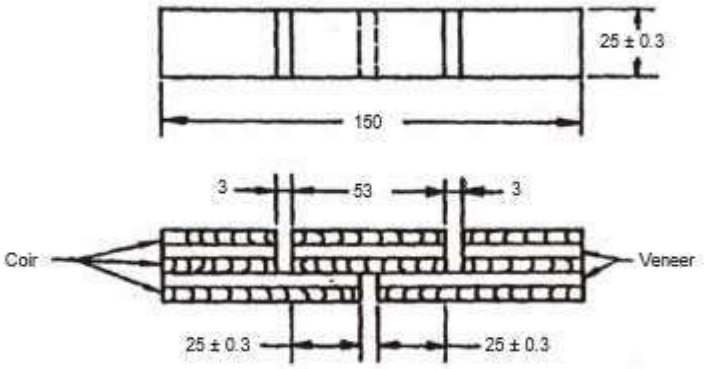
K-4.2 All details shall be recorded under the following sub-heads.

(a) Name of the manufacturer/source from whom the coir veneer board is procured
(b) Type and grade of coir veneer board
(c) Adhesive used
(d) End use of coir veneer board
(e) Specimen No. /Ref.
(f) Area of cross-section of bonding surface under shear
(g) Maximum load and
(h) Percentage failure of glue/ply

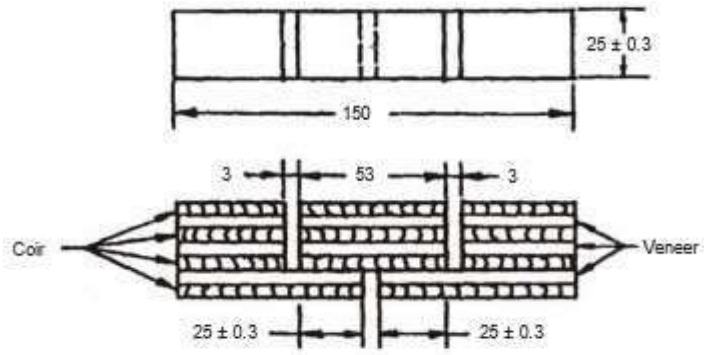
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1A : 3-ply Test Specimen



1B : 5-ply Test Specimen



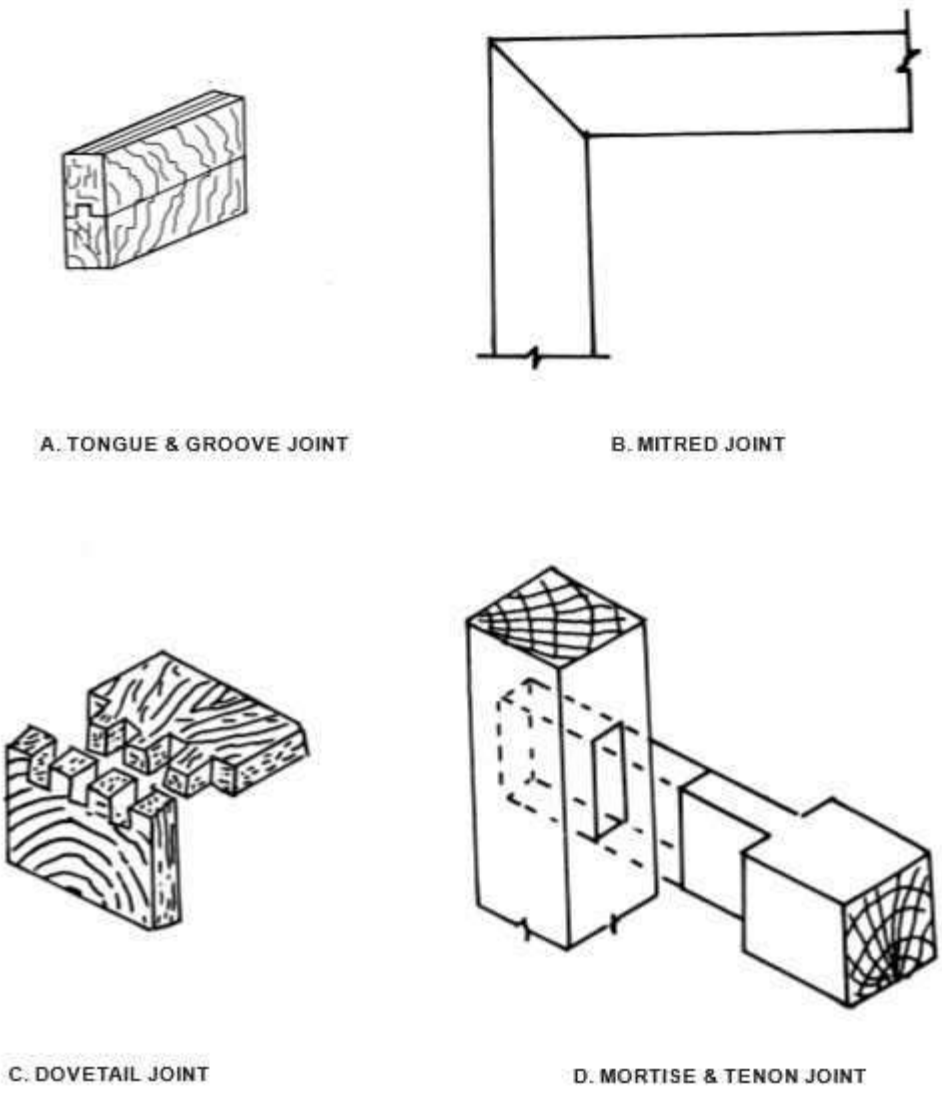
1C : 7-ply Test Specimen

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All dimensions are in mm

Fig. 1 : Test Specimen for Glue Adhesion Test

JOINTS IN TIMBER

Sub Head : Wood Work and PVC Work
Clause : 9.0

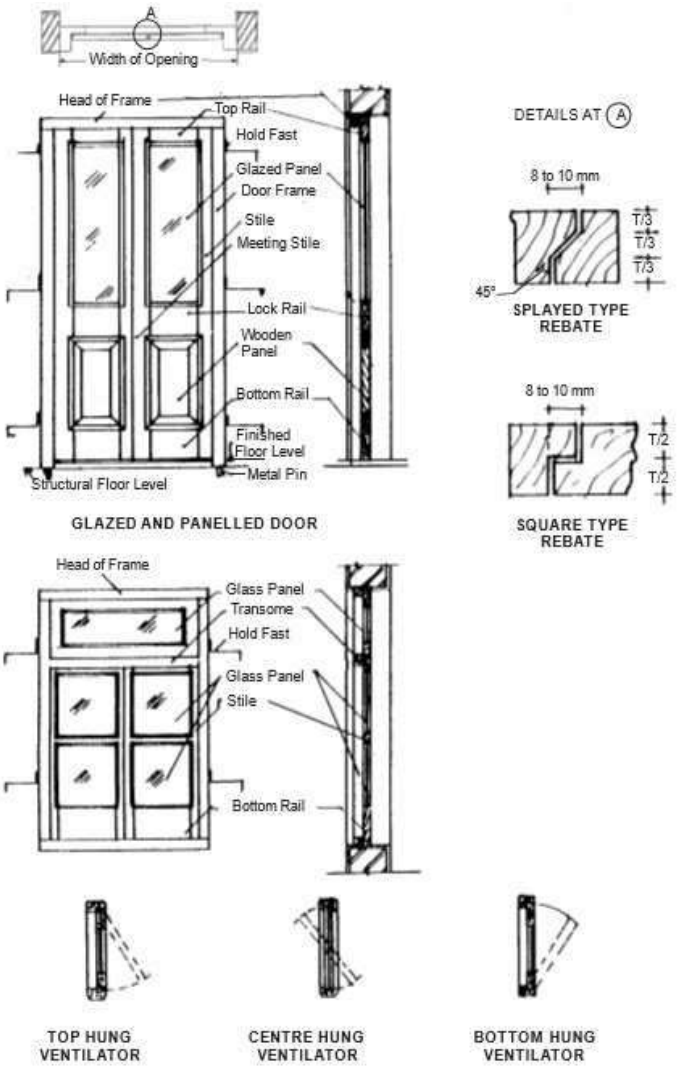


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Fig. 9.1 : Joints in Timber

TERMINOLOGY TIMBER DOOR, WINDOW & VENTILATOR COMPONENTS

Sub Head : Wood Work and PVC Work
Clause : 9.6



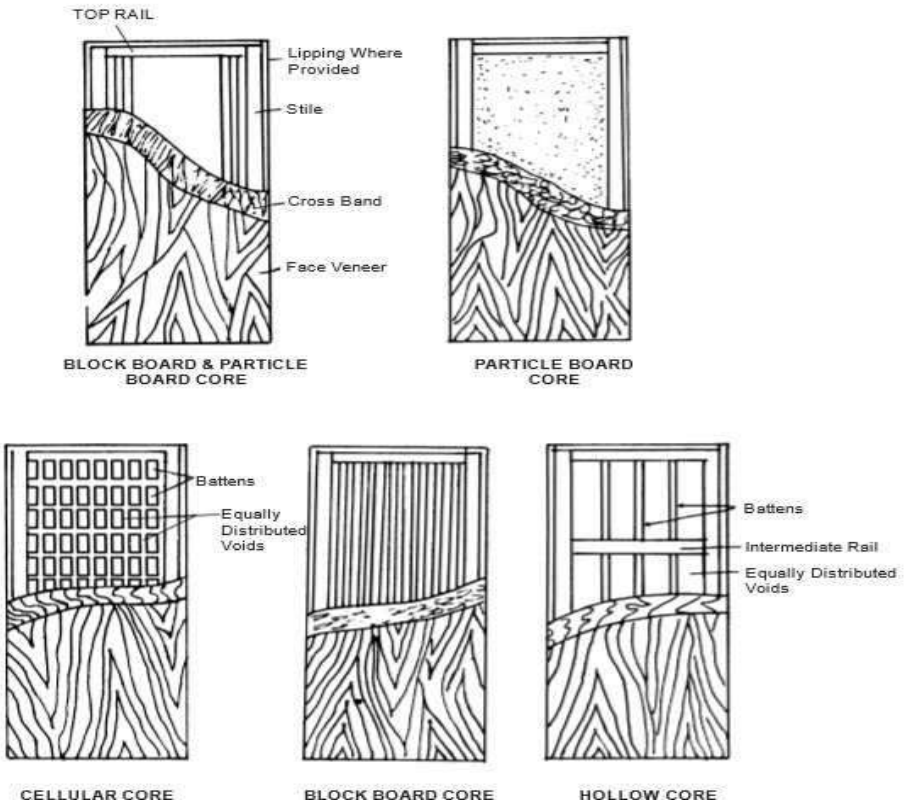
WINDOWS AND VENTILATORS

Drawing not to Scale
All dimensions are in mm

Fig. 9.2 : Terminology Timber Door, Window & Ventilator Components

WOODEN FLUSH DOORS SHUTTERS

Sub Head : Wood Work and PVC Work
Clause : 9.7

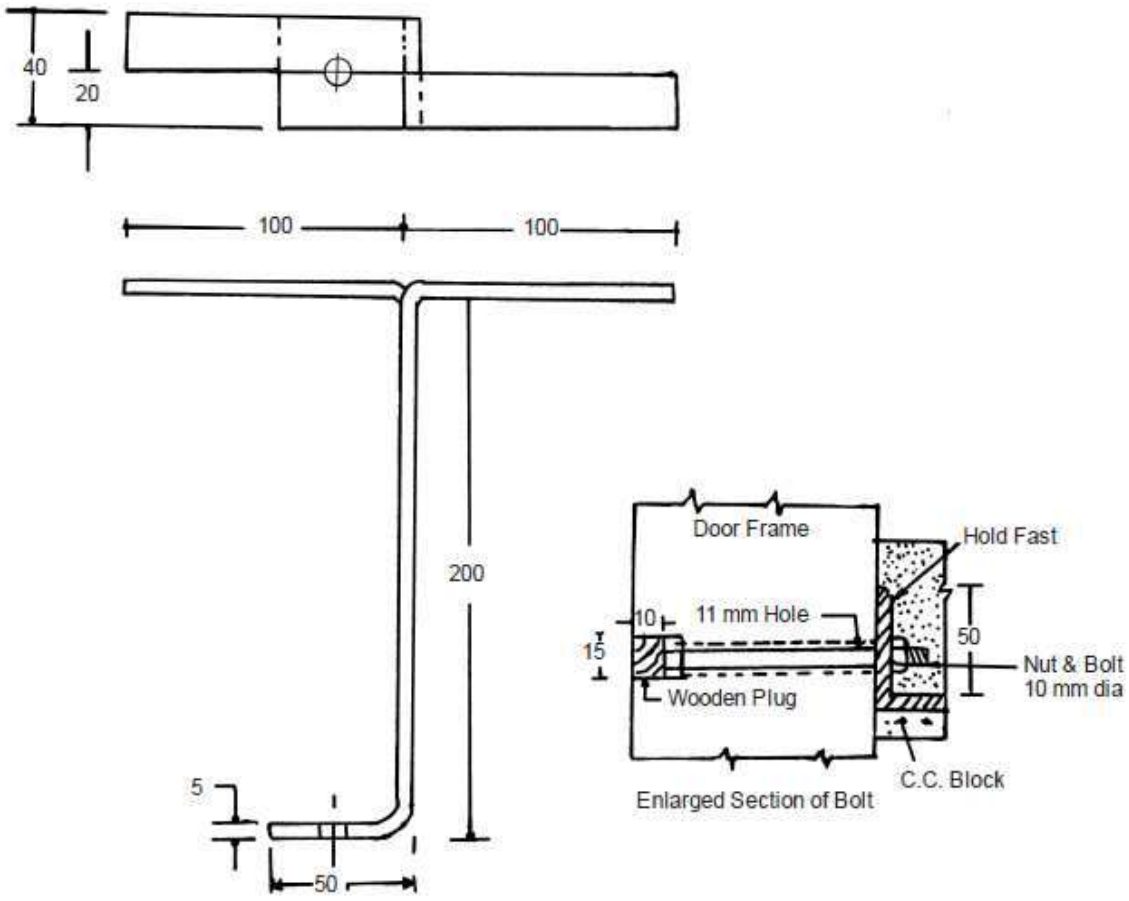


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Fig. 9.3 : Wooden Flush Doors Shutters

HOLD FAST

Sub Head : Wood Work and PVC
Clause : 9.13

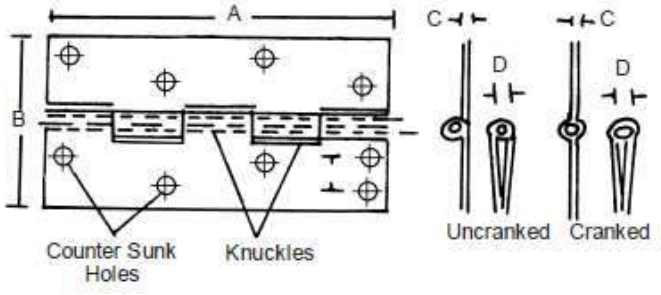


Drawing not to Scale
All dimensions are in mm

Fig. 9.4 : Hold Fast

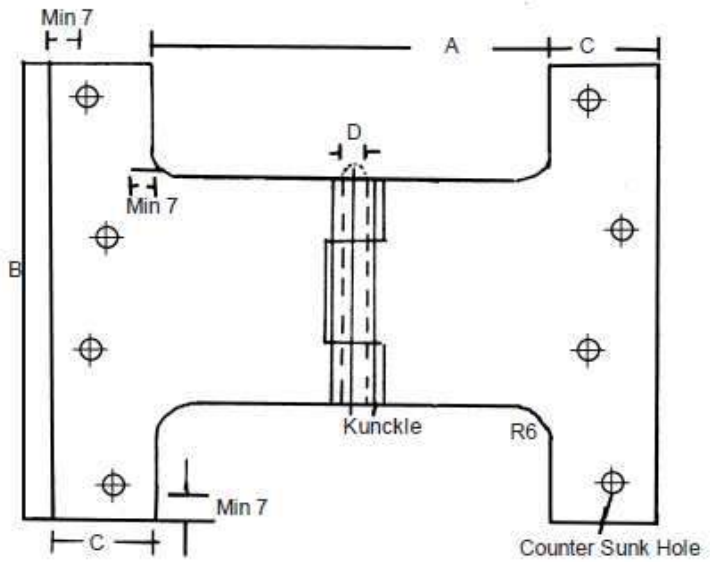
HINGES

Sub Head : Wood Work and PVC Work
Clause : 9.15.1 to 9.15.2



A. DIMENSION OF MEDIUM WT. MILD STEEL BUTT HINGES

Size of Hinge	Length (A)	Breadth (B)	Thickness of Flap (C)	Dai of Hinge Pin (D)	No. of Knuckles	No. of Holes	Holes for Screw No
1	2	3	4	5	6	7	8
50	50±0.5	37±1	1.50±0.06	3.15±0.008	3	4	6
75	75 ± 0.5	47 ± 1	1.70 ± 0.06	4.00 ± 0.08	5	6	8
100	100 ± 0.5	58 ± 1	1.90 ± 0.06	5.60 ± 0.08	5	8	10



B. PARLIAMENT HINGES

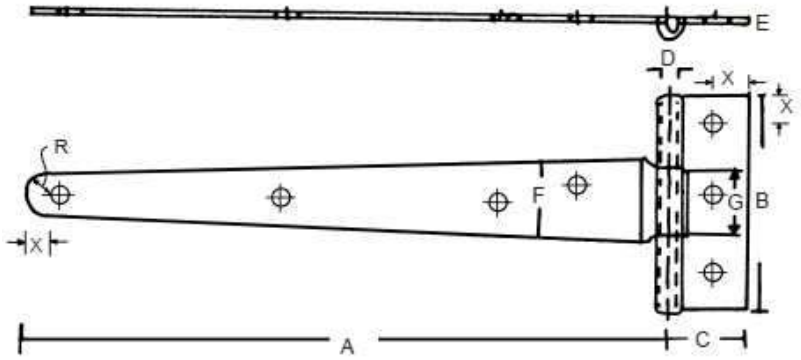
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All dimensions are in mm

Fig. 9.5 : Hinges

HINGES

Sub Head : Wood Work and PVC Work
Clause : 9.15.5, 9.15.6

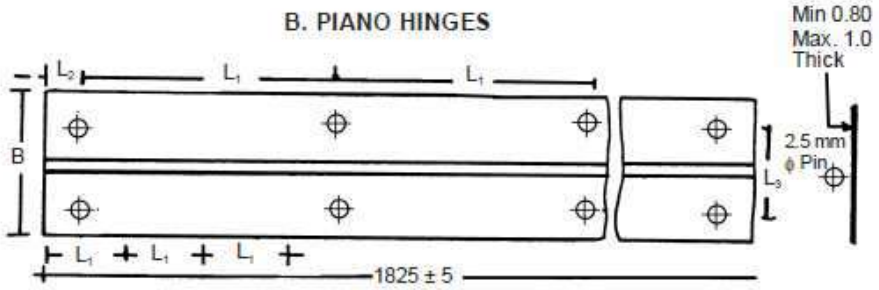
A. TEE HINGES



DIMENSIONS

Size	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*R*	*Screw Desig-nation No.*	*No. of Holes in Strap*	*No. of Holes in Tee*
250	250 ±3	100 ±2	30 ±15	5.6 ±0.10	2.24±0.10	45 ±2	40 ±1	8 ±1	9	5	3
300	300 ±3	115 ±2	30 ±1.5	6.30±0.10	2.26 ±0.10	50 ±2	50 ±1	8±1	9	5	3

B. PIANO HINGES



DIMENSIONS

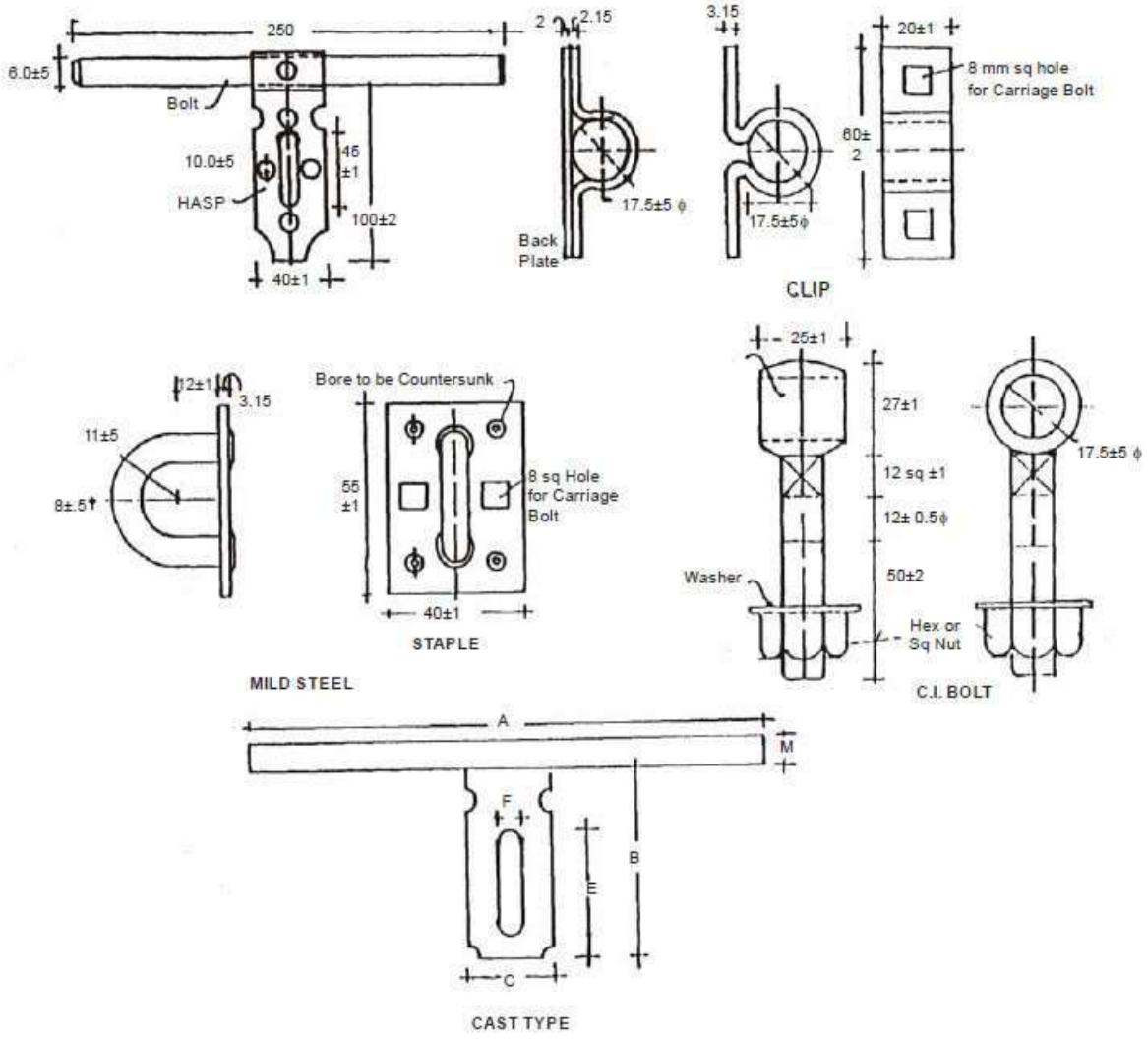
Nominal Size	B	L1	L2	L3
40	40 ± 1	25 ± 2	25 ± 1	20 ± 1
30	30 ±1	75 ± 2	25 ± 1	15 ± 1

Drawing not to Scale
All dimensions are in mm

Fig. 9.6 : Hinges

SLIDING DOOR BOLTS

Sub Head : Wood Work and PVC Work
Clause : 9.15.7



DIMENSIONS

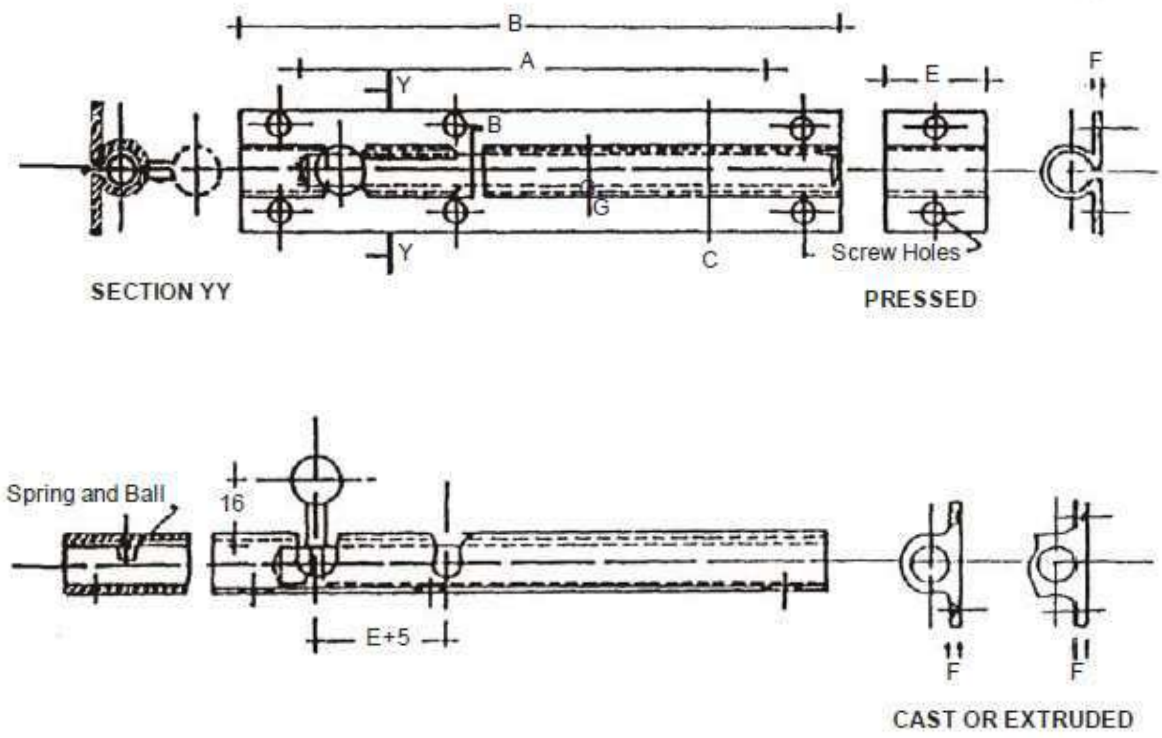
Size	A	B	C	E	F	M	Screw Designation No.
250	250 ± 2	100 ± 2	45 ± 1	55 ± 1	15 ± 1	16.0 ± 0.5	9
300	300 ± 2	100 ± 2	45 ± 1	55 ± 1	15 ± 1	16.0 ± 0.5	9

Drawing not to Scale
All dimensions are in mm

Fig. 9.7 : Sliding Door Bolts

BARREL TOWER BOLTS

Sub Head : Wood Work and PVC Work
Clause : 9.15.8



DIMENSIONS

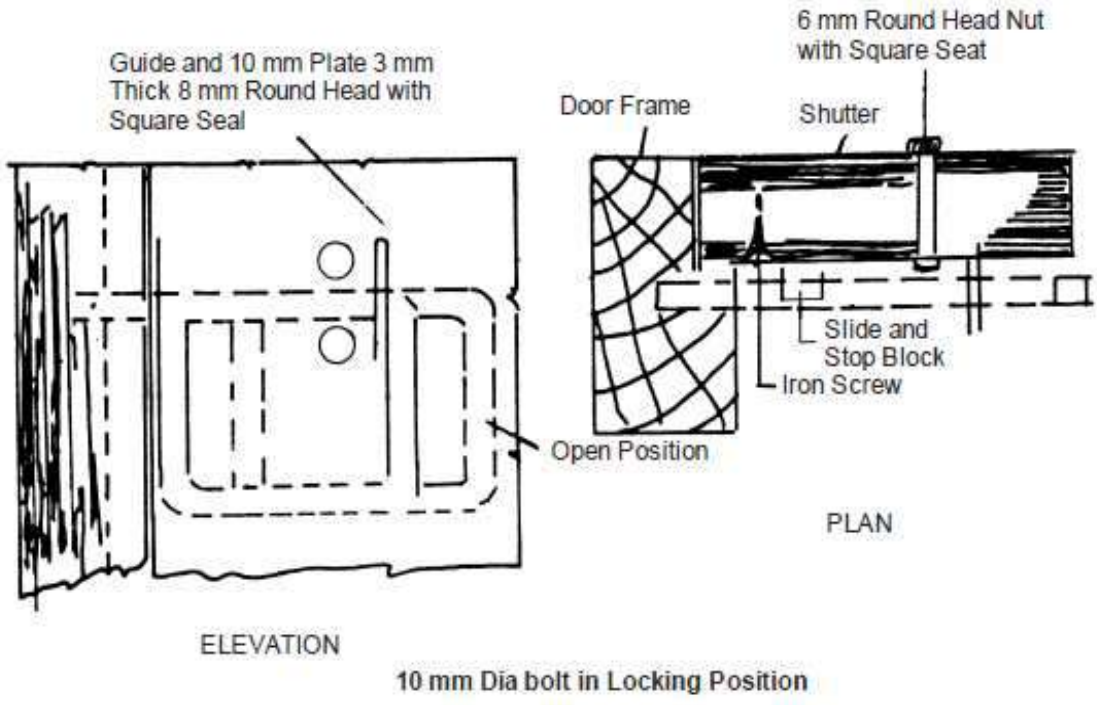
Size	A	B	Width of Barrel C When D=10.0	Width of Barrel C When D=12.00	D	E	Thickness of Metal of Barrel Sheet F Brass or Zinc Alloy	F Aluminium Alloy When D=10.0	F Aluminium Alloy When D=12.0	F Sheet Mild Steel or Brass	G	Screw Desig-nation No.
150	150+3 -1	170 + 3 -1	32+3 -1	38+3 -1	10 or 12 ± 0.5	25±1	2.0 +0.5 -0.2	1.60 ±10.33	2.40 ±0.36	1.25 mm ±0.15	1 to 1:5 more than dia of bolt	8
200	200+3 -1	220+3 -1	32+3 -1	38+3 -1	10 or 12 ± 0.5	25±1	2.0 +0.5 -0.2	1.60 ±0.33	2.40 ±0.36	1 to 1.25 ±0.15		8
250	250+3 -1	270+3 -1	32+3 -1	38+3 -1	10 or 12 ±0.5	25±1	2.0 +0.5 -0.2	1.60 ±0.33	2.40 ±0.36	1 to 1.25 ±0.15		10

Drawing not to Scale
All dimensions are in mm

Fig. 9.8 : Barrel Tower Bolts

PULL BOLT LOCKS

Sub Head : Wood Work and PVC Work
Clause : 9.15.10

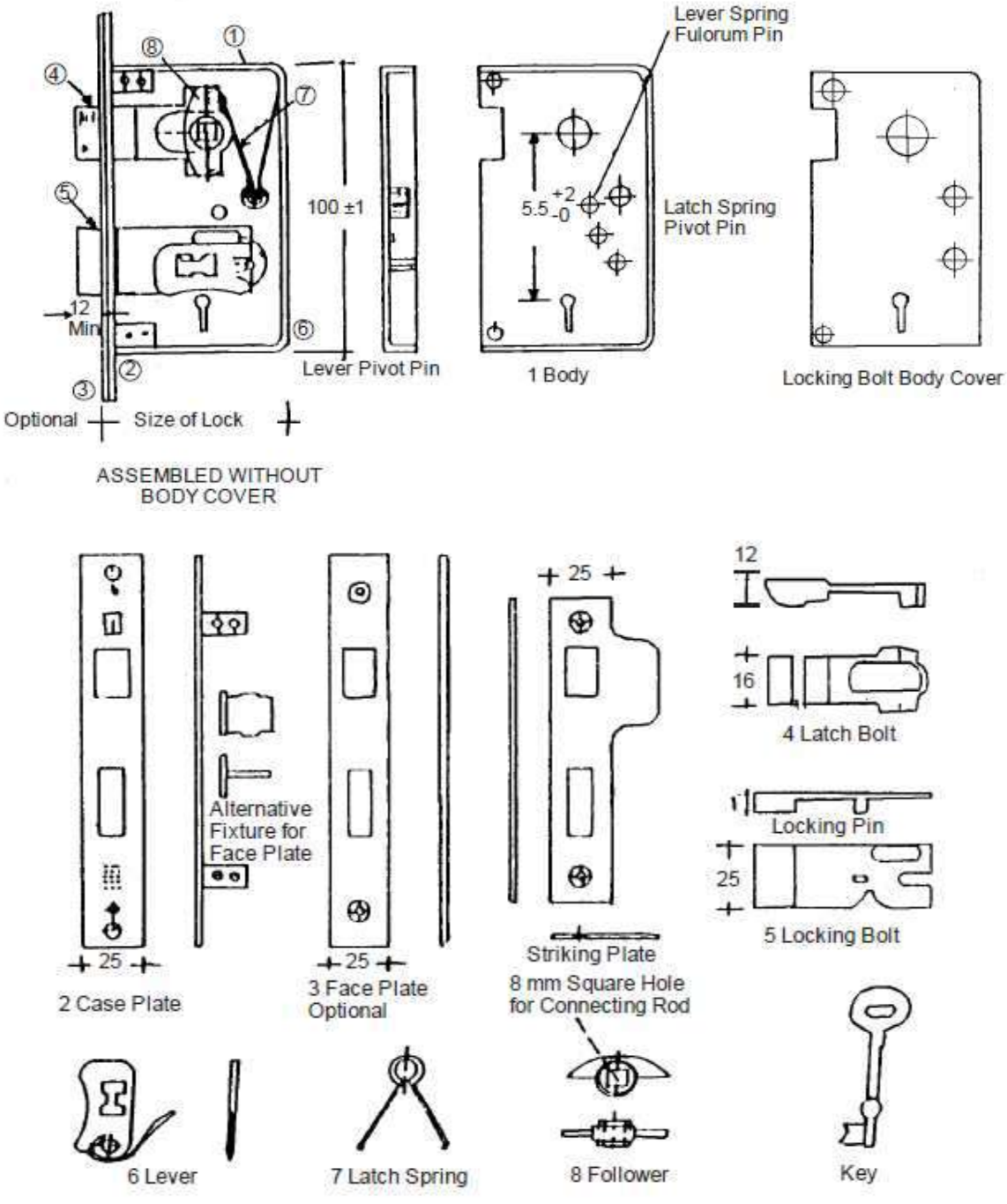


Drawing not to Scale

Fig. 9.9 : Pull Bolt Locks

MORTICE LOCK & LATCH

Sub Head : Wood Work and PVC Work
Clause : 9.15.13
Locking Bolt Guide Pin

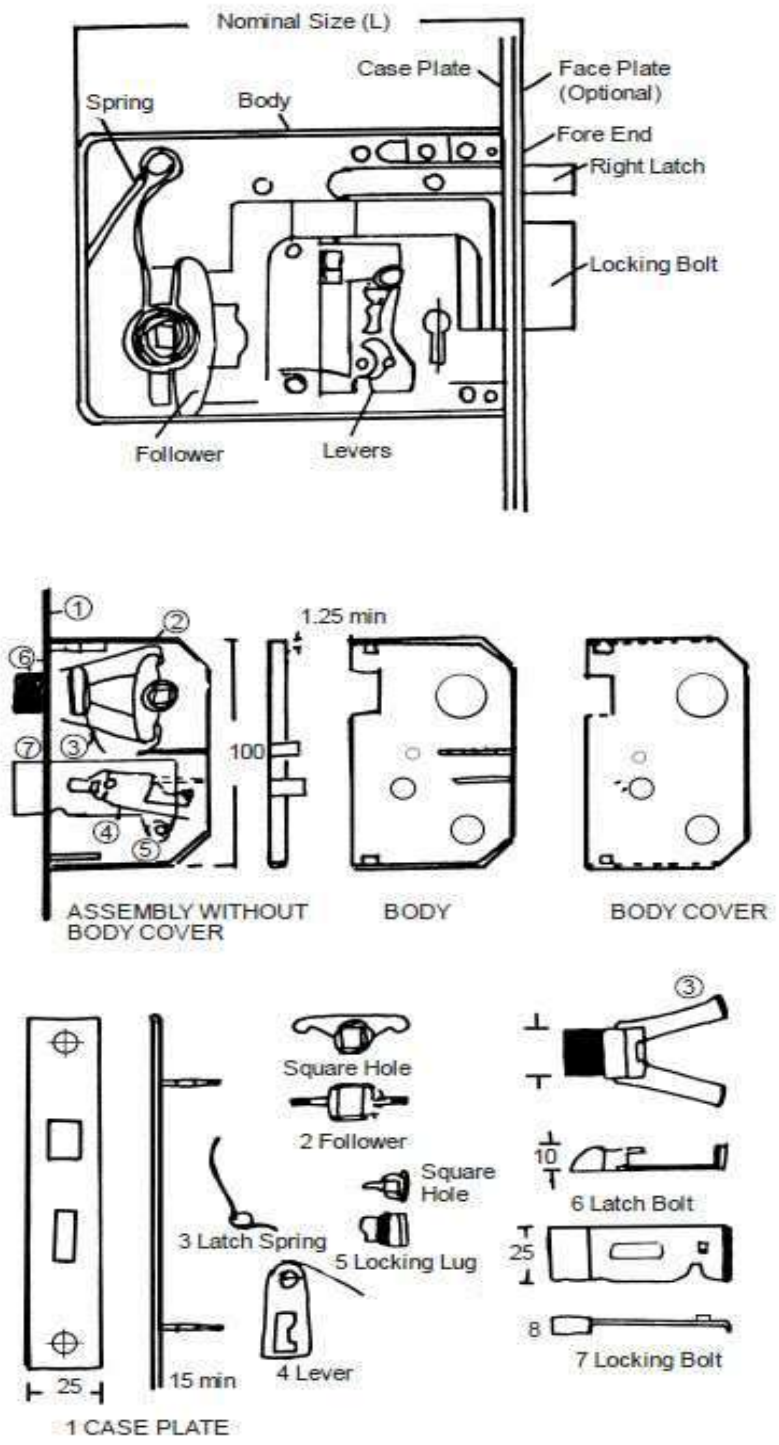


Drawing not to Scale
All dimensions are in mm

Fig. 9.10 : Mortice Lock & Latch

MORTICE NIGHT LATCH

Sub Head : Wood Work and PVC Work
Clause : 9.15.16

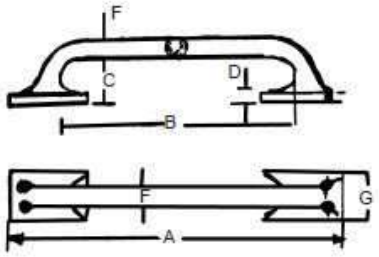


Drawing not to Scale
All dimensions are in mm

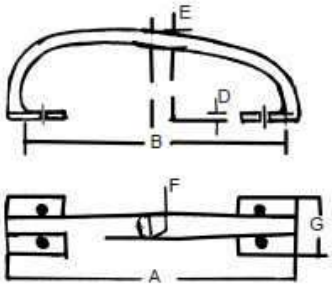
Fig. 9.11 : Mortice Night Latch

HANDLES FOR DOORS AND WINDOWS

Sub Head : Wood Work and PVC Work
Clause : 9.15.19



1A



1B

Fig. 9.12.1 : Typical Door Handle (Type 1)

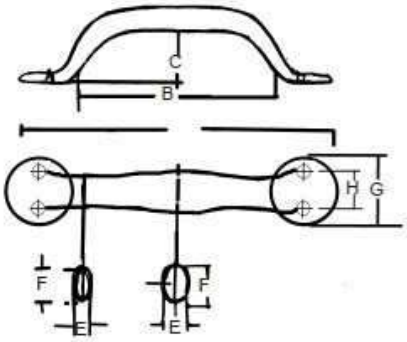


Fig. 9.12.2 : Typical Door Handle (Type 2)

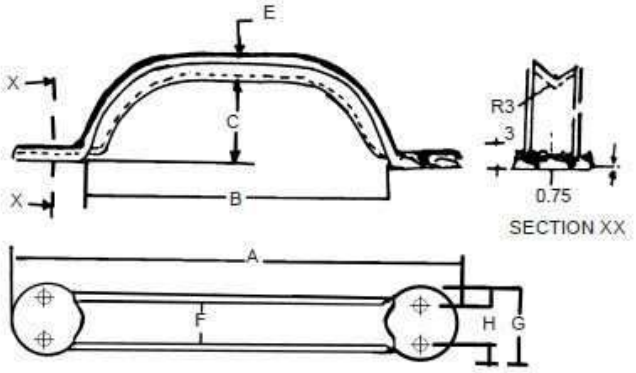
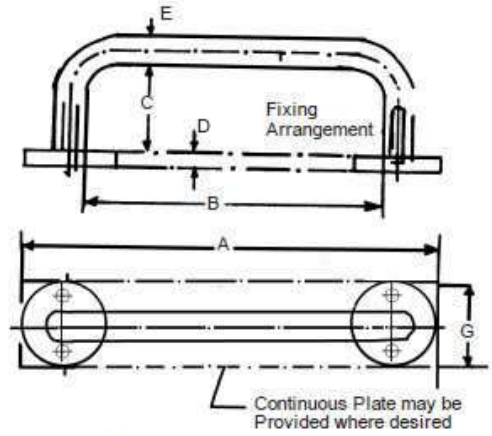


Fig. 9.12.3 : Typical Door Handle (Type 3)



Note : M5 x 20 mm G.I. Countersunk machine screw or any other suitable fixing arrangement may be used

Fig. 9.12.4 : Typical Door Handle (Type 4)

Drawing not to Scale
All dimensions are in mm

Fig. 9.12 : Handles for Doors and Windows

TABLE 2A DIMENSIONS OF DOOR HANDLES

(Fig. 9.12.1 to 9.12.3)

All dimensions in millimetres

Type of Head	Ref to. Fig.	Sizes	A	B	C	D	E	F	G	H	I	Screw Holes*	
			Min	Min	Min	Min	Min	Min	Min	Min	Min	No. in Each Lug	Size Designation of Counter-sunk Head Wood Screw (see IS 6760-1972#)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
1.	9.12.1A	75	125	75	20	2.5	5	8	15	-	-	2	6
		100	150	100	25	3.0	8	10	20	-	-	2	6
		125	190	125	25	4.0	10	12	22	-	-	2	6
		150	215	150	30	1.5	12	15	25	-	-	2	8
	9.12.1B	75	85	75	20	2.5	5	8	15	-	-	2	6
		100	110	100	25	3.0	5	10	20	-	-	2	6
		125	140	125	25	3.0	7.5	12	22	-	-	2	6
		150	165	150	30	4.0	7.5	15	25	-	-	2	8
2.	9.12.2	75	125	75	20	-	10	16	32	20	1.0	2	6
		100	150	100	25	-	11	19	38	20	1.0	2	6
		115	175	115	28	-	13	22	45	25	1.0	3	8
		135	200	135	30	-	14	25	50	32	1.25	3	8
3	9.12.3	75	100	75	20	-	5	14	16	8	1.25	1	6
		90	125	90	25	-	6	16	20	10	1.25	2	6
		100	150	100	28	-	7	18	25	12	1.60	2	6

TABLE 2B DIMENSIONS OF DOOR HANDLES

All dimensions in millimetres.

Type	Ref to Fig.	Sizes	A	B	C	D	E#	G	Screw Holes**		
			Min		Min			Dia	No. in Each Lug	No. in a plate when a continuous Plate is used	Size Designation of Counter-sunk Head Wood Screws (see IS : 6760-1972$)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
4	9.12.4	75	115	75	25	5 ± 0.5	10 ± 0.5	30 +0 −1	2	4	6
		100	140	100	30	5 ± 0.5	10 ± 0.5	30 +0 −1	2	4	6
		125	175	125	35	5 ± 0.5	12 ± 0.5	38 +0 −1	3	6	6
		150	200	150	35	5 ± 0.5	12 ± 0.5	38 +0 −1	3	6	6

In case a continuous base plate is used, the thickness may be reduced to 3 mm.

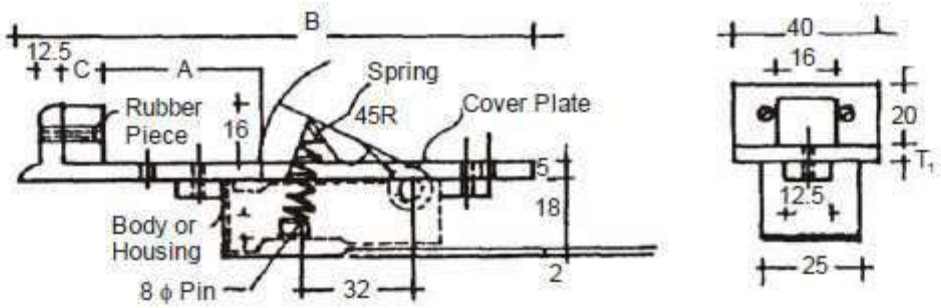
\# Hexagonal or round.

** More evenly placed screw holes may be provided, if so required by the purchaser.

$ Specification for slotted countersunk head wood screws.

FLOOR DOOR STOPPER - CAST TYPE

Sub Head : Wood Work and PVC Work
Clause : 9.15.20



DIMENSION

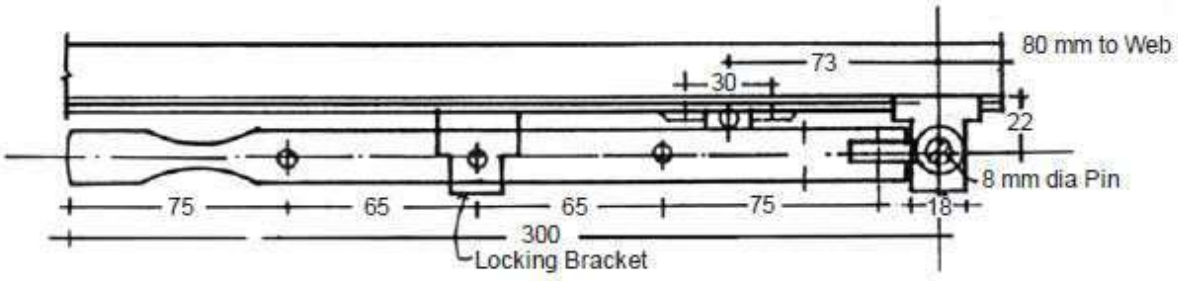
Thickness of Door Shutter	*A*	*B*	*C*	*Casting T_1*	*Screw Designation No.*	*No. of Holes for T_1*
30	35.0 ± 0.5	140.0 ± 0.5	13	4.5 + 0.3 -0	9	4
35	40.0 ± 0.5	140.0 ± 0.5	8	4.5 ± 0.3 -0	9	4
40	45.0 ± 0.5	150.0 ± 0.5	13	4.5 + 0.3 - 0	9	4
45	50.0 ± 0.5	150.0 ± 0.5	8	4.5 + 0.3 - 0	9	4

Drawing not to Scale
All dimensions are in mm

Fig. 9.13 : Floor Door Stopper – Cast Type

WINDOW STAY

Sub Head : Wood Work and PVC Work
Clause : 9.15.23

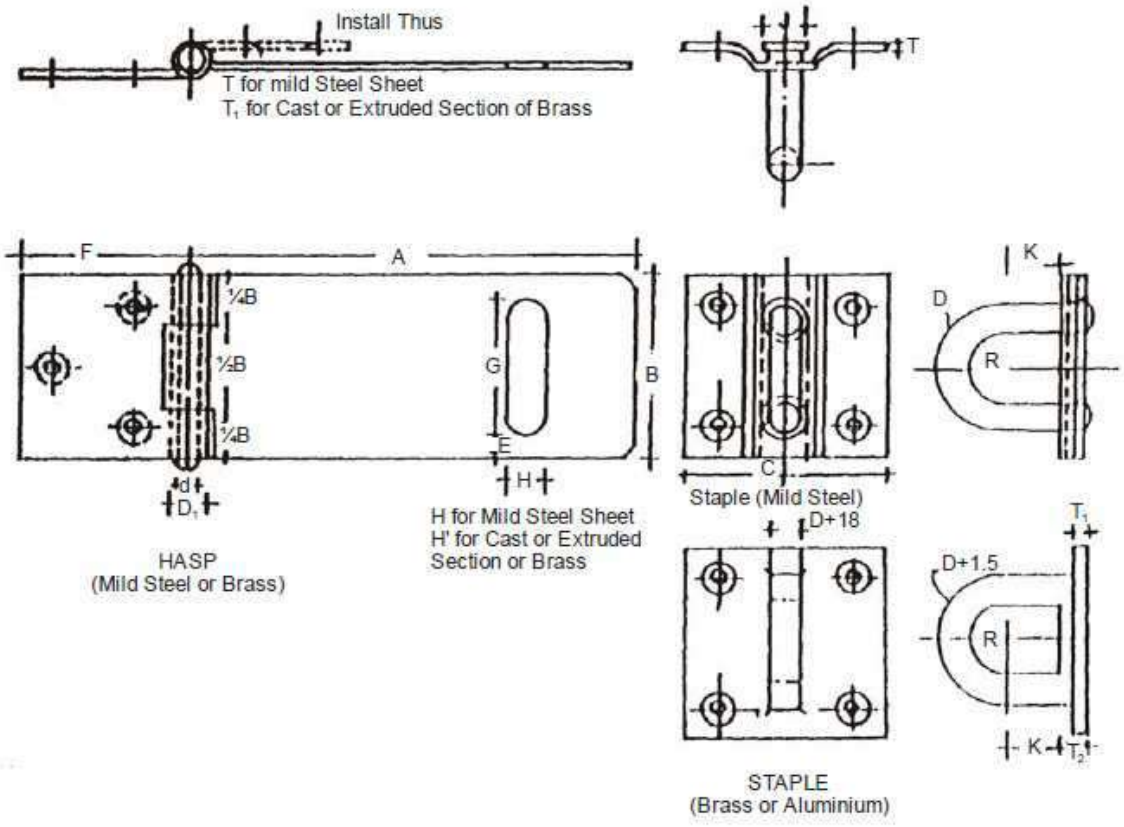


Drawing not to Scale
All dimensions are in mm

Fig. 9.14 : Window Stay

HASP & STAPLES

Sub Head : Wood Work and PVC Work
Clause : 9.15.25



MILD STEEL

Size	A	B	C	D	E	F	G	H	J	K	R	Thick-ness of Sheet T	Dia of Hinge Pin d	Screw Holes No. on Hasp	Screw Holes No. on Staple	Screw Desig-nation No.
90	90±2	38±1.5	46±2	5.0± .10	5.0± .5	35±1.5	28±1.5	8±.5	12±1	8±1	8±.5	2± .10	4± .10	3	4	8
115	115±2	38±1.5	46±2	5.0± .10	5.0± .5	55±1.5	28±1.5	8±.5	12±1	8±1	8±.5	2± .10	4± .10	3	4	8
150	150±2	45±1.5	60±2	6.30± .10	6.0± .5	65±1.5	33±.5	10±.5	15±1	14±1	9±.5	2.24± .10	5± .10	4	4	10

BRASS CAST OR EXTRUDED

Size	A	B	C	D	E	F	G	H	K	R	Thick-Ness T_1	Thick-Ness T_2	Dia of Hinge Pin d	Dia of Butt D_1	Screw Holes No. on Hasp	Screw Holes No. on Staple	Screw Desig-nation No.
90	90±2	40±1.5	42±1.5	5±.25	6±.5	35±1	28±.5	10±.5	8±1	6.5±.5	2±.25	3±.25	3.15±.10	6±.2	3	4	5
115	115±2	40±1.5	42±1.5	5±.25	6±.5	45±1	28±.5	10±.5	11±1	6.5±.5	2±.25	3±.25	3.15±.10	6±.2	3	4	8
150	150±2	46±1.5	48±1.5	6±.25	7±.5	65±1	32±.5	11±.5	14±1	7.5±.5	3±.25	4±.25	4±.10	8±.2	4	4	0

Drawing not to Scale
All dimensions are in mm

Fig. 9.15 : Hasp & Staples

LVL SHUTTER

Sub Head : Wood Work and PVC Work
Clause : 9.16.6

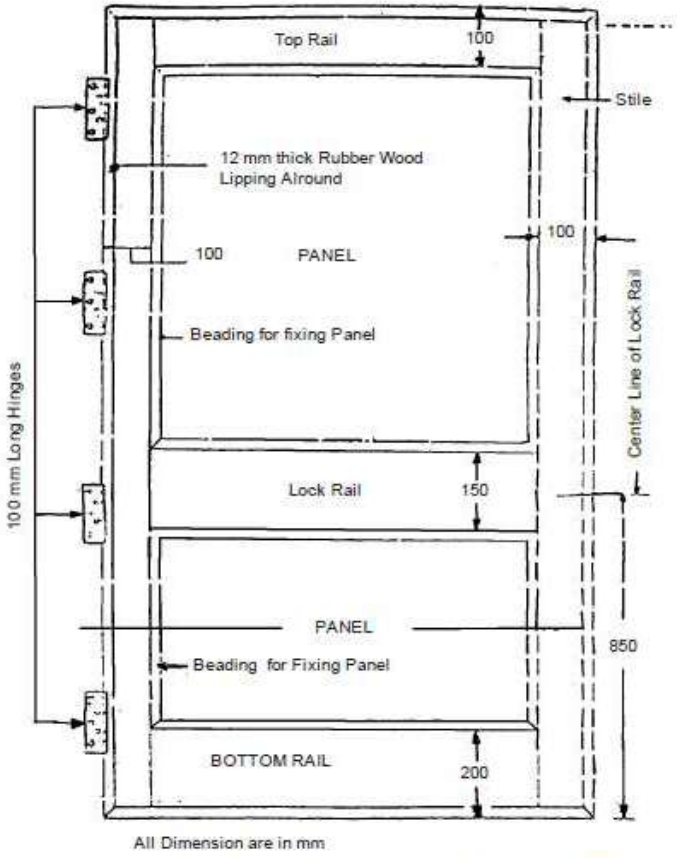


Fig. 9.16 : Typical Illustratino of Panelled LVL Door Shutter

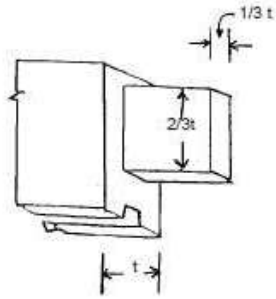


Fig. 9.16A : Single Tenon Joint

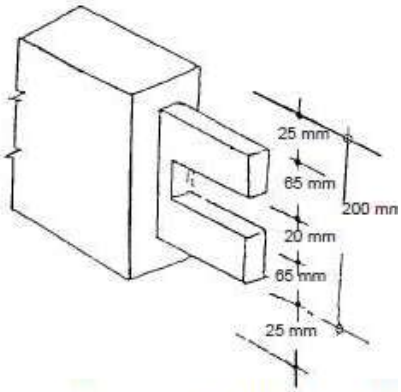


Fig. 9.16B : Double Tenon Join

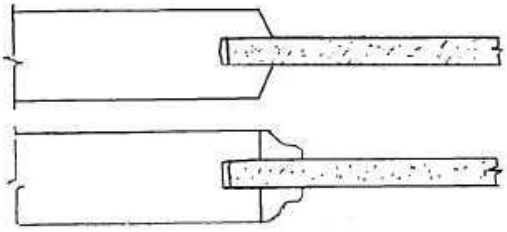


Fig. 9.16C : Common Methods of Joining Panel with Stiles and Rails with/ without Beading

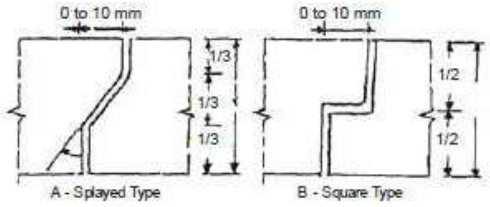
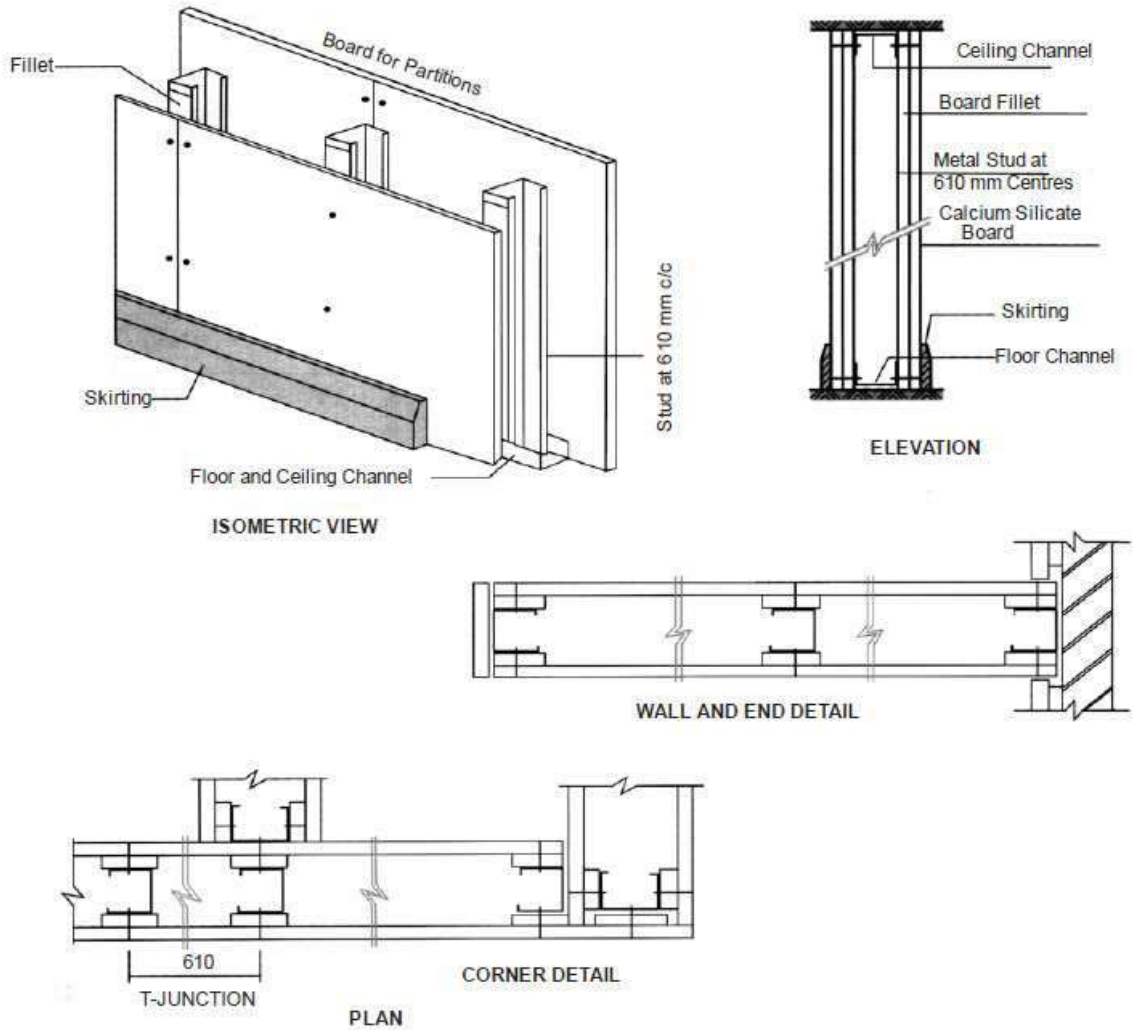


Fig. 9.16D : Meeting of Stiles for Double Leaved Door Shutters

Fig. 9.16 : LVL Shutter

PARTITIONS

Sub Head : Wood Work and PVC Work
Clause : 9.17.2



DETAILS		
Board 8 / 10 / 12 mm	Thick	One layer board on each side of studs
Board Fillets	60 / 100 mm	On each side of all studs and channels
Floor/Ceiling Channel	50 x 32 x 32 x 0.55 mm	Top and bottom perimeter of the partition
Stud	48 x 50 x 48 x 0.55 mm	Vertically at 610 mm c/c
Bracing Member	45 x 15 x 15 x 0.9 mm	At horizontal board joint on both side
Screws (C/S head)	25 & 35 mm long, self drilling with under head cutter	12 mm from the edge & 40 mm from the corner of the board at 200 mm c/c

Fig. 9.17 : Partitions

UPVC DOOR FRAME

Sub Head : Wood Work and PVC Work
Clause : 9.18.1

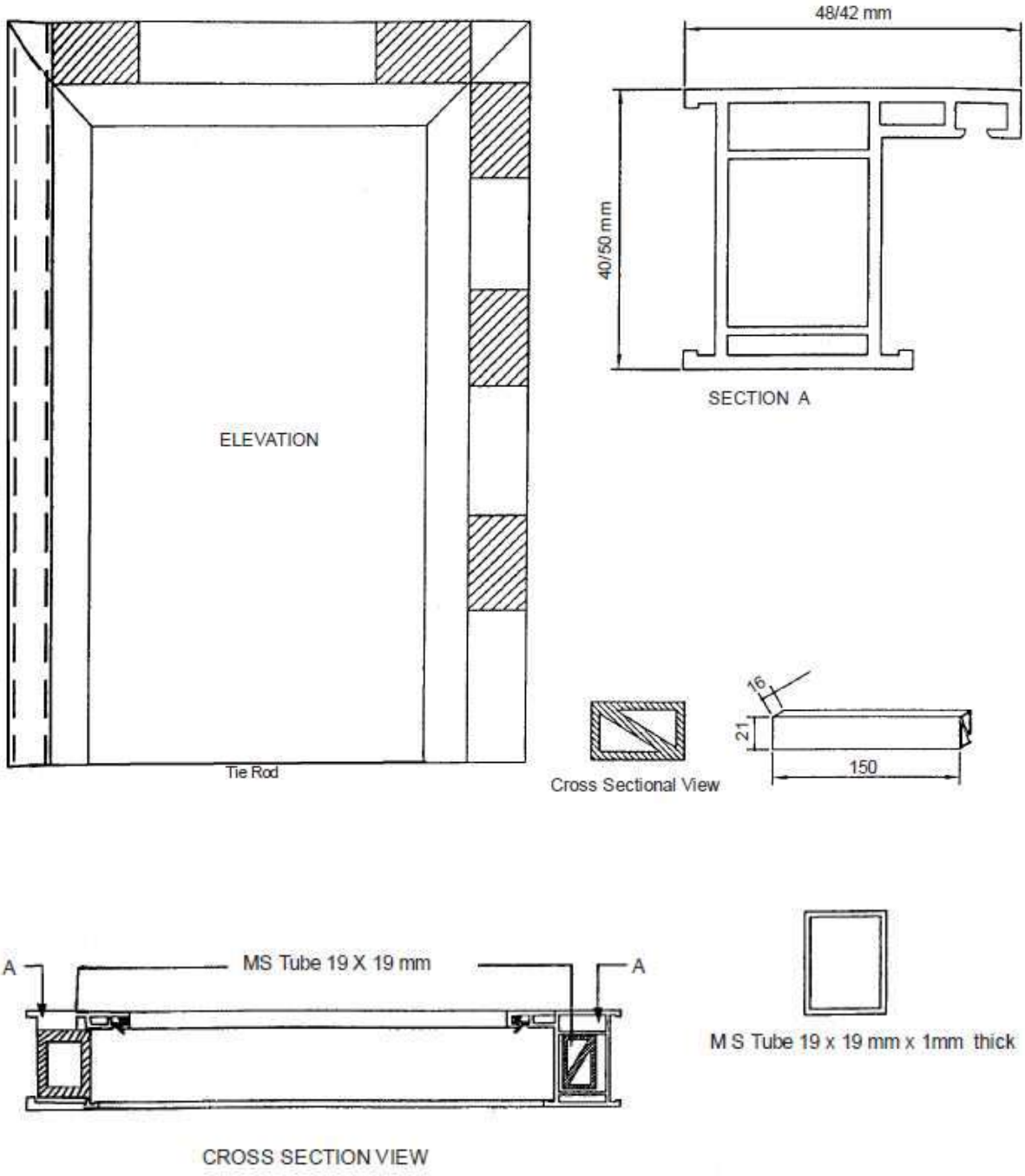


Fig. 9.18 : UPVC Door Frame

24 MM THICK PVC DOOR SHUTTERS

Sub Head : Wood Work and PVC Work
Clause : 9.19.1

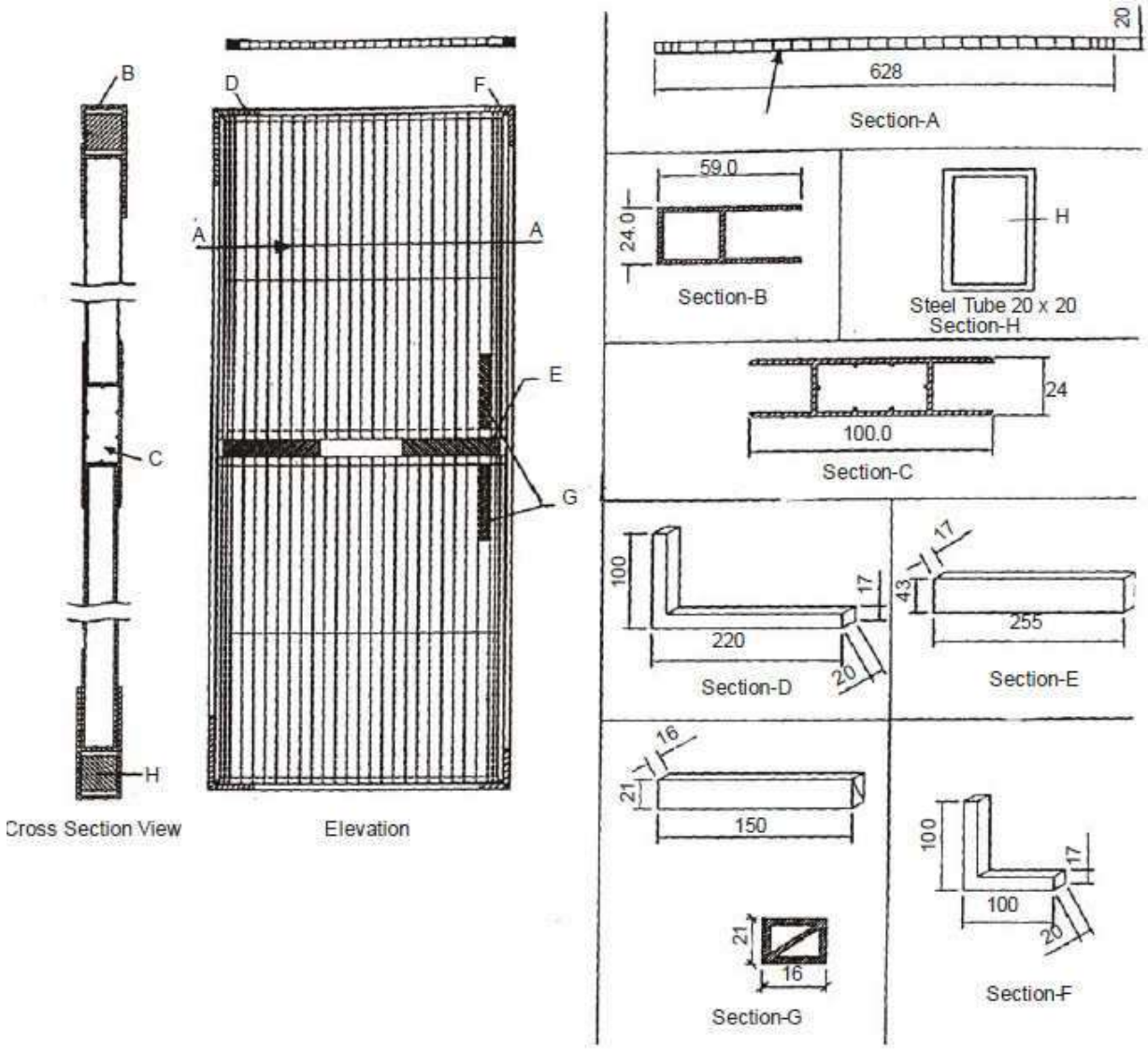


Fig. 9.19 : 24 mm Thick PVC Door Shutters

30 MM THICK PVC DOOR SHUTTERS

Sub Head : Wood Work and PVC Work
Clause : 9.19.2

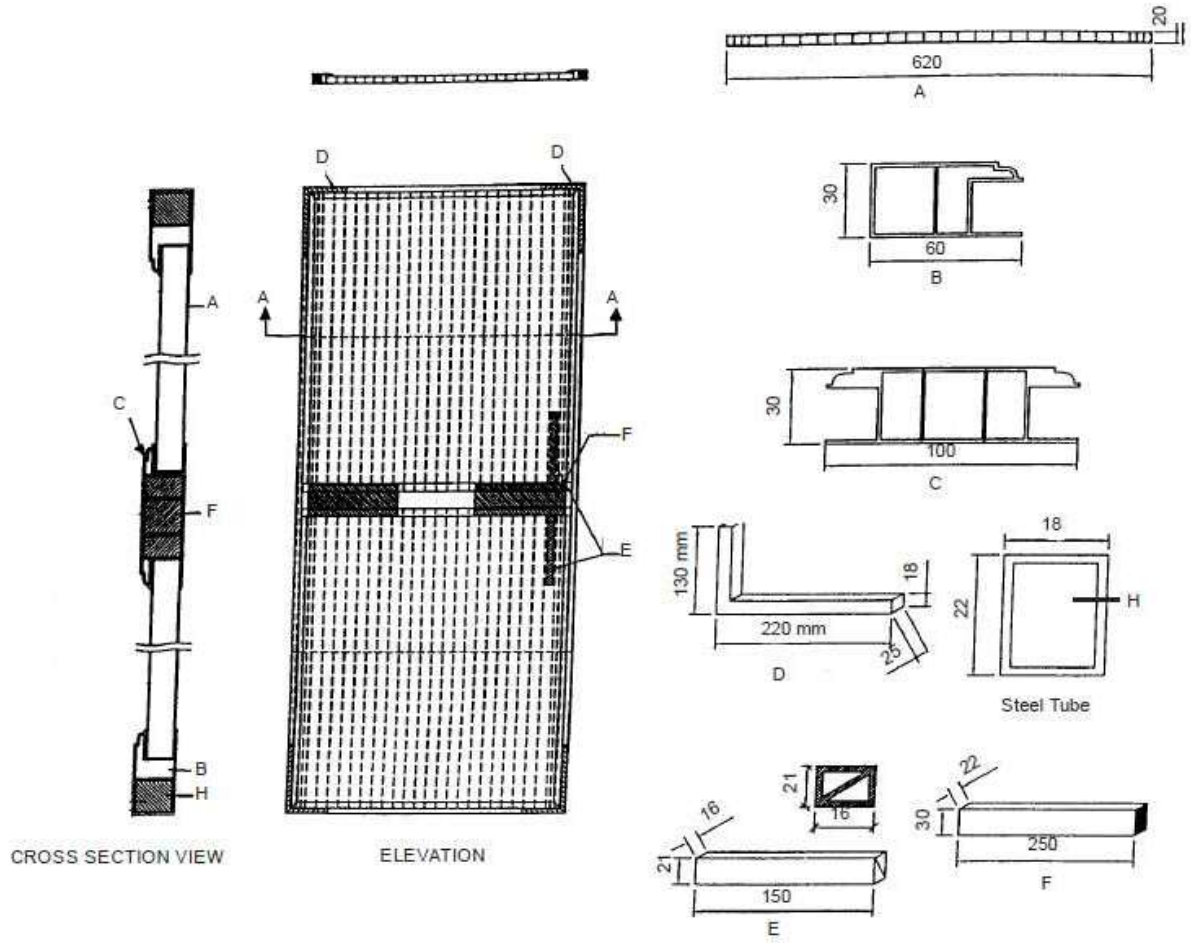


Fig. 9.20 : 30 mm Thick PVC Door Shutters

PVC DOOR FRAME

Sub Head : Wood Work and PVC Work
Clause : 9.20.1

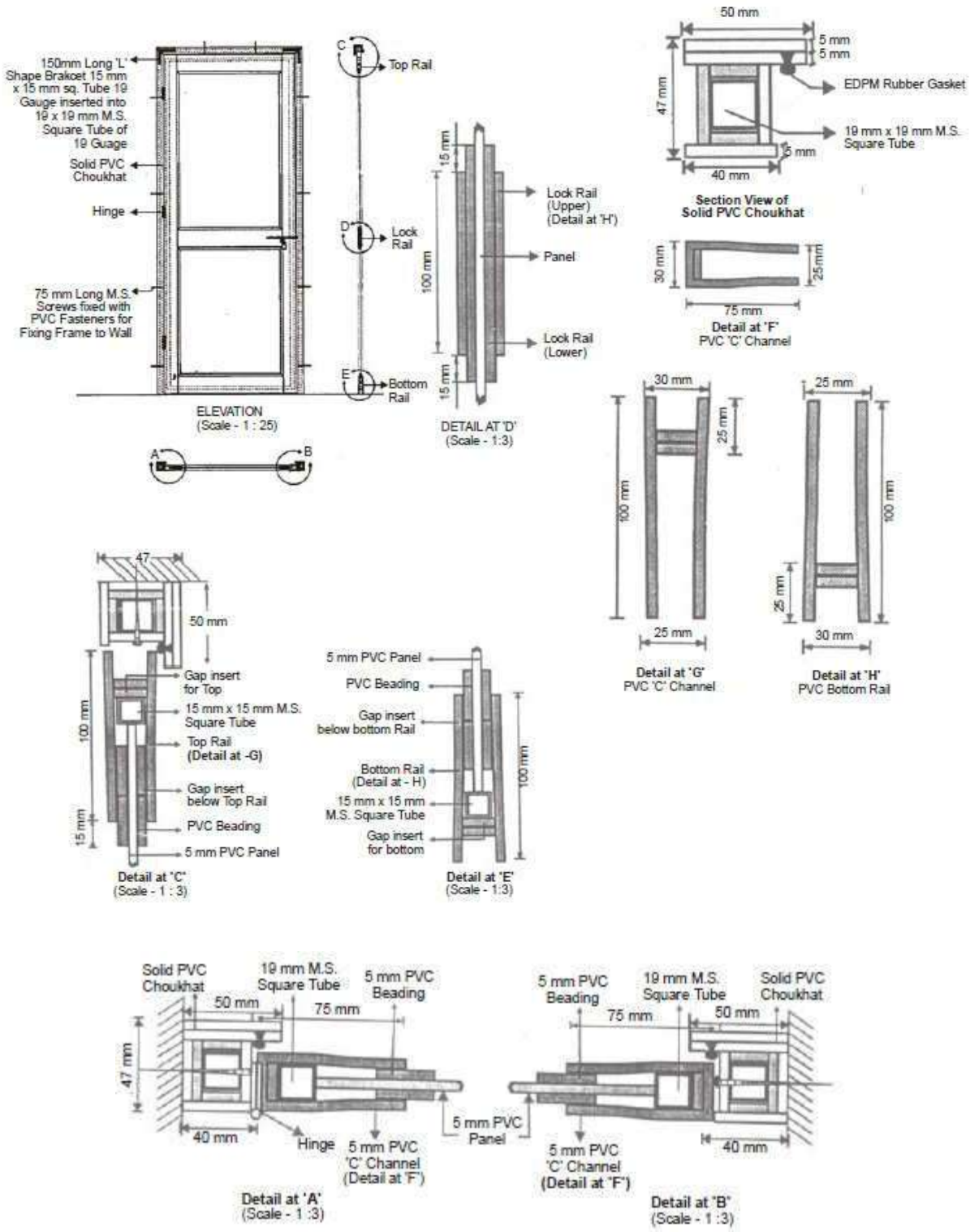


Fig. 9.21 : PVC Door Frame

30 mm THICK PANEL PVC DOOR SHUTTER

Sub Head : Wood Work and PVC Work
Clause : 9.21.1(a)

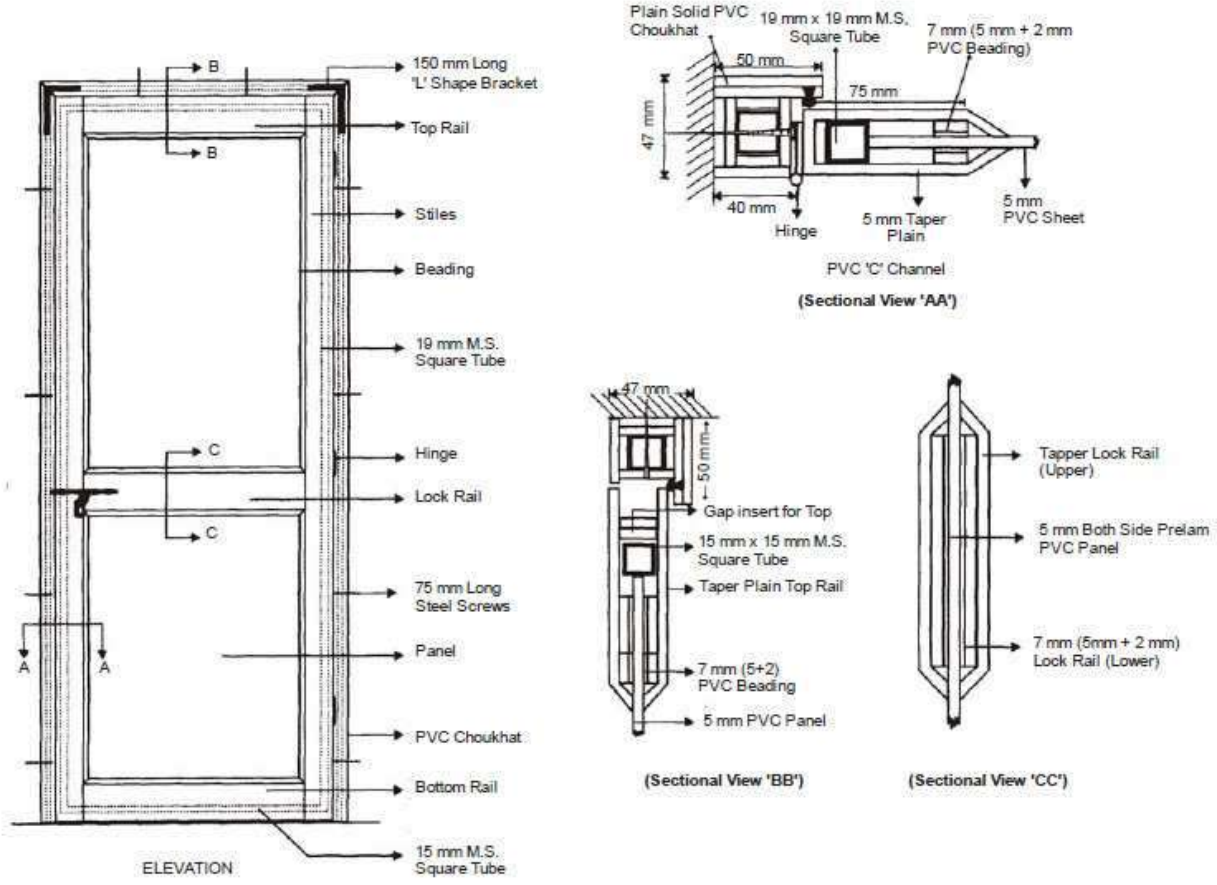


Fig. 9.22 : 30 mm Thick Panel PVC Door Shutter

FRP DOOR FRAME

Sub Head : Wood Work and PVC Work
Clause : 9.22.0

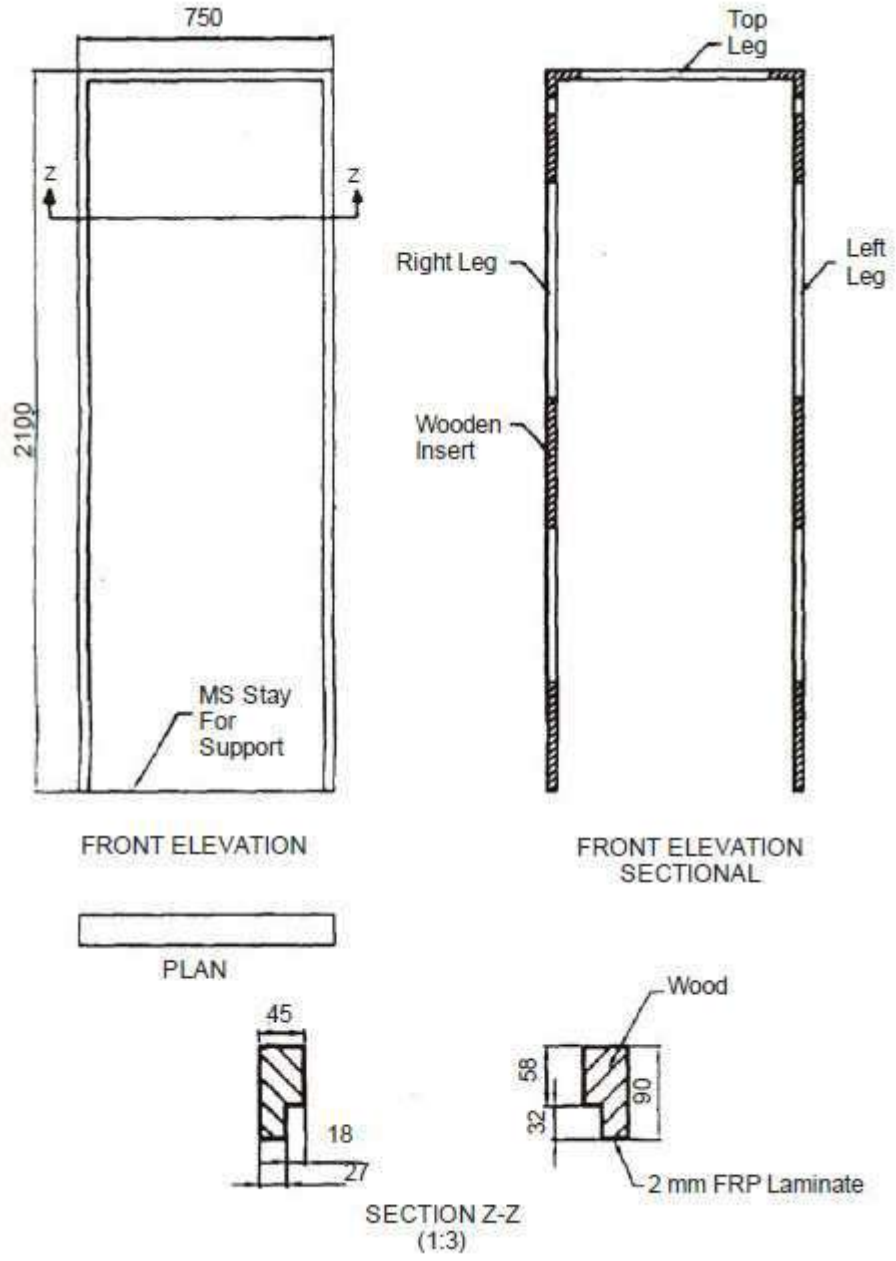
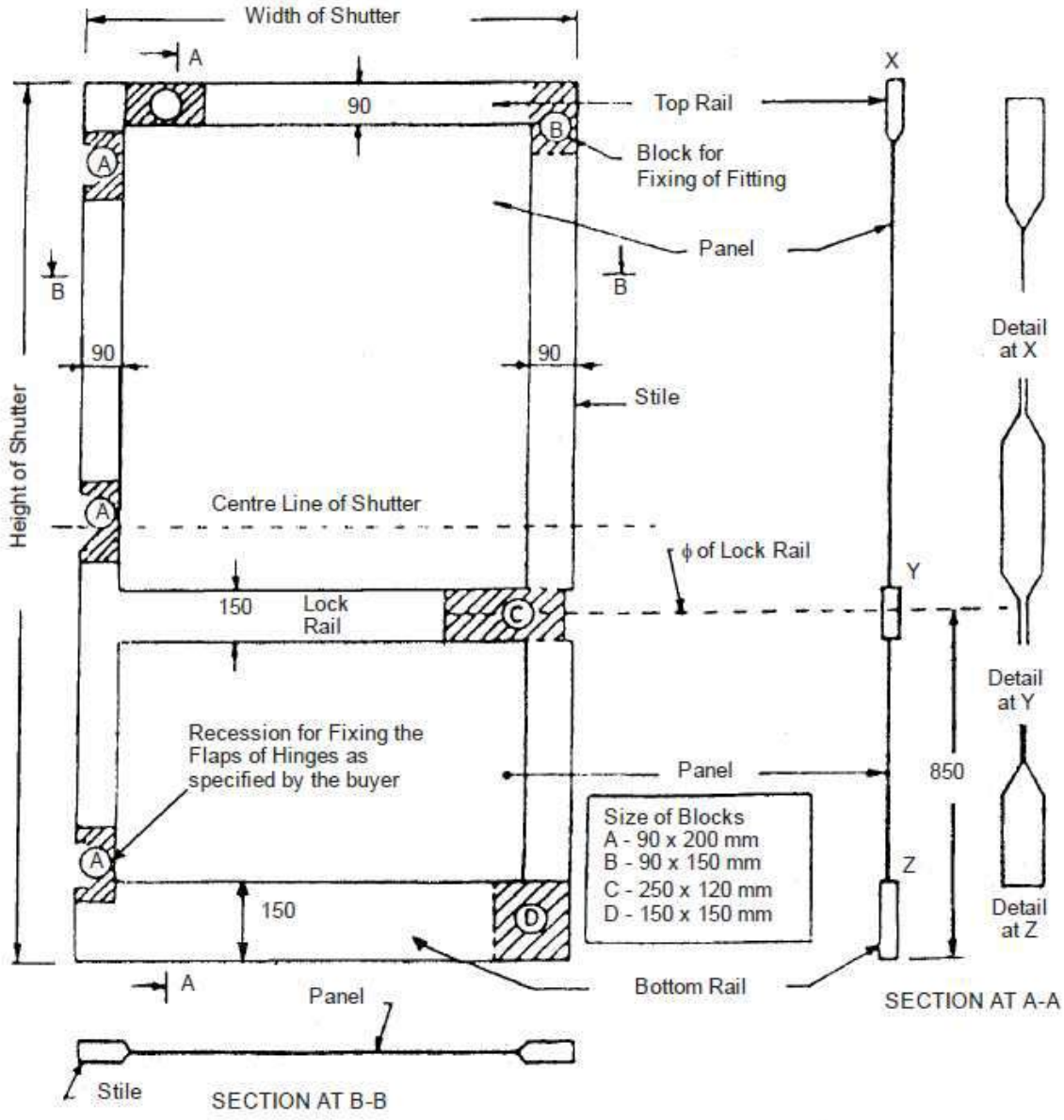


Fig. 9.23 : FRP Door Frame

TYPICAL SKETCH OF FRP DOOR SHUTTERS

Sub Head : Wood Work and PVC Work
Clause : 9.23.1



All dimensions in mm

Fig. 9.24A : Typical Sketch of FRP Door Shutters

SKETCH ILLUSTRATING DIMENSIONS OF SHUTTER

Sub Head : Wood Work and PVC Work
Clause : 9.23.1

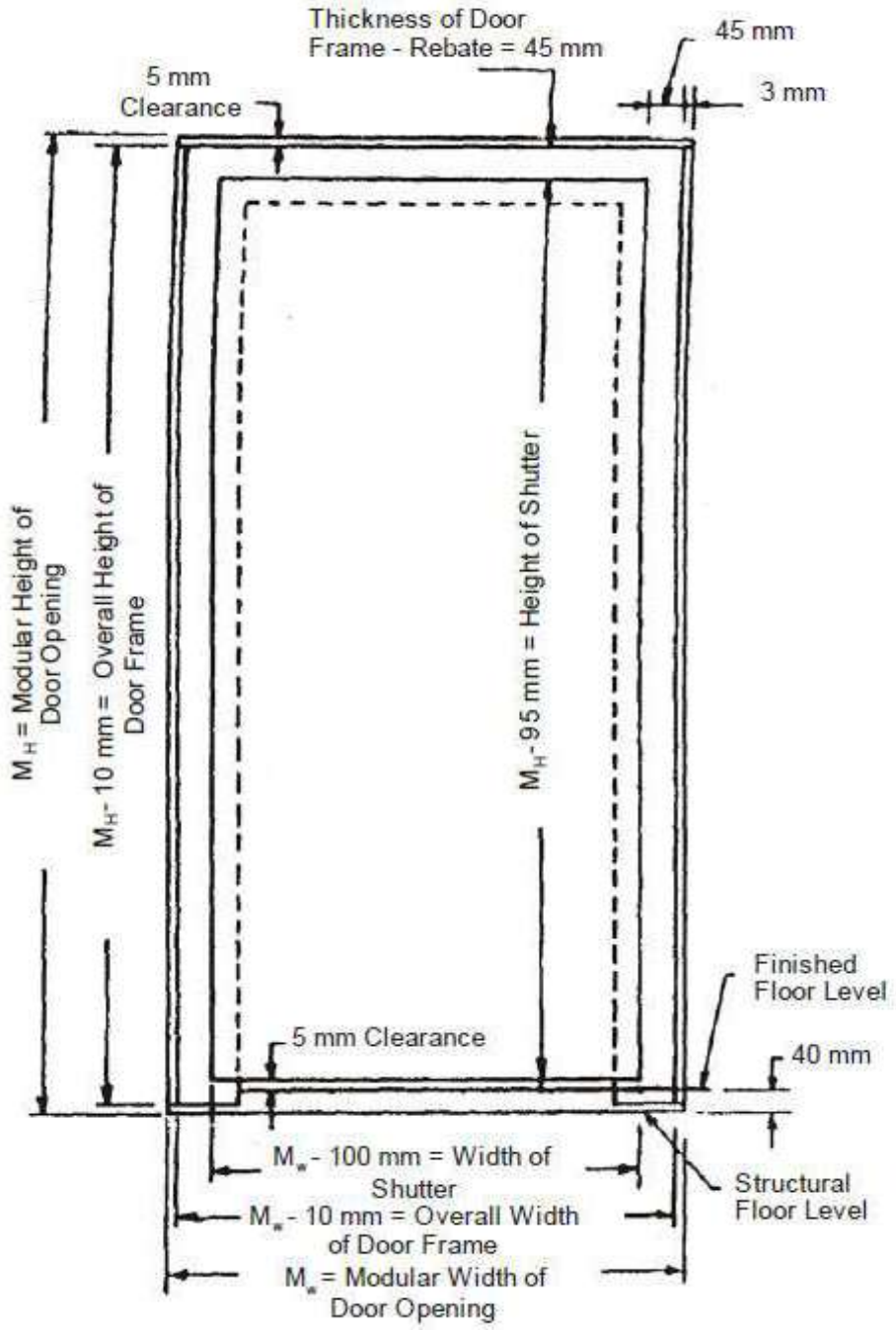
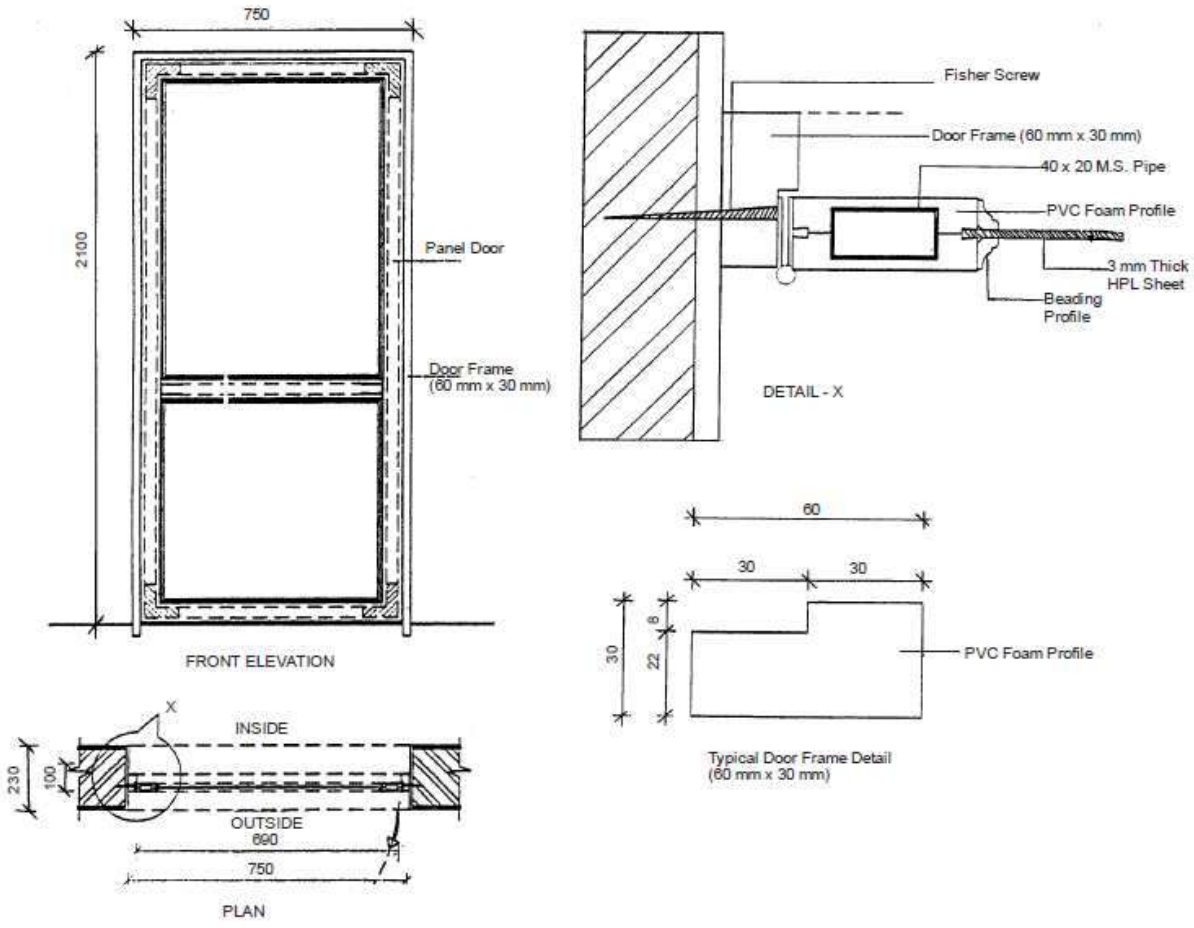


Fig. 9.24B : Sketch Illustrating Dimensions of Shutter

SINGLE REBATE DOOR FRAME

Sub Head : Wood Work and PVC Work
Clause : 9.24.1



Drawing not to scale
Al dimensions are in mm

Fig. 9.25 : Solid PVC Foam Profile Frame

DOOR SHUTTER DETAIL (28 MM THK - FABRICATION DETAIL)

Sub Head : Wood Work and PVC Work
Clause : 9.25.1

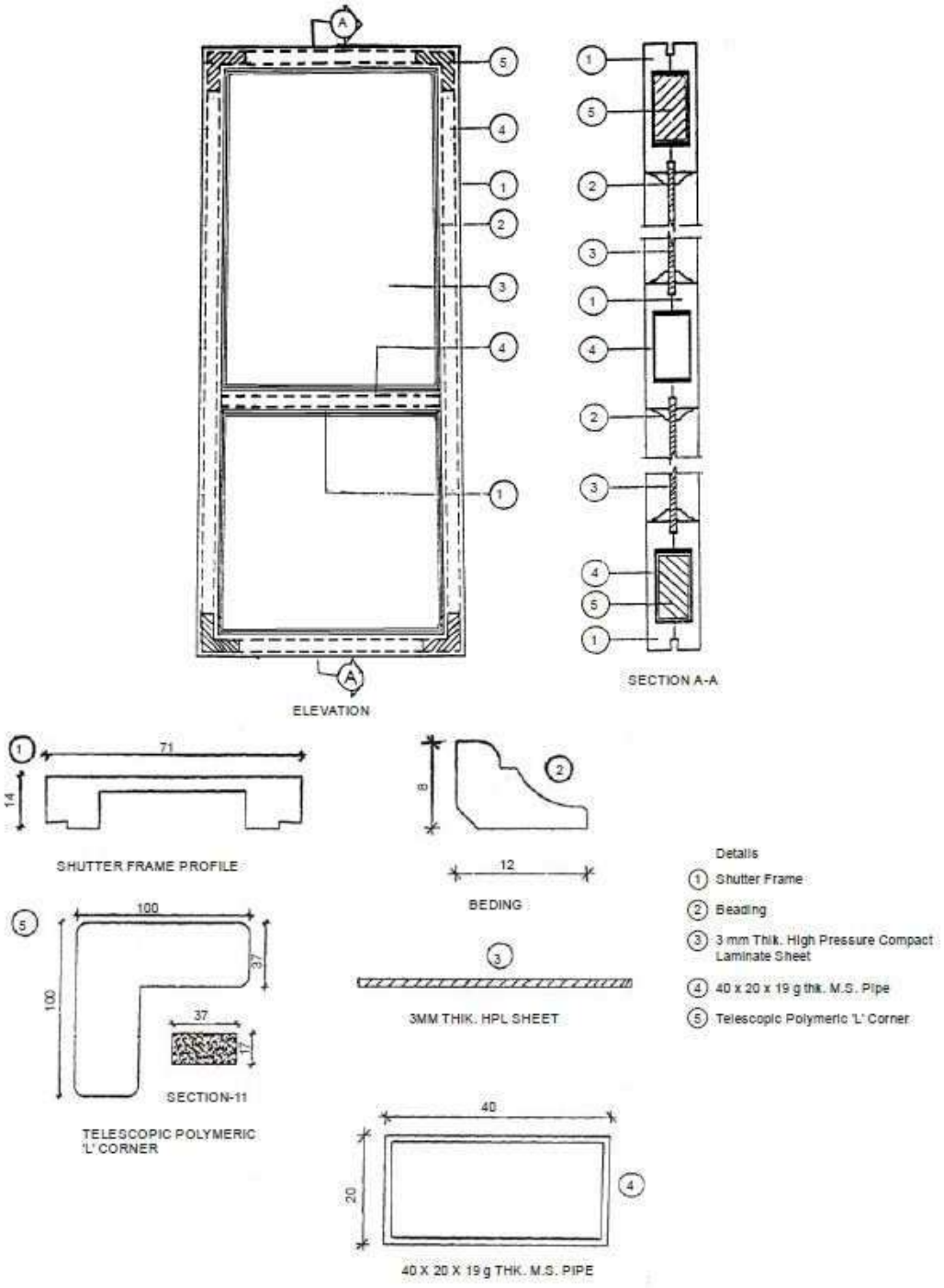


Fig. 9.26 : Solid PVC Foam Shutter (28 mm Thick - Fabrication Detail)

F.R.P. CHAJJA

Sub Head : Wood Work and PVC Work
Clause : 9.26

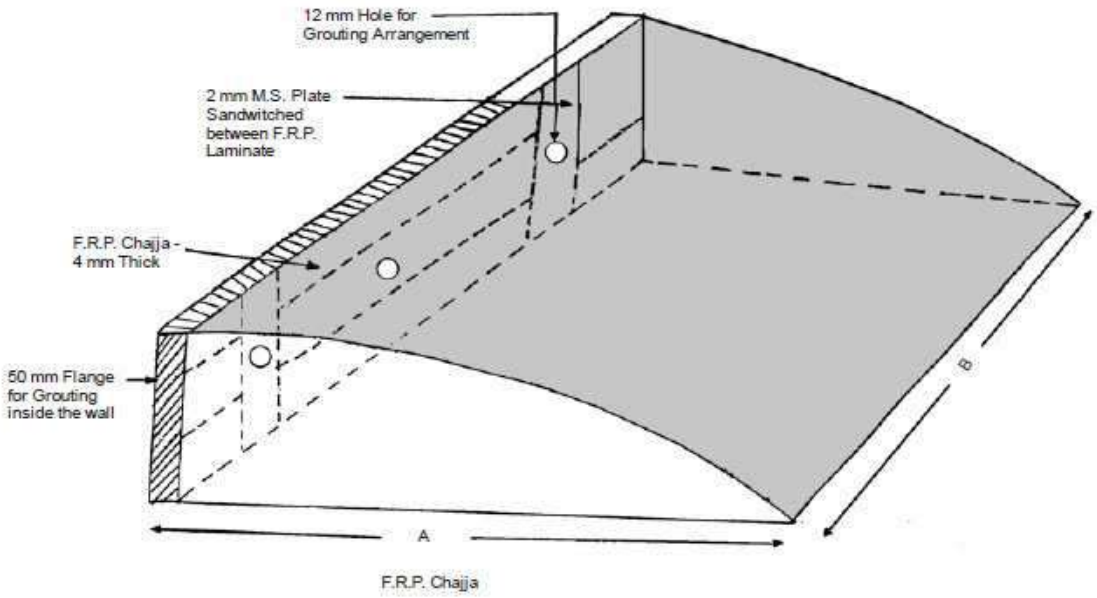


Fig. 9.27 : F.R.P. Chajja

WALL PANELLING

Sub Head : Wood Work and PVC Work
Clause : 9.27

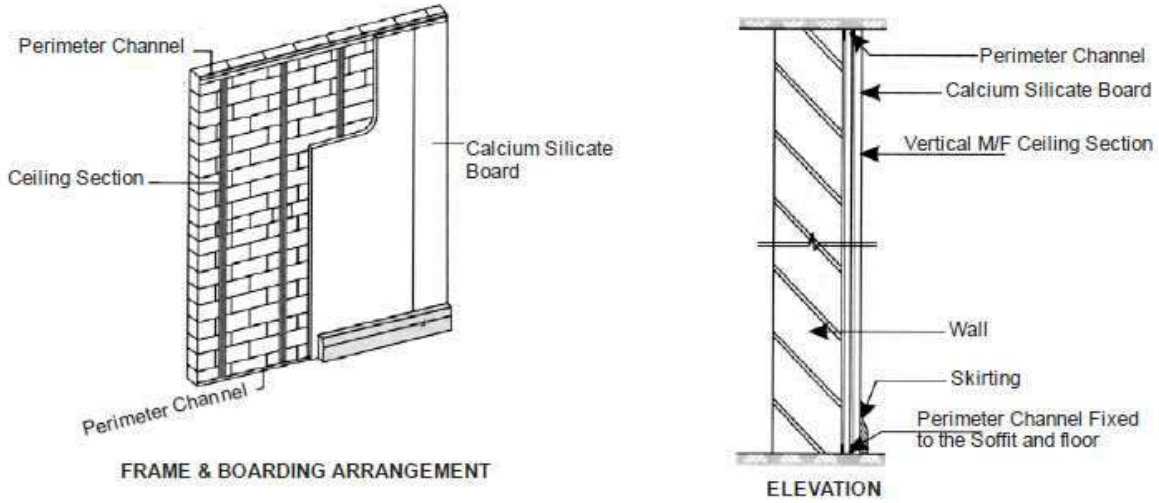


Fig. 9.28 : Wall Panelling

uPVC DOOR AND WINDOWS

SUB HEAD : WOOD WORK & PVC WORK
CLAUSE : 9.28

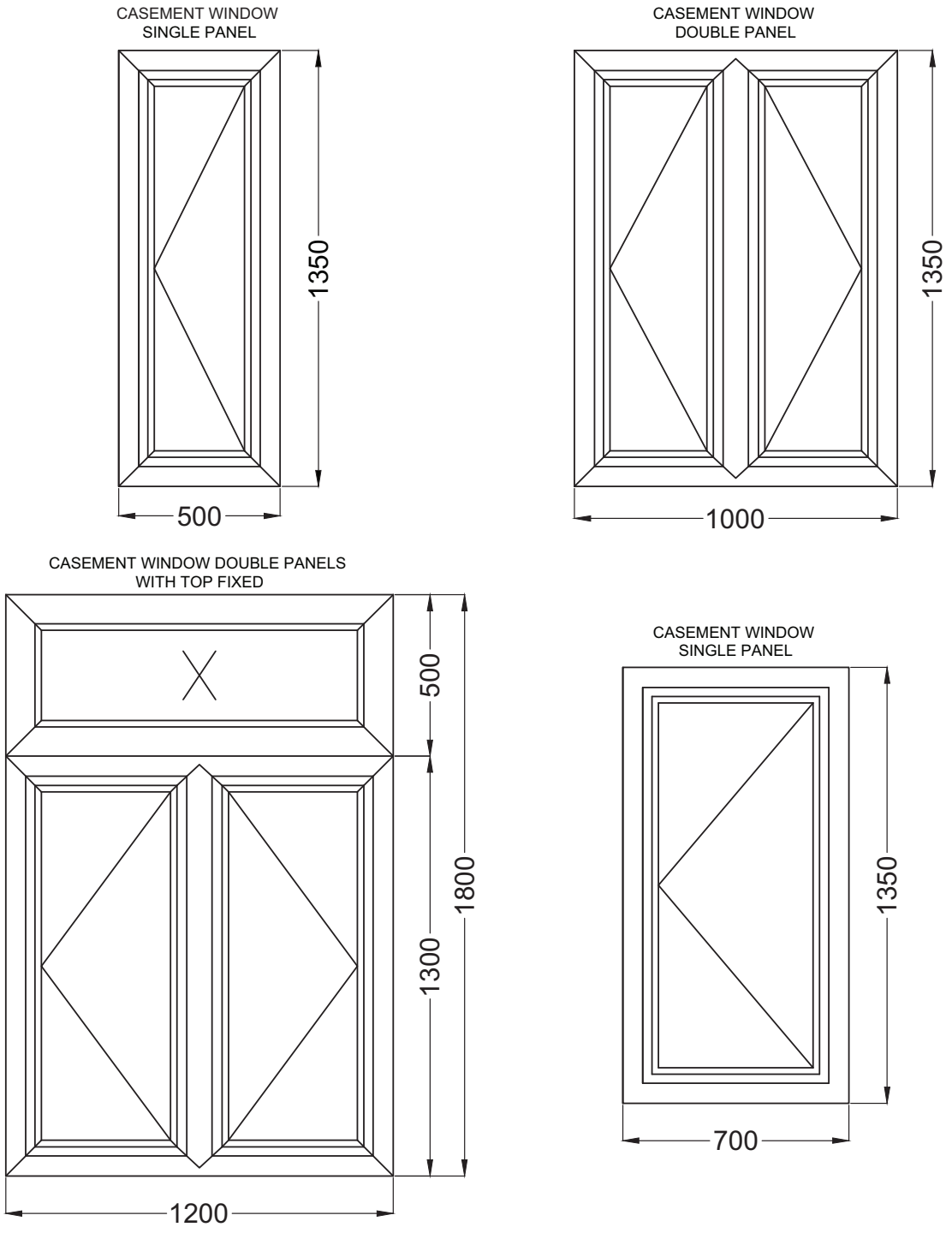


Fig. 9.29: uPVC Doors and Windows

uPVC DOOR AND WINDOWS

SUB HEAD : WOOD WORK & PVC WORK
CLAUSE : 9.28

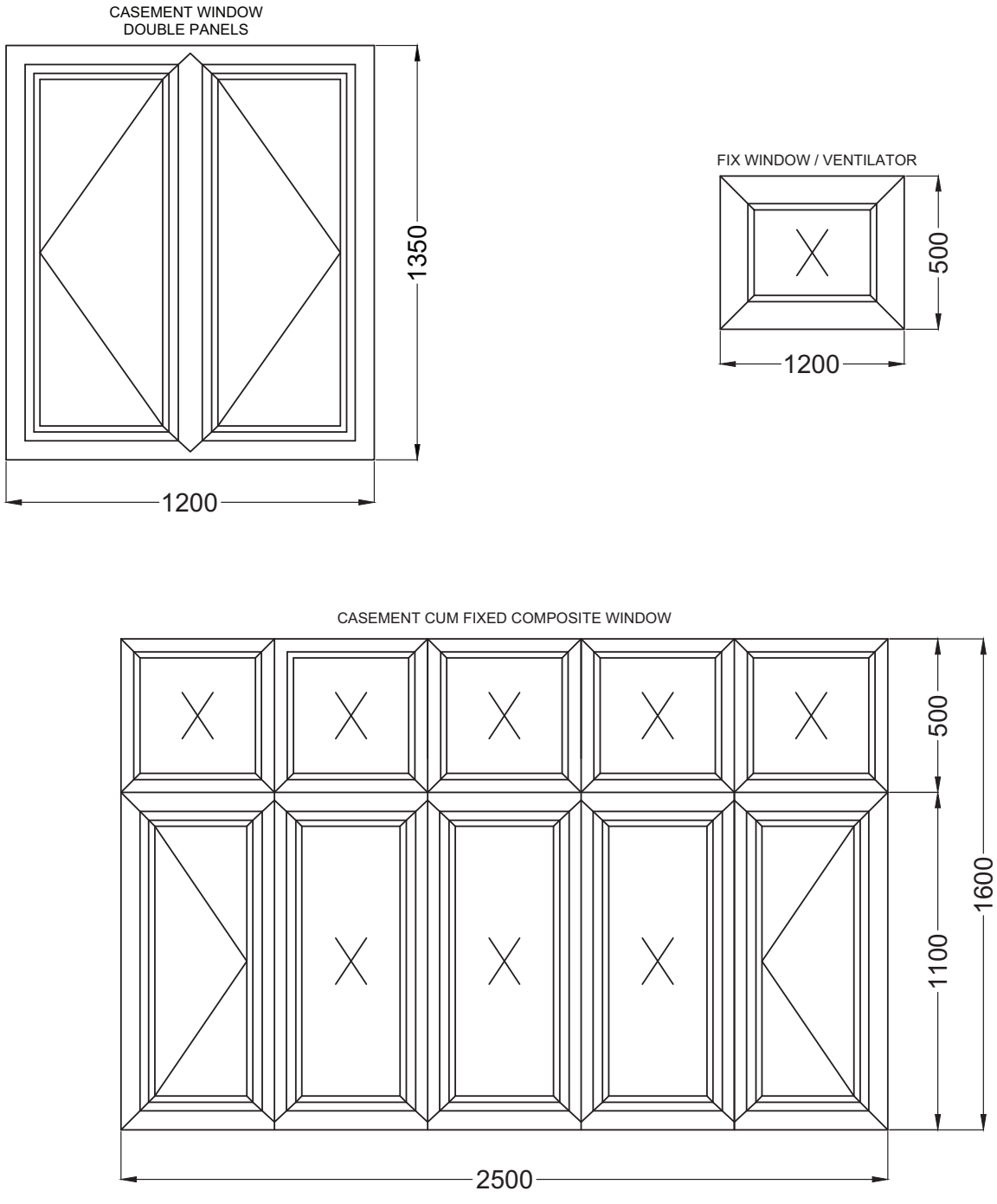


Fig. 9.30: uPVC Doors and Windows

uPVC DOOR AND WINDOWS

SUB HEAD : WOOD WORK & PVC WORK
CLAUSE : 9.28

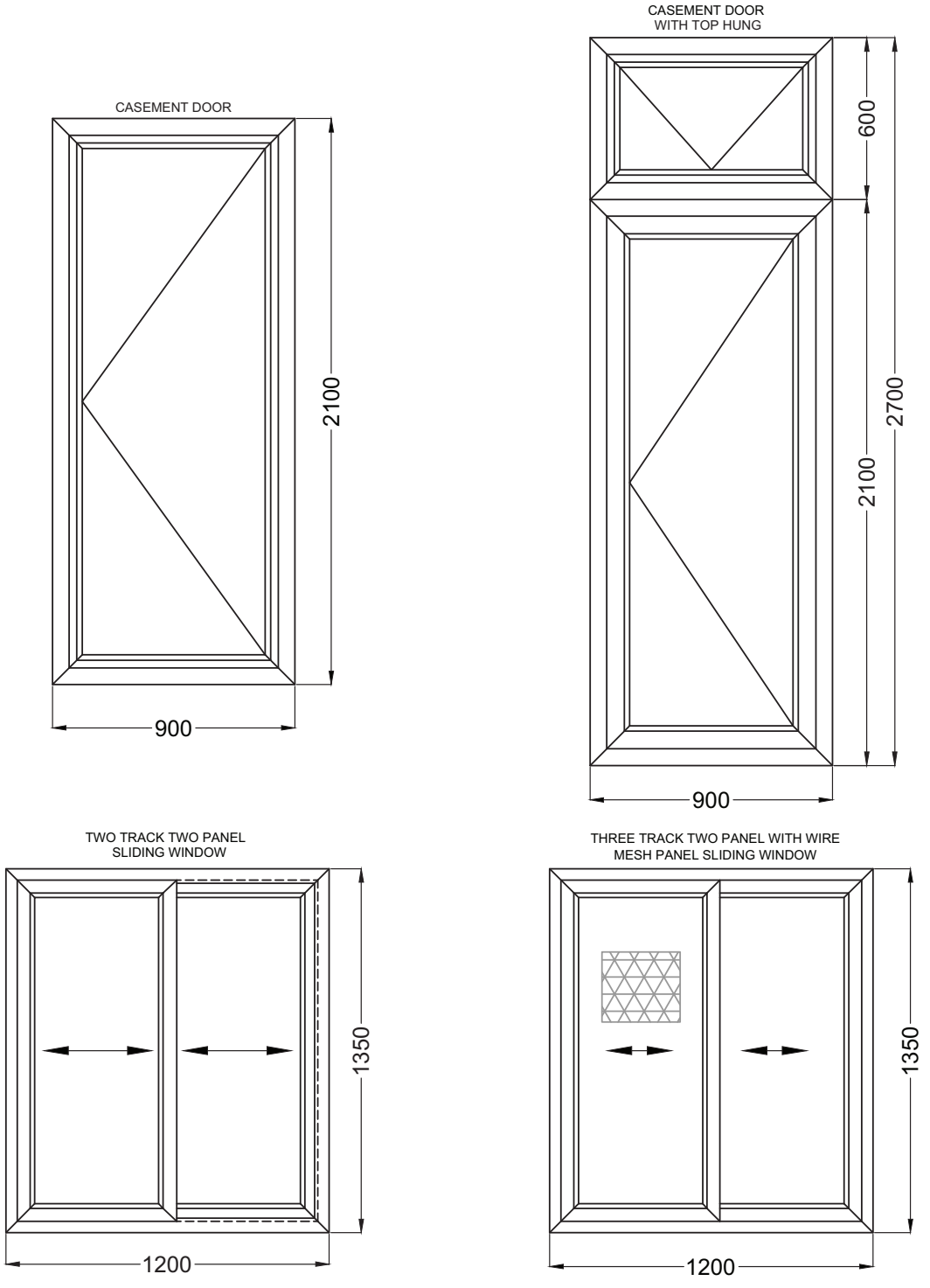


Fig. 9.31: uPVC Doors and Windows

uPVC DOOR AND WINDOWS

SUB HEAD : WOOD WORK & PVC WORK
CLAUSE : 9.28

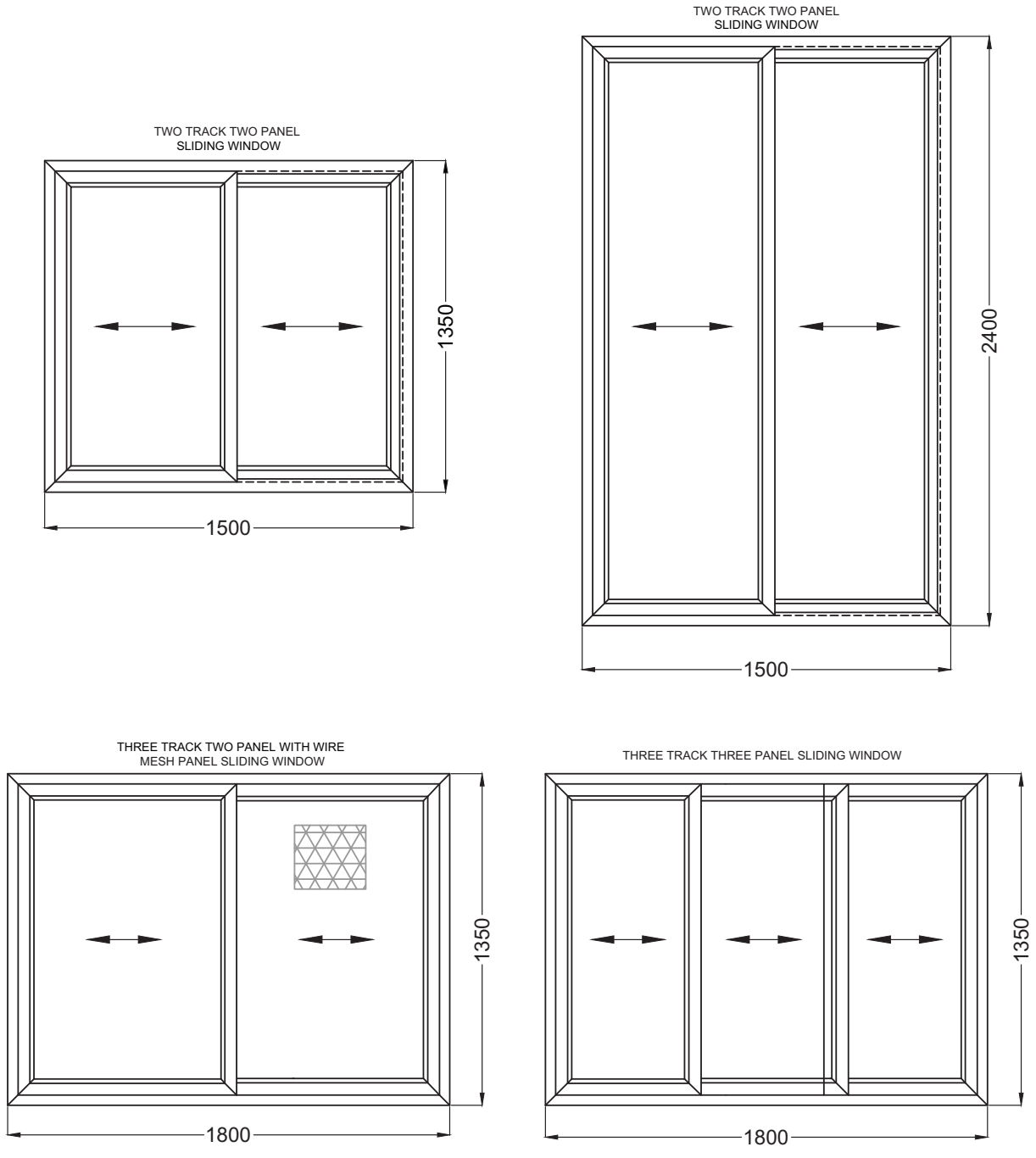


Fig. 9.32: uPVC Doors and Windows

SUB HEAD : WOOD WORK & PVC WORK
CLAUSE : 9.28

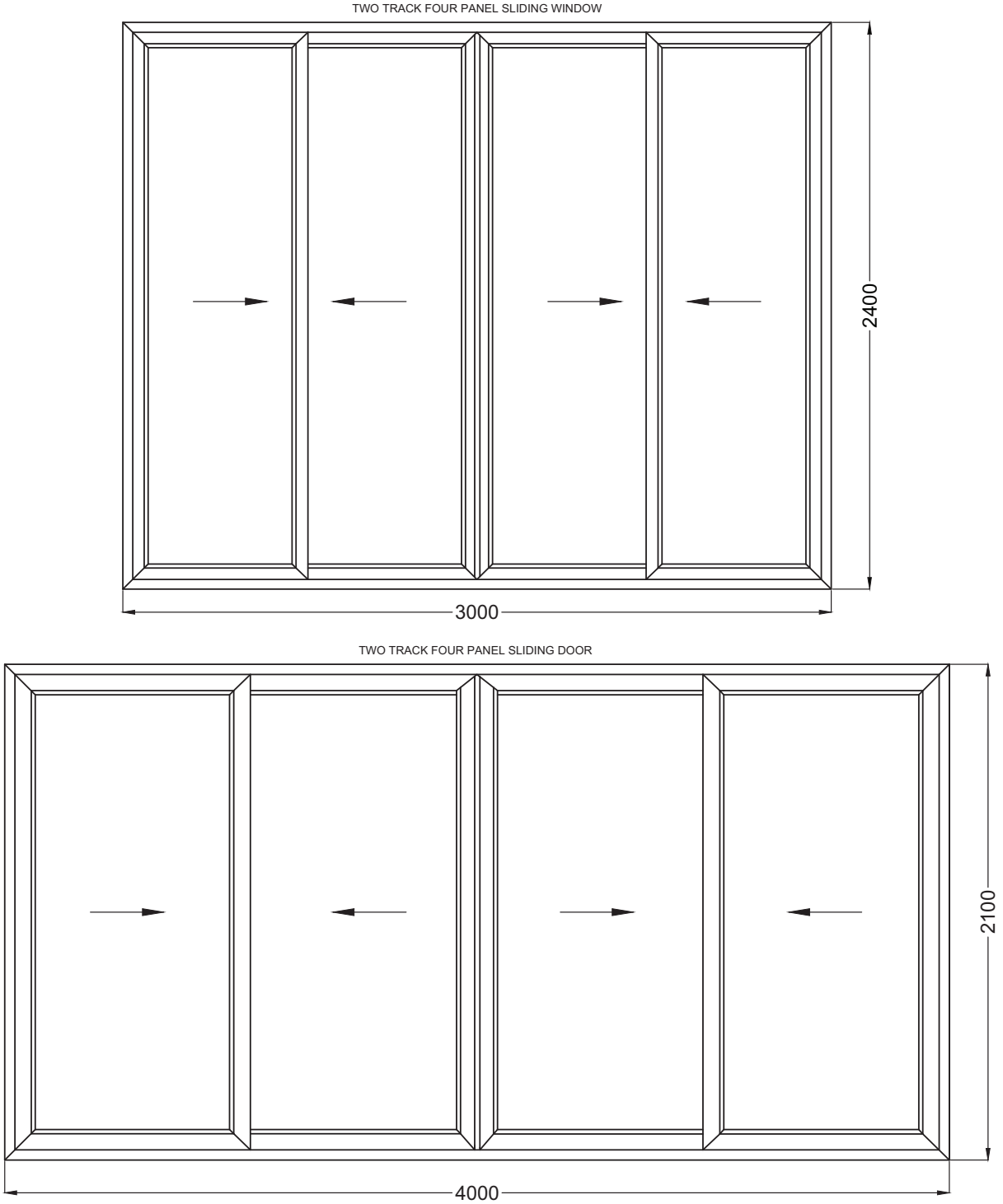


Fig. 9.33: uPVC Doors and Windows

uPVC DOOR AND WINDOWS

SUB HEAD : WOOD WORK & PVC WORK
CLAUSE : 9.28

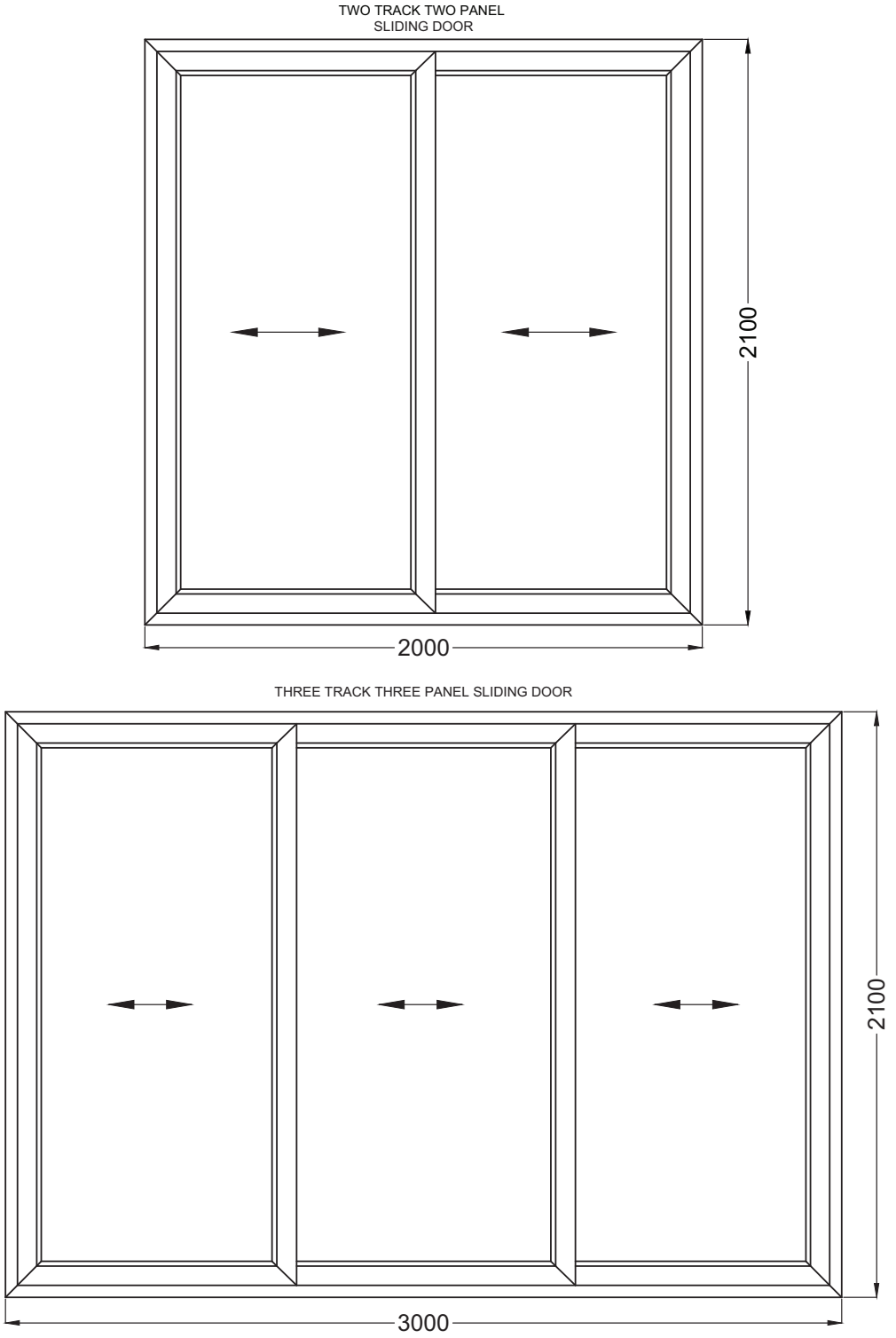


Fig. 9.34: uPVC Doors and Windows

uPVC DOOR AND WINDOWS

SUB HEAD : WOOD WORK & PVC WORK
CLAUSE : 9.28

THREE TRACK TWO PANEL WITH
WIRE MESH PANEL SLIDING DOOR

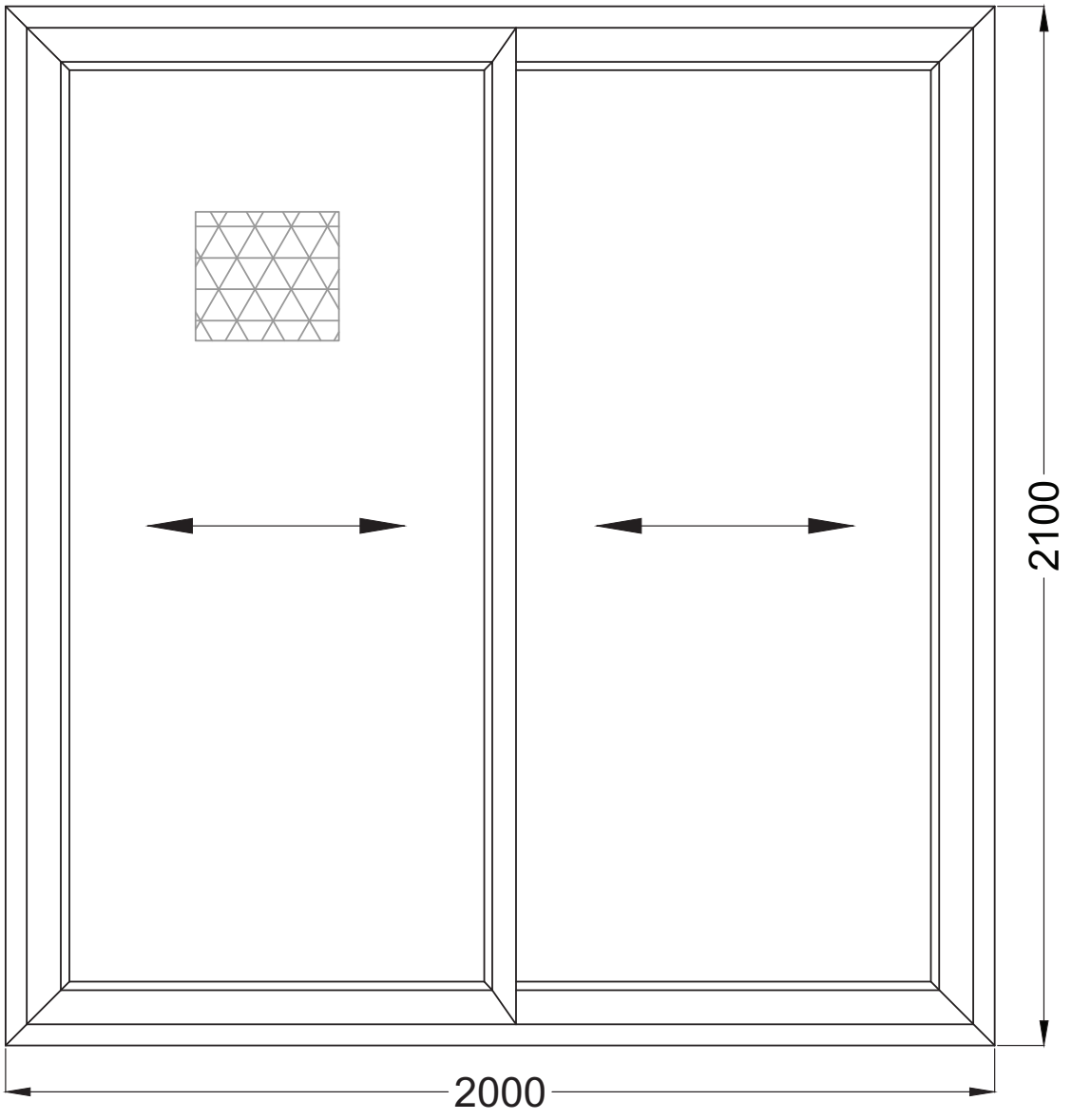


Fig. 9.35: uPVC Doors and Windows

uPVC DOOR AND WINDOWS

SUB HEAD : WOOD WORK & PVC WORK
CLAUSE : 9.28

TYPICAL CASEMENT SYSTEM

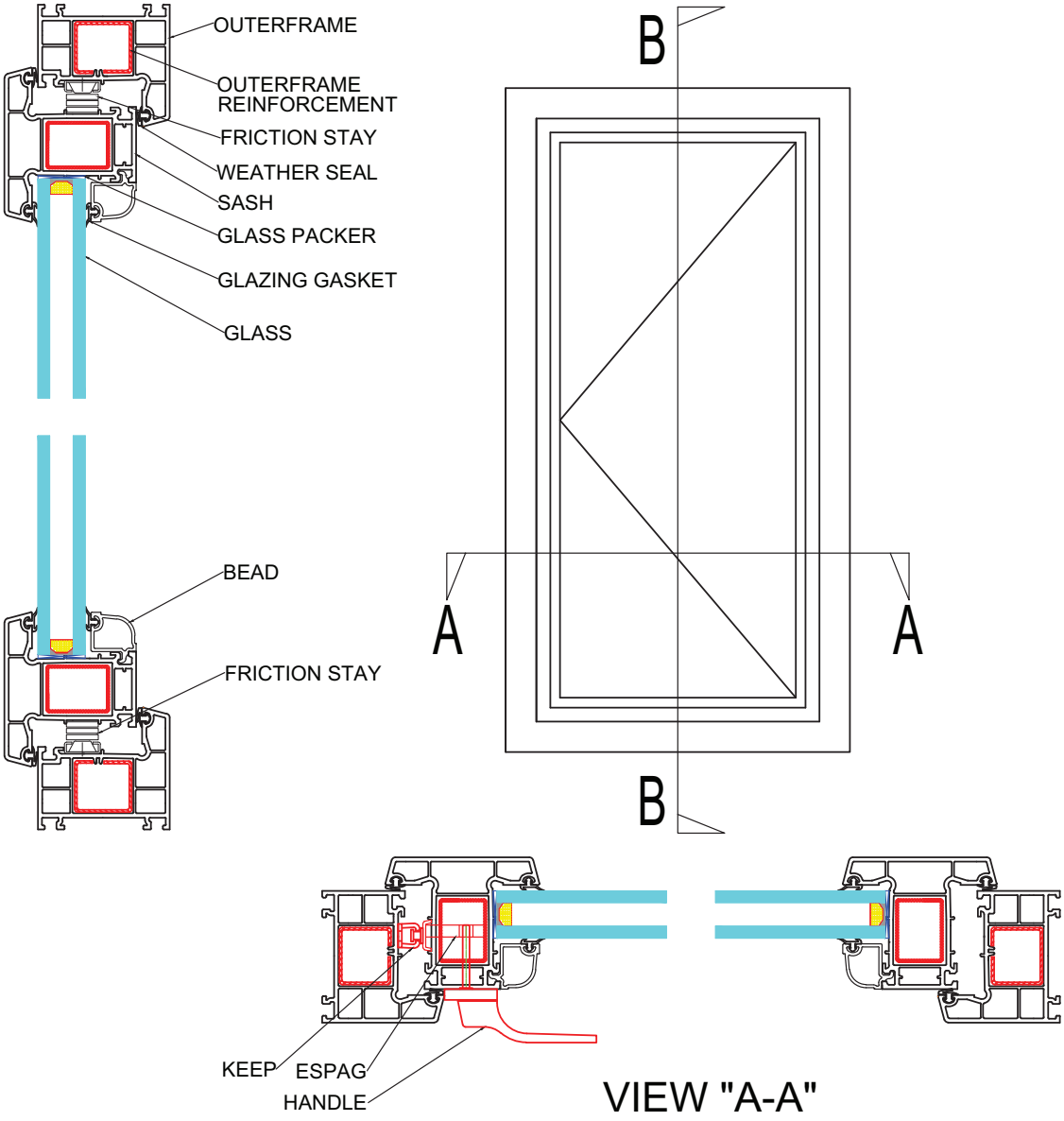


Fig. 9.36: uPVC Doors and Windows (Typical casement system)

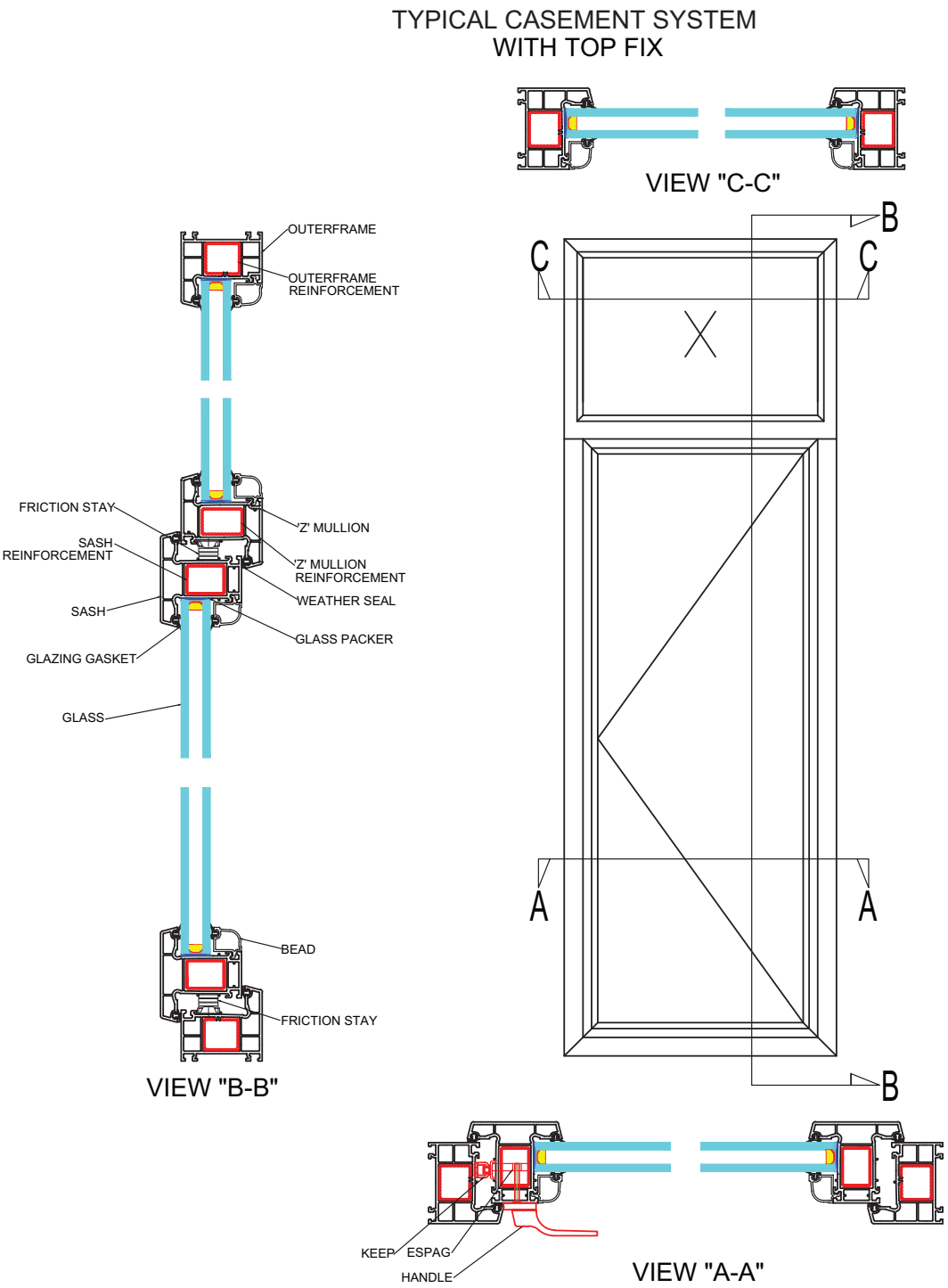


Fig. 9.37: uPVC Doors and Windows (Typical casement with top fixed system)

uPVC DOOR AND WINDOWS

SUB HEAD : WOOD WORK & PVC WORK
CLAUSE : 9.28

TYPICAL SLIDER SYSTEM

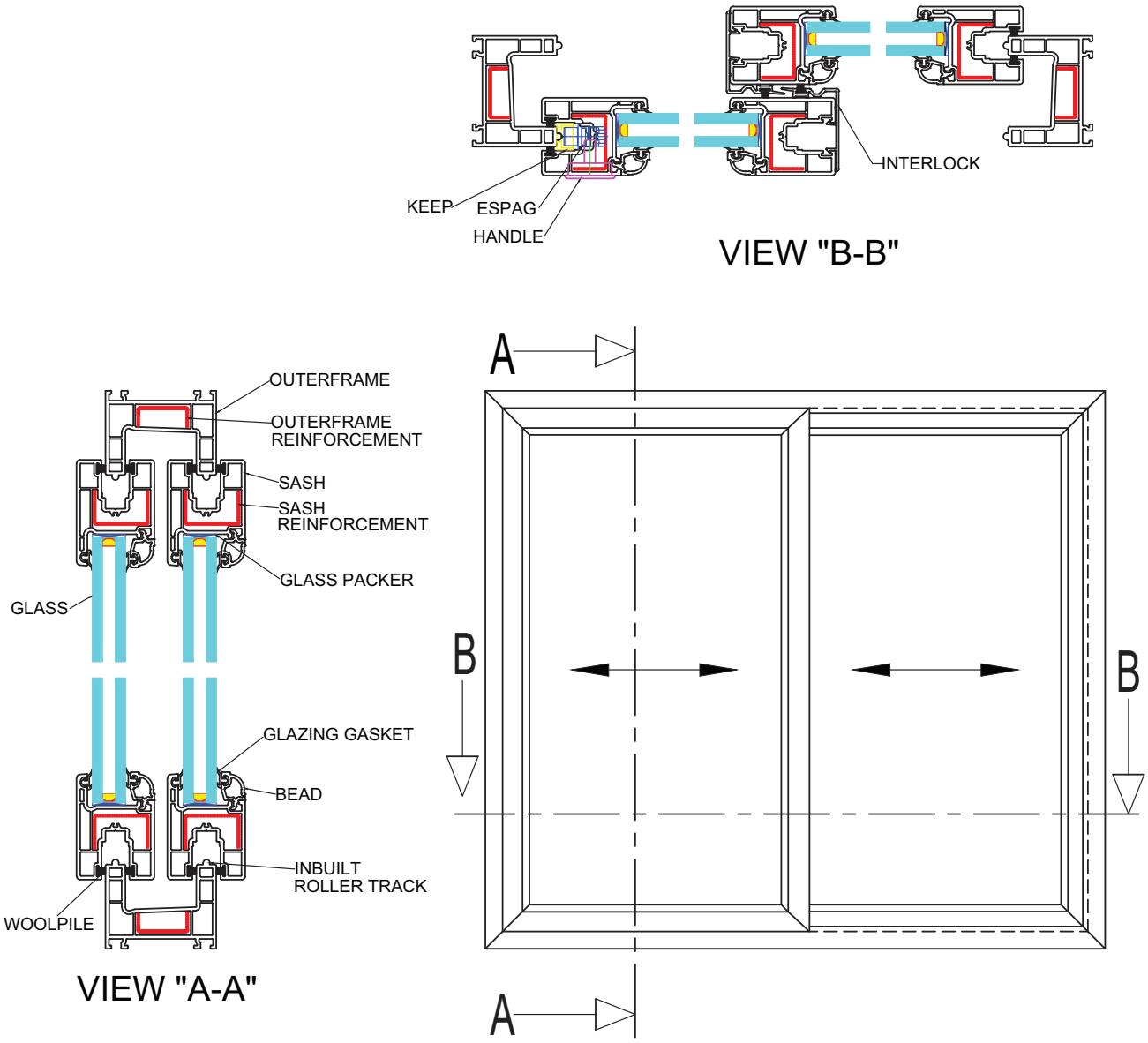
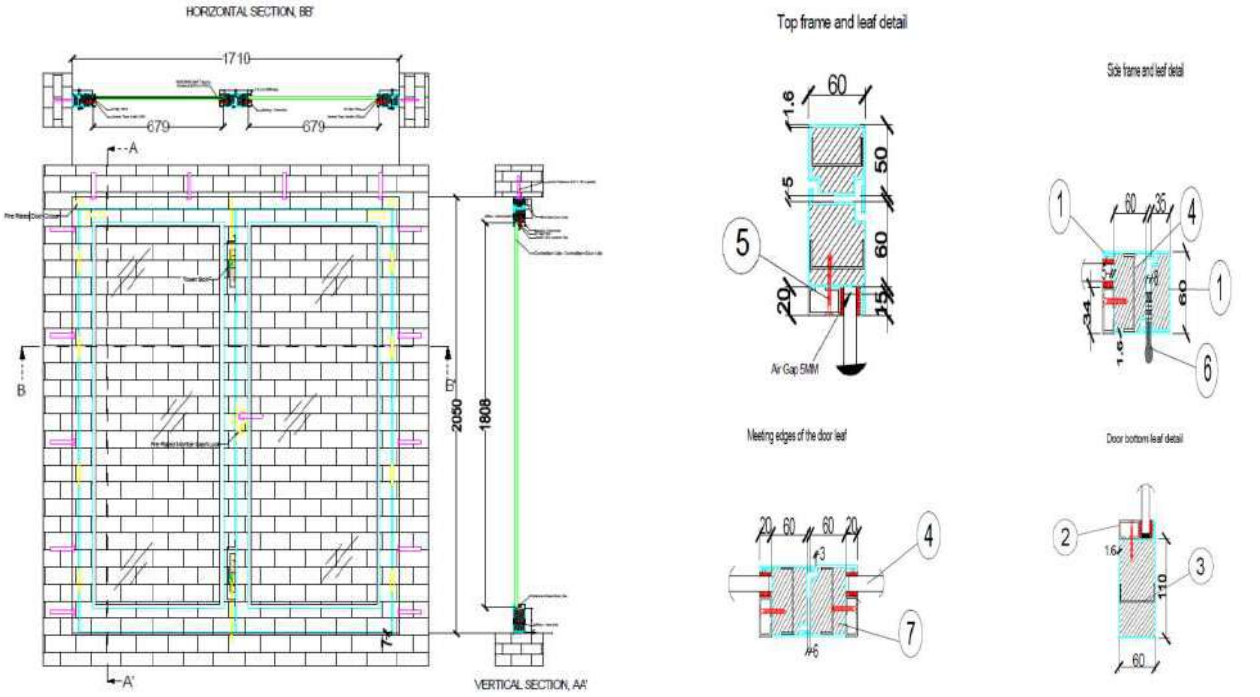


Fig. 9.38: uPVC Doors and Windows (Typical slider system)

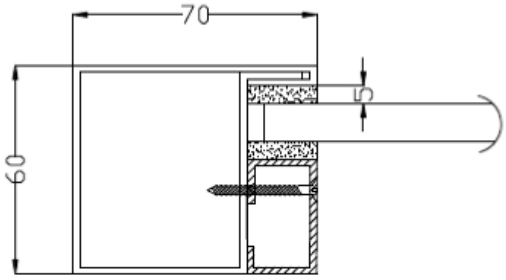
FIRE RATED DOOR/WINDOW/PARTITION

Sub Head: Wood work and PVC Work
Clause: 9.29



Glass					
Sl. No	Type	Glass	Thickness	Size	Quantity
1	Double leaf door	Clear toughened interlayer fire rated glass	11 mm	679mmx1808mm	2

Partition section



1. Door frames and leaf: 1.6 mm thick GI sheet.
2. Glazing bead: 1.6 mm thick GI sheet.
3. Stiffeners: 1.6 mm thick GI sheet.
4. Glass: Clear toughened interlayer fire rated glass.
5. Beading screw: M4x35 mm @ 150mm (approx) C/C.
6. SS ball bearing butt hinges 100x89x3 mm.
   Ceramic wool infill (Density – 96 kg/m^3)

Fig. 9.39 Detail of Fire rated Door/Window/Partition

SUB HEAD : 10.0

STEEL WORK

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LIST OF MANDATORY TESTS

Material	*Clause*	*Test*	*Field/ laboratory test*	*Test procedure*	*Min. quantity of material for carrying out the test*	*Frequency of testing*
1	*2*	*3*	*4*	*5*	*6*	*7*
Steel if arranged by the contractor	10.1.1	(a) Tensile strength (b) Bend test	Laboratory	IS 1599	20 tonne	Every 20 tonne or part thereof.
Steel tubular pipes	10.13	(a) Tensile Test (b) Bend Test (c) Flattening Test	Laboratory	IS 1608 IS 2329 IS 2328	Every 8 tonne or part thereof	Every 8 tonne or part thereof

LIST OF BUREAU OF INDIAN STANDARDS CODES

Sl. No.	*Code No.*	*Subject*
1	IS 63	Whiting for paints and putty
2	IS 198	Varnish gold size
3	IS 228	Structural steel (Standard quality)
4	IS 277	Specification for galvanized steel sheets (Plain and corrugated)
5	IS 419	Putty for use on window frames
6	IS 800	Code of practice for use of structural steel in general in steel construction
7.	IS 806	Code of practice for use of steel Tubes in general building construction
8.	IS 808	Dimensions for Hot rolled steel beams, columns, channel and angle sections
9.	IS 812	Glossary of terms relating to welding and cutting metals
10	IS 813	Scheme of symbols for welding
11	IS 814	Covered electrodes for manual metal arc welding of carbon and carbon manganese steel
12	IS 816	Code of practice for use of metal arc welding for general construction in mild steel
13	IS 817	Code of practice for training and testing of metal arc welders
14	IS 818	Code of practice for safety and healthy requirements in electric and gas welding and cutting operations
15	IS 822	Code of procedure for inspection of welds
16	IS 823	Manual for metal arc welding in mild steel
17	IS 1038	Steel doors, windows and ventilators
18	IS 1081	Code of practice for fixing and glazing of metal (Steel and aluminium) doors, windows and ventilators
19	IS 1148	Hot rolled steel rivet bars (upto 40 mm diameters) for structural purposes
20	IS 1161	Steel tubes for structural purposes
21	IS 1182	Recommended practice for radiographic examination of fusion welded butt joints in steel plates
22	IS 1200- (Pt. VIII)	Method of measurements of steel work and iron works
23	IS 1363 Part I	Haxagon head bolts, screws, and nuts of product grade C (Hexagon Head bolt)
24	IS 1363 Part II	Haxagon Head Bolts, screws and nuts of product Grade 'C'

25	IS 1363 Part-III	HaxaganM Head Bolts, screws and Nuts of product grade 'C'
26	IS 1367	Technical supply conditions for threaded steel fasteners
27	IS 1568	Wire cloth for general purposes
28	IS 1599	Method for bend test
29	IS 1608	Metallic materials – Tensile Testing at Ambient Temperature.
30	IS 1730	Dimensions for stainless steel plates, sheets strips and flats for general engineering purposes
31	IS 1821	Dimensions for clearance holes for bolts and screws
32	IS 1852	Rolling and cutting tolerance for hot rolled steel products
33	IS 1894	Method for tensile testing of steel tubes
34	IS 1977	Structural steel (ordinary quality)
35	IS 2062	Hot Rolled low, medium and high tensile structural steel
36	IS 2074	Ready mixed paint, air drying redoxide zinc chrome priming
37	IS 4351	Specification for steel door frames
38	IS 4454 (Part I)	Steel wires for mechanical springs. Cold drawn unalloyed steel wire.
39	IS 4711	Methods for sampling of steel pipes, tube and fittings.
40	IS 4736	Hot – dip zinc coating on mild steel tubes
41	IS 4923	Hollow Steel Sections for Structural Use - Specification
42	IS 6248	Metal rolling shutters and rolling grills
43	IS 6911:2017	Stainless steel plate, sheet and strip
44	IS 7452	Specification for hot rolled steel sections for doors, windows and ventilators.

10.0 STEEL WORK

10.0 DEFINITIONS/ TERMINOLOGY

Bead

A single run of weld metal deposited on surface.

Butt Weld

A weld in which the weld metal lies substantially within the extension of the planes arc the surfaces *on* the parts joined.

Crater

A depression left in weld metal where the *arc* was broken or the flame was removed.

End Crater

A crater at the end of a weld or at the end of a joint.

Fillet Weld

A weld of approximately triangular cross-section joining two surfaces approximately at the right angles to each other in a lap joint, tee joint or corner joint. It is of two types:

(1) Continuous
(2) Intermittent.

Fusion Welding

Any welding process in which the weld is made between metals in a state of fusion without hammering or pressure.

Non- fusion Welding

A term applied to the deposition, by the Oxy-Acetylene process of filler metal on parent metal without fusion of the latter.

Oxy-Acetylene Pressure Welding

Pressure welding in which any Oxy-Acetylene flame is used to make the surface to be united plastic. No filler metal is used.

Run

The metal deposited during one passage of the electrode or blow pipe in the making of a joint.

Throat thickness

See Fig. 10.1.

Weld

A union between two pieces of metal at faces rendered plastic or liquid by heat or pressure, or both, Filler metal may be used to effect the union.

10.1 MATERIALS

Micro-Alloying Elements

Elements such as niobium, boron, vanadium and titanium added singly or in combination to obtain higher strength to weight ratio and better toughness, formability and weldability as compared to unalloyed steel of similar strength level.

Weldability

A metallic substance is considered to be weldable by a given process and for the given purpose, when metallic continuity to a stated degree can be obtained by welding using a suitable procedure, so that the joints comply with the requirements specified in regard to both their local properties and their influence on the construction of which they form a part.

Controlled Rolling

A hot rolling process in which the temperature of the steel and its reduction ratio are controlled, particularly during the final rolling passes, in order to achieve fine grain micro structure and optimum mechanical properties.

Normalizing Rolling

A hot rolling process in which the final rolling passes are carried out at a suitable higher temperature, followed by cooling in natural air to a temperature below the transformation temperature, in order to produce a structure, analogous to that obtained by a separate normalizing treatment of hot rolled product.

10.1.1 Steel

10.1.1.1 ***Supply of Material*** **:** General requirements relating to supply of structural steel shall conform to IS 8910.

10. 1.1.2 ***Grades :*** There shall be nine grades of steel as given in Tables 10.1 and 10.2. While placing the order the steel should be designated by 'Designation' (See Table 10.1 and 10.2).

10.1.1.3 ***Manufacture :*** The processes used in the steel making and further hot rolling into steel plates, strips, sections, flats, bars, etc., are left to the discretion of the manufacturer/supplier. If required, secondary refining may follow steel making, as also normalizing rolling/controlled rolling during manufacturing of sections or as per the agreement between the purchaser and the manufacturer/ supplier.

10.1.1.4 ***Freedom from Defects***

10.1.1.4.1 All finished materials shall be well and cleanly rolled to the dimensions, sections and masses specified. The finished material shall be reasonably free from surface flaws; laminations; rough/ jagged and imperfect edges and all other harmful defects.

10. 1.1.4.2 Minor surface defects may be removed by the manufacturer/supplier by grinding provided the thickness is not reduced locally by more than 4 percent below the minimum specified thickness. Reduction in thickness by grinding greater than 4 percent but not exceeding 7 percent may be made subject to mutual agreement between the purchaser and manufacturer/supplier.

10.1.1.4.3 Subject to agreement with the purchaser, surface defects which cannot be dealt with as in 10.1.1.4.2 may be repaired by chipping or grinding followed by welding and inspection by a mutually agreed procedure such that :

(a) After complete removal of the defects and before welding, the thickness of the item is not to be reduced by more than 20 percent at any place.
(b) Welding is carried out by procedure APPROVED by competent authority with approved electrodes and the welding is ground smooth to the correct nominal thickness; and
(c) Subsequent to the finish grinding, the item may be required to be normalized or otherwise heat-treated at the purchaser's discretion.

10.1.1.4.4 Welding as mentioned in 10.1.1.4.3 is not permissible for grade designation E 250 material.

10. 1.1.5 ***Chemical Composition :*** Ladle Analysis the ladle analysis of the steel, when carried out by the method specified in the relevant part of IS 228 or any other established instrumental /chemical method, shall be as given in Table 10.1. In case of dispute, the procedure given in IS 228 and its relevant parts shall be the referee method and where test methods are not specified shall be as agreed to between the purchaser and the manufacturer/supplier.

10.1.2 Rivets

Rivets shall be made from rivet bars of mild steel as per IS 1148.

10.1.3 Bolts

These are of two types namely turned and fitted bolts and black bolts. Turned & fitted bolts are turned to exact diameter in automatic lathe. For these bolts, whether reamed or drilled bolts, the same unit stresses are allowed as for rivets. In case of black bolts which are not finished to exact sizes, a lower working stress other than for turned bolts is adopted. They shall conform to IS 1367 – Technical supply conditions for threaded steel fasteners.

10.1.4 Electrodes

The electrodes required for metal arc welding shall be covered electrodes and shall conform to IS 814.

10.2 STEEL WORK IN SINGLE SECTION FIXED INDEPENDENTLY WITH CONNECTING PLATE

10.2.0 The steel work in single section of R.S. joists, flats, Tees Angles fixed independently with or without connecting plate, is described in these clauses.

10.2.1 Fabrication

The steel sections as specified shall be straightened and cut square to correct lengths and measured with a steel tape. The cut ends exposed to view shall be finished smooth. No two pieces shall be welded or otherwise jointed to make up the required length of member.

All straightening and shaping to form, shall be done by pressure. Bending or cutting shall be carried out in such a manner as not to impair the strength of the metal.

10.2.2 Painting

All surfaces which are to be painted, oiled or otherwise treated shall be dry and thoroughly cleaned to remove all loose scale and loose rust. Surfaces not in contact but inaccessible after shop assembly, shall receive the full specified protective treatment before assembly. This does not apply to the interior of sealed hollow sections. Part to be encased in concrete shall not be painted or oiled. A priming coat of approved steel primer such as Red Oxide/Zinc Chromate primer conforming to IS 2074 shall be applied before any member of steel structure are placed in position or taken out of workshop.

10.2.3 Erection

Steel work shall be hoisted and placed in position carefully without any damage to itself and other building work and injury to workmen. Where necessary mechanical appliances such as lifting tackle winch etc. shall be used. The suitability and capacity of all plant and equipment used for erection shall be upto the satisfaction of the Engineer-in-charge.

10.2.4 Measurements

The work as fixed in place shall be measured in running metres correct to a millimetre and weights calculated on the basis of standard tables correct to the nearest kilogram. The standard weight of steel sections shall conform to IS 808 with tolerance in sizes as per IS 1852. Tolerance in weight is given in Table 10.3. Steel sections shall be acceptable within tolerance limits. Payment for steel sections shall be made as per actual weight within tolerances. Sections having weight on higher side than permissible tolerance, may be acceptable but payment shall be made on the basis of standard weight only. Steel sections having weight variations lower side than permissible variation shall not be acceptable.

Unless otherwise specified, weight of cleats, brackets, packing pieces, bolts, nuts, washers, distance pieces, separaters, diaphgram gussets (taking overall square dimension) fish plates, etc. shall

be added to the weight of respective items. In riveted work allowance is to be made for weight of rivet heads. Unless otherwise specified an addition of 2.5% of the weight of structure shall be made for shop and site rivet heads in riveted steel structures.

No deduction shall be made for rivet/ or bolt holes (excluding holes for anchor or holding down bolts).

Deduction in case of rivet or bolt hole shall however be made if its area exceeds 0.02 sqm.

The weight of steel sheets, plates and strips shall be taken from relevant Indian standards based on 7.85 Kg/m^2 for every millimetre sheet thickness. For rolled sections, steel rods and steel strips, weight given in relevant Indian Standards shall be used.

10.2.5 Rate

Rate includes the cost of labour and materials required for all the operations described above.

10.3 STEEL WORK IN BUILT UP SECTIONS (RIVETED AND BOLTED)

The steel work in built up section (Riveted and bolted) such as trusses, framed work etc. is specified in this clause.

10.3.1 Laying Out

A figure of the steel structure to be fabricated shall be drawn on a level platform to full scale. This may be done in full or in parts, as shown on drawings or as directed by the Engineer-in-Charge. Steel tape shall be used for measurements.

10.3.2 Fabrication

Fabrication shall generally be done as specified in IS 800. In major works or where so specified, shop drawings giving complete information for the fabrication of the component parts of the structure including the location, type, size, length and details or rivets, bolts or welds, shall be prepared in advance of the actual fabrication and approved by the Engineer-in-charge. The drawings shall indicate the shop and field rivets, bolts and welds. The steel members shall be distinctly marked or stenciled with paint with the identification marks as given in the shop drawings.

Great accuracy shall be observed in the fabrication of various members, so that these can be assembled without being unduly packed, strained or forced into position and when built up, shall be true and free from twist, kinks, buckles or open joints.

Wooden or metal sheet templates shall be made to correspond to each member, and position of rivet holes shall be marked accurately on them and holes drilled. The templates shall then be laid on the steel members, and holes for riveting and bolting marked on them. The ends of the steel members shall also be marked for cutting as per required dimensions. The base of steel columns and the positions of anchor bolts shall be carefully set out at the required location.

10.3.2.1 The steel section shall be straight or to be straightened or flattened by pressure unless required to be of curvilinear form and shall free from twists. These shall be cut square either by shearing or sawing to correct length and measured by steel tape. No tow pieces shall be welded or joined to make up for the required length of member.

10.3.2.2 ***Making Holes :*** Holes through more than one thickness of materials for members, such as compound stanchion and girder flanges shall, where possible, be drilled after the members are assembled and tightly clamped or bolted together. Punching may be permitted before assembly, provided the holes are punched 3mm less in diameter than the required size and reamed after assembly to the full diameter. The thickness of material punched shall be not greater than 16 mm.

Rivet Holes

The diameter for rivets and black bolts holes shall be taken as the nominal diameter of a rivet/ black bolts plus 1.5 mm for rivets/ bolts of nominal diameter less than or equal to 25 mm" and 2.0 mm for rivets of nominal diameter exceeding 25 mm, unless specified otherwise. Holes for turned and fitted bolts shall be drilled or reamed large by 0.2 to 8 mm depending upon the dia. of bolts.

Holes shall have their axis perpendicular to the surface bored through. The drilling or reaming shall be free from burrs, and the holes shall be clean and accurate. Holes for rivets and bolts shall not be formed by gas cutting process.

Holes for counter sunk bolts shall be made in such a manner that their heads sit flush with the surface after fixing.

10.3.2.3 ***Assembly :*** Before making holes in individual members, for fabrication and steel work intended to be riveted or bolted together shall be assembled and clamped properly and tightly so as to ensure close abutting, or lapping of the surfaces of the different members. All stiffeners shall be fixed (or placed) tightly both at top and bottom without being drawn or caulked. The abutting joints shall be cut or dressed true and straight, and fitted close together.

Web plates of girders, which have no cover flange plates, shall have their ends flush with the tops of angles unless otherwise required. The web plate when spliced, shall have clearance of not more than 5mm. The erection clearance of cleated ends of members connecting steel to steel shall preferably be not greater than 1.5 mm. The erection clearance at the ends of beams without web cleats shall not be more than 3 mm at each end but where for practical reasons, greater clearance is necessary, seating designed suitably shall be provided.

Column splices and butt joints of struts and compression members *requiring c* ontact for stress transmission shall be accurately, machined and close butted over the whole section. In column caps and bases, the ends of shafts together with the attached gussets, angles, channels etc. after riveting together shall be accurately machined so that the parts connected, butt against each other over the entire surfaces of contact. Connecting angles or channels shall be fabricated and placed in position with great accuracy so that they are not unduly reduced in thickness by machining.

The ends of all bearing stiffeners shall be machined or grounded to fit tightly both at top and bottom.

10.3.2.4 ***Riveting :*** Rivets shall be used, where slip under load has to be avoided.

Preliminaries before Rivetings:- Members to be riveted shall have all parts firmly placed and held together before and during riveting, and special care shall be taken in this respect for all single riveted connections. For multiple riveted connections, a service bolt shall be provided in every third or fourth hole.

Process of Riveting

The riveting shall be carried out by using machines of the steady pressure type. However, where such facilities are not available hand riveting may be permitted by the Engineer-in -charge. The rivets shall be heated red hot, care being taken to control the temperature of heating so as not to burn the steel. Rivets of diameter less than10mm may be driven cold. Rivets shall be finished neat with heads full and of equal size. The heads shall be central on shanks and shall grip the assembled members firmly.

All loose, burnt, or badly formed rivets with eccentric or deficient heads shall be cut out and replaced. In cutting out rivets, care shall be taken so as not to injure the assembled members. Caulking and recapping shall not be permitted.

For testing rivets, a hammer weighing approx. 0.25 kg shall be used and both heads of the rivet (Specially the machine head) shall be tapped. When so tested, the rivets shall not give a hollow sound and a jar where so specified, other tests shall be carried out to ensure the soundness of rivets.

All rivets heads shall be painted with approved steel primer paint within a week of their fixing.

10. 3.2.5 ***Bolting :*** The nominal length of the bolt shall be the distance from the underside of the head to the further end of the shank. The nominal diameter of the bolt shall be the diameter at the shank above the

screwed threads. Bolts, nuts and washers shall be thoroughly cleaned and dipped in double boiled linseed oil, before use. All bolts heads and nuts shall be hexagonal unless specified otherwise. The screwed threads shall conform to IS 1363 and the threaded surface shall not be tapered. The bolts shall be of such length as to project at least two clear threads beyond the nuts when fixed in position, and these shall fit in the holes without any shake. The nuts shall fit in the threaded ends of bolts properly.

Where necessary, washers shall be tapered or otherwise suitably shaped to give the heads and nuts of bolts a satisfactory bearing. The threaded portion of each bolt shall project through the nut at least two thread. In all cases where the full bearing area of the bolt is to be developed, the bolt shall be provided with a washer of sufficient thickness under the nuts to avoid any threaded portion of the bolt being within the thickness of the parts bolted together.

Where there is a risk of the nuts being removed or becoming loose due to vibrations or reversal of stresses, these shall be secured from slackening by the use of lock nut, spring washers as directed by the Engineer-in-charge.

10.3.3 Erection

10.3.3.0 Steel members shall be hoisted and erected in position carefully, without any damage to itself, other structures and equipment and injury to workmen. The method of hoisting and erection proposed to be adopted by the contractor shall be got approved from the Engineer-in-charge in advance. The contractor however shall be fully responsible for the work being carried out in a safe and proper manner without unduly stressing the various members and proper equipment such as derricks, lifting tackles, winches, ropes etc. shall be used.

10.3.3.1 The work of erection may be done in suitable units as may be directed by the Engineer-in-charge. Fabricated members shall be lifted at such points so as to avoid deformation or excessive stress in members. The structure or part of it placed in position shall be secured against over-turning or collapse by suitable means.

During execution, the steel members shall be securely bolted or otherwise fastened when necessary temporarily braced to provide for all loads including those due to erection equipments and its operation to be carried safely by structure during erection. The steel members shall be placed in proper position as per approved drawing, final riveting or permanent bolting shall be done only after proper alignment has been checked and confirmed.

10.3.3.2 Trusses shall be lifted only at nodes. The trusses above 10 m in span shall not be lifted by slinging at two mid points of rafters, which shall be temporary braced by a wooden member of a suitable section. After the trusses are placed in position, purlins and wind bracings shall be fixed as soon as possible.

The end of the truss which faces the prevailing winds shall be fixed with holding down bolts, and the other end kept free to move. In case of trusses of spans upto 10m the free end of the truss shall be laid on lead sheet or steel plate as per design, and the holes for holding down bolts shall be made in the form of oblong slots so as to permit the free movements of the truss end. For larger spans the truss shall be provided with proper bearing as per design.

10.3.3.3 Columns and stanchions shall be erected truly vertical with the necessary cross bracing etc. and the base shall be properly fixed with the foundation concrete by means of anchor bolts etc. as per drawing.

10.3.3.4 Anchor bolts to be placed in the concrete foundation should be held in position with a wooden template. At the time of concreting anchor bolt locations shall be provided with suitable timber mould or pipe sleeve to allow for adjustment which shall be removed after initial setting of concrete. The spaces left around anchor bolts shall be linked to a stopping channel in the concrete leading to the side of the pedestal and on the underside of the base plate to allow the spaces being grouted up after the base

plate is fixed in the position along with the column footing. Grouting shall be of cement mortar 1:3 (1 cement: 3 coarse sand) or as specified.

10.3.3.5 ***Bedding of Column, Stanchions etc.*****:-** Bedding shall not be carried out until the steel work has been finally levelled, plumbed and connected together. The stanchion shall be supported on steel wedges and adjusted to make the column plumb. For multistoreyed buildings, the bedding shall not be done until sufficient number of bottom lengths of stanchions have been properly lined, levelled and plumbed and sufficient floor beams are fixed in position. The base plates shall be wedged clear of the bases by M.S. wedges and adjusted where necessary to plumb the columns. The gaps under the base plate may be made upto 25 mm which shall be pressure grouted with cement grouts.

With small columns, if permitted by the Engineer-in-charge, the column base shall be floated on a thick cement grout on the concrete pedestal. The anchor bolt holes in the base plate may be made about 10 to 15 mm larger than the bolts. In such cases suitable washers shall be provided.

10.3.4 Painting

Before the members of the steel structure are placed in position or taken out of the workshop these shall be painted as specified in 10.2.2.

10.3.5 Measurements

The work as fixed in position shall be measured in running metres correct to a millimeter and their weight calculated on the basis of standard tables correct to the nearest kilogram.

The standard weight of steel sections shall conform to IS 808 with tolerance in sizes as per IS 1852. Tolerenace in weight is given in Table 10.3. Steel sections shall be acceptable within tolerance limits. Payment for steel sections shall be made as per actual weight within tolerances. Sections having weight on higher side than permissible tolerance, may be acceptable but payment shall be made on the basis of standard weight only. Steel sections having weight variations lower than permissible variation shall not be acceptable.

Unless otherwise specified. Weight of cleats, brackets, packing pieces, bolts nuts, washers, distance pieces, separators diaphragm gussets (taking overall square dimensions) fish plates etc. shall be added to the weight of respective items. No deductions shall be made for skew cuts. In riveted work, allowance is to be made for weight of rivet heads. Unless otherwise specified and addition of 2.5% of the weight of structure shall be made for shop and site rivet heads in riveted steel structures. No deduction shall be made for rivet/ or bolt holes (excluding holes for anchor or holding down bolts). Deduction in case of rivet or bolt hole shall, however, be made if its area exceeds 0.02 m^2.

The weight of steel sheet and strips shall be taken from relevant Indian Standards based on 7.85 kg/m^2 for every millimeter sheet thickness. For rolled sections, steel rods and steel strips, weight given in relevant Indian Standards shall be used.

10.3.6 Rate

The rate shall include the cost of all materials and labour involved in all the operation described above.

10.4 STEEL WORK IN BUILT UP SECTION (WELDED)

10.4.0 The steel work in built up sections (welded) such as in trusses, form work etc. is specified in this clause.

10.4.1 Laying out

It shall be as specified in 10.3.1.

10.4.2 Fabrication

10.4.2.1 Straightening, shaping to form, cutting and assembling, shall be as per 10.3.2 as far as applicable, except that the words “riveted or bolted” shall be read as “welded” and holes shall only be used for the bolts used for temporary fastening as shown in drawings.

10.4.2.2 ***Welding :*** Welding shall generally be done by electric arc process as per IS 816 and IS 823. The electric arc method is usually adopted and is economical. Where electricity for public is not available generators shall be arranged by the contractor at his own cost unless otherwise specified. Gas welding shall only by resorted to using oxyacetylene flame with specific approval of the Engineer-in- charge. Gas welding shall not be permitted for structural steel work Gas welding required heating of the members to be welded along with the welding rod and is likely to create temperature stresses in the welded members. Precautions shall therefore be taken to avoid distortion of the members due to these temperature stresses.

The work shall be done as shown in the shop drawings which should clearly indicate various details of the joint to be welded, type of welds, shop and site welds as well as the types of electrodes to be used. Symbol for welding on plans and shops drawings shall be according to IS 813.

As far as possible every efforts shall be made to limit the welding that must be done after the structure is erected so as to avoid the improper welding that is likely to be done due to heights and difficult positions on scaffolding etc. apart from the aspect of economy. The maximum dia of electrodes for welding work shall be as per IS 814. Joint surfaces which are to be welded together shall be free from loose mill scale, rust, paint, grease or other foreign matter, which adversely affect the quality of weld and workmanship.

10.4.2.3 ***Precautions :*** All operation connected with welding and cutting equipment shall conform to the safety requirements given in IS 818 for safety requirements and Health provision in Electric and gas welding and cutting operations.

10.4.2.4 Operation, Workmanship and process of Welding is described in Appendix B,

10.4.2.5 Inspection and testing of welds shall be as per IS 822.

10.4.2.6 ***Assembly :*** Before welding is commenced, the members to be welded shall first be brought together and firmly clamped or tack welded to be held in position. This temporary connection has to be strong enough to hold the parts accurately in place without any disturbance. Tack welds located in places where final welds will be made later shall conform to the final weld in quality and shall be cleaned off slag before final weld is made.

10.4.2.7 ***Erection :*** The specification shall be as described in 10.3.3 except that while erecting a welded structure adequate means shall be employed for temporary fastening the members together and bracing the frame work until the joints are welded. Such means shall consists of applying of erection bolts, tack welding or other positive devices imparting sufficient strength and stiffness to resist all temporary loads and lateral forces including wind. Owing to the small number of bolts ordinarily employed for joints which are to be welded, the temporary support of heavy girders carrying columns shall be specially attended. Different members which shall be fillet welded, shall be brought into as close contact as possible. The gap due to faulty workmanship or incorrect fit if any shall not exceed. 1.5 mm if gap exceeds 1.5 mm or more occurs locally the size of fillet weld shall be increased at such position by an amount equal to the width of the gap.

10.4.2.8 ***Painting :*** Before the member of the steel structures are placed in position or taken out of the workshop these shall be painted as specified in para 10.2.2.

10.4.3 Measurements

The mode of measurements shall be the same as specified in 10.2.4 except that weight of welding material shall not be added in the weight of members for payment and nothing extra shall be paid for making and filling holes for temporary fastening of members during erection before welding.

10.4.4 Rate

The rate shall include the cost of all labour and materials involved in all the operations described above.

10.5 COLLAPSIBLE STEEL GATES

10.5.0 These shall be of approved manufacture and shall be fabricated from the mild steel sections.

10.5.1 The gates shall consist of double or single collapsible gate depending on the size of the opening. These shall consist of vertical double channels each 20 x 10 x 2 mm. at 10 cm. centre to centre braced with flat iron diagonals 20 x 5 mm and top and bottom rails of T- iron 40 x 40 x 6 mm @ 3.5 kg/m with 40 mm dia. ball bearings in every fourth double channel, unless otherwise specified. Wherever collapsible gate is not provided within the opening and fixed along the outer wall surface, T- iron at the top may be replaced by flat iron 40 x 10 mm.

The collapsible gate shall be provided with necessary bolts and nuts, locking arrangement, stoppers and handles. Any special fittings like spring, catches and locks, shall be so specified in the description of item where so required. The gate shall open and close smoothly and easily.

10.5.2 Fixing

T- iron rails shall be fixed to the floor and to the Lintel at top by means of anchor bolts embedded in cement concrete of floor and lintel. The anchor bolts shall be placed approximately at 45 cm centres alternatively in the two flanges of the T- iron. The bottom runner (T- iron) shall be embedded in the floor and proper groove shall be formed along the runner for the purpose. The collapsible shutter shall be fixed at sides by fixing the end double channel with T -iron rails and also by hold- fasts bolted to the end double channel and fixed in masonry of the side walls on the other side. In case the collapsible shutter is not required to reach the lintel, beam or slab level, a Tee -section suitably designed may be fixed at the top, embedded in masonry and provided with necessary clamps and roller arrangement at the top. All the adjoining work damaged in fixing of gate shall be made good to match the existing work, without any extra cost.

10.5.3 Painting

All the members of the collapsible gate including T-iron shall be thoroughly cleaned off rust, scales, dust etc. and given a priming coat of approved steel primer conforming to IS 2074 before fixing them in position.

10.5.4 Measurements

The height and breadth shall be measured correct to a cm. The height of the gate shall be measured as the length of the double channels and breadth from outside to outside of the end fixed double channels in open position, of the gate. The area shall be calculated in square metres, correct to two places of decimal.

10.5.5 Rate

The rate shall include the cost of materials and labour involved in all the operations described above.

10.6 M.S. SHEET SLIDING SHUTTER

10.6.0 These shall be manufactured as per drawings and specification. These shall be fabricated from mild steel sheets.

10.6.1 The shutters shall be double or single leaf shutter as specified. The shutters shall be fabricated of specified size of M.S. angle iron frame diagonally braced with the same size of M.S. angle riveted / welded together with 3mm gusset plate at junction to form a rigid frame. M.S. sheet of 1 mm thickness or as specified shall be fixed to the frame with rivets/welds as approved by the Engineer- in-charge. These shall also be provided with top and bottom guide rails of specified size angles or T- irons and 25 mm diameter pulley or with 25 mm diameter ball bearing at the bottom and guide block with steel

pulleys at the top. The shutters shall also be provided with locking arrangement, handles, stoppers, and holdfasts, other fittings as specified in the description of the item.

The guide rails shall be sufficiently long and continued along the wall on both ends so that the sliding shutters can rest against the walls, giving full opening when so required.

10.6.2 Fixing

The guide rails shall be fixed to the floor by means of anchor bolts embedded in the cement concrete floor. The steel section at the top shall be suitably supported from the walls. Two channel sections shall be suitable fixed vertically below the extreme clamps in the wall and floor to avoid the shutter from going out of the supports at top and bottom. A suitable clamping arrangement will be provided at either end of the opening to avoid the shutters from rolling back into the opening.

All the adjoining work damaged in fixing shall be made good to match the existing work.

10.6.3 Painting

All members of the sliding shutters including fittings shall be thoroughly cleaned of rust, scales, dust etc. and given a priming coat of approved steel primer i.e. Red oxide zinc chrome primer conforming to IS 2074 before fixing them in position.

10.6.4 Measurements

The height and width shall be measured correct to a cm and its area for payment shall be calculated in square metres correct to two places of decimal. The height of the shutter shall be measured from outside to outside of the guide rail and width out side to out side of the shutter including the vertical position channels in sides, when shutter closed.

10.6.5 Rate

The rate shall include the cost of materials and labour involved in all the operation described above. It also includes the cost of the full length of guide rails.

10.7 M.S. SHEET SHUTTERS

10.7.0 These shall be manufactured as per drawing and specification. These shall be fabricated from mild steel sheets and angle iron.

10.7.1 The doors shall be provided as double leaf shutters unless otherwise specified . The shutters shall be fabricated with frame of M.S. angle 40 x 40 x 6 mm @ 3.5 kg/ metre and two diagonal braces of the same section as shown in Fig. 3 unless otherwise specified. The frame shall be riveted and/ or welded at the junctions. Wherever riveting shall be done 3.15 mm (10 G) thick gusset plate shall be provided at the junction. M.S. sheet of 1 mm thickness or as specified, shall be fixed to the frame with rivets or welds as approved by the Engineer-in-charge.

Alternatively the diagonal bracing may be replaced by one horizontal and two cross flats 30 x 6 mm as shown in Fig. 10.3 unless otherwise specified.

The outer frame shall be provided with cleats made of section 40 x 10 mm and bent in the shape of angle cleats with one arm 150 mm long and the other arm 50 mm long and fixed to the angle iron frame of the door with two 12 mm dia bolts and nuts. For doors upto 2.40 m height, two angles cleats per door shall be provided.

The cleat shall have a vertical leg of 150 mm which shall be fixed with frame and horizontal leg of about 50 mm which shall be provided with a hole of 24 mm dia and fixed in the projected pin of the pin clamp.

10.7.2 Fittings and Fixtures

The shutters shall be fixed to the wall masonry with four pin clamps (pintles) where the height of the shutter is upto 2.4 m. Each pin clamp shall consist of 50 x 6 mm flat iron 45 cm long bent and forked at one end and provided with 20 mm diameter M.S. pin on the other. The pin shall be firmly riveted or welded to the pin clamp, the other end of which shall be embedded in masonry by means of cement

concrete block 40 x 23 x 20 cm of 1:3:6 mix (1 cement :3 coarse sand:6 graded stone aggregate 20 mm nominal size). It shall be so placed that bottom pin shall face upwards and “top pin downward”in order that the gate may not be removed by lifting over pins.

One hook with eye 45 cm long of 10 mm diameter shall be provided for each shutter to keep it fixed in open position. The hook shall be fixed in wall masonry with wooden block and the eye shall be fixed on 6 mm thick M.S. plate as staple and fixed in the shutter frame with rivet or weld.

A cement concrete block 15 x 10 x 20 cm in 1:2:4 (1 cement:2 coarse sand:4 grades stone aggregate of 20 mm nominal size) mix shall be embedded in the floor or at junction of two shutters so that door shutter open only on the outside and not on the inside.

The shutters shall also be provided with locking arrangement and two handles of the shape and pattern as approved by the Engineer-in-charge.

10.7.3 Painting

All the members of the door including angle iron shall be thoroughly cleaned off rust, scales, dust etc. and given a priming coat of approved steel primer i.e. Red Oxide/ Zinc chrome primer confirming to IS 2074 before fixing them in position.

10.7.4 Measurements

The width and height of shutters shall be measured to the nearest cm. The area shall be calculated in square metre correct to two places of decimal.

10.7.5 Rate

The rate shall include the cost of materials and labour involved in all the operation described above. Nothing extra shall be paid for cement concrete block or wooden blocks nor anything deducted for these from the measurement of the masonry wall.

10.8 ROLLING SHUTTERS

10.8.1 Rolling shutters shall conform to IS 6248. These shall include necessary locking arrangement and handles etc. These shall be suitable for fixing in the position as specified i.e. outside or inside on or below lintel or between jambs of the opening. The door shall be either push and pull type or operated with mechanical device supplied by the firm. Shutters upto 10 sq. metre shall be of push and pull type and shutters with an area of over 10 sq. metre shall generally be provided with reduction gear operated by mechanical device with chain or handle, if bearings are specified for each of operation, these shall be paid for separately.

10.8.1.1 ***Shutter :*** The shutter be built up of inter locking lath section formed from cold rolled steel strips. The thickness of the sheets from which the lath sections have been rolled shall be not less than 0.90 mm for the shutters upto 3.5 m width. Shutters above 9 metres width should be divided in 2 parts with provision of one middle fixed or movable guide channel or supported from the back side to resist wind pressure. The lath section shall be rolled so as to have interlocking curls at both edges and a deep corrugation at the centre with a bridge depth of not less than 12 mm to provide sufficient curtain of stiffness for resisting manual pressures and normal wind pressure. Each lath section shall be continuous single piece without any welded joint. When interlocked, the lath sections shall have a distance of 75 mm rolling centers. Each alternate lath section shall be fitted with malleable cast iron or mild steel clips securely riveted at either ends, thus locking in the lath section at both ends preventing lateral movement of the individual lath sections. The clips shall be so designed as to fit the contour of the lath sections.

10.8.1.2 ***Spring :*** The spring shall be of coiled type. The spring shall be manufactured from high tensile spring steel wire or strips of adequate strength conforming to IS 4454- Part I .

10.8.1.3 ***Roller and Brackets :*** The suspension shaft of the roller shall be made of steel pipe conforming to heavy duty as per IS 1161. For shutter upto 6 metre width and height not exceeding 5 metre, steel pipes of 50 mm nominal bore shall be used. The shaft shall be supported on mild steel

brackets of size 375 x 375 x 3.15 mm for shutters upto a clear height of 3.5 metre. The size of mild steel brackets shall be 500 x 500 x 10 mm for shutters of clear height above 3.5 m and upto 6.5 m. The suspension shaft clamped to the brackets shall be fitted with rotatable cast iron pulleys to which the shutter is attached. The pulleys and pipe shaft shall connected by means of pretensioned helical springs to counter balance the weight of the shutter and to keep the shutter in equilibrium in any partly open position.

10.8.1.4 When the width of the opening is greater than 3.5 mtr. The cast iron pulleys shall be interconnected with a cage formed out of mild steel flats of at least 32 x 6 mm and mild steel dummy rings made of similar flats to distribute the torque uniformly. Self aligning two row ball bearing with special cast iron casings shall be provided at the extreme pulley and caging rings shall have a minimum spacing of 15mm and at least 4 number flats running throughout length of roller shall be provided.

10.8.1.5 In case of shutters of large opening with mechanical device for opening the shutter the roller shall be fitted with a purion wheel at one end which in contact with a worm fitted to the bracket plate, caging and pulley with two ball bearing shall be provided.

10.8.1.6 ***Guide Channel :*** The width of guide channel shall be 25 mm the minimum depth of guide channels shall be as follows:

Clear width of shutters	*Depth of guide channel*
Upto 3.5 m	65 mm
3.5 m upto 8 m	75 mm
8 m and above	100 mm

10.8.1.7 The gap between the two legs of the guide channels shall be sufficient to allow the free movement of the shutter and at the same time close enough to prevent rattling of the shutter due to wind.

10.8.1.8 Each guide channel shall be provided with a minimum of three fixing cleats or supports for attachment to the wall or column by means of bolts or screws. The spacing of cleats shall not exceed 0.75 m. Alternatively, the guide channels may also be provided with suitable dowels, hooks or pins for embedding in the walls.

10.8.1.9 The guide channels shall be attached to the jambs, plumb and true either in the overlapping fashion or embedded in grooves, depending on the method of fixing.

10.8.1.10 ***Cover :*** Top cover shall be of mild steel sheets not less than 0.90 mm thick and stiffened with angle or flat stiffeners at top and bottom edges to retain shape.

10.8.1.11 Lock plates with sliding bolts, handles and anchoring rods shall be as per IS 6248.

10.8.2 Fixing

The arrangement for fixing in different situations in the opening shall be as per IS 6248.

10.8.2.1 Brackets shall be fixed on the lintel or under the lintel as specified with rawl. Plugs and screws bolts etc. The shaft along with the spring shall then be fixed on the brackets.

10.8.2.2 The lath portion (shutter) shall be laid on ground and the side guide channels shall be bound with ropes etc. The shutter shall then be placed in position and top fixed with pipe shaft with bolts and nuts. The side guide channels and cover frames shall then be fixed to the walls through the plate welded to the guides. These plates and bracket shall be fixed by means of steel screws bolts, and rawl plugs concealed in plaster to make their location invisible. Fixing shall be done accurately in a workmen like manner that the operation of the shutter is easy and smooth.

10.8.3 Measurements

Clear width and clear height of the opening for rolling shutter shall be measured correct to a mm. The clear distance between the two jambs of the opening shall be clear width and the clear distance between the sill and the soffit (bottom of lintel) of the opening shall be the clear height.

The area shall be calculated in square metres correct to two places of decimal.

10.8.4 Rate

The rate shall include the cost of materials and labour involved in all the operations described above including cost of top cover and spring except ball bearing and mechanical device of chain and crank operation, which shall be paid for separately.

10.9 ROLLING GRILLS – SHUTTERS

10.9.0 Rolling grill shutter is meant to provide visibility or ventilation or both, the degree of protection and safety is less as compared to a rolling shutter. The situations where a certain amount of ventilation combined with safety is required rolling shutter-cum-grill may be provided in which the rolling shutter may have a rolling grill portion either at the top or at the bottom or at both places. In addition, the rolling grill portion may also be provided in the middle of the shutter. The total height of the grill portion in all the segments of rolling shutter- cum-grill shall not exceed 1.0 m and the height of the grill portion in any individual segment shall not be more than 0.5 m.

10. 9.1 Rolling grills shutters are similar in design, construction and operation to rolling shutters and all the provisions of Para 10.8 shall be applicable to rolling grills shuters except in respect of the shutter portion, and shall conform to IS 6248.

10.9.2 Shutters

Rolling grill shutter and the rolling grill portion of the rolling shutter-cum-grill shall be fabricated with 8 mm diameter mild steel round bars. Straight bars and bars bent to the required profile are placed alternatively and held in position with 20 mm wide and 5 mm thick mild steel flat links. Straight bars shall be spaced not exceeding 150 mm centre to centre and the bars bent to required profile shall be placed symmetrically between two consecutive straight bars. Unless otherwise specified or directed by the Engineer-in-charge, bars placed alternatively with straight bars shall be bent to form a corrugated profile such that the pitch of the corrugation is 100 to 120 mm and the depth of corrugation is 80 to 100 mm. all the bent bars shall have uniform profile. Straight bar along with the adjoining bent bars on it both sides shall be held in position by passing the bars through holes in the links. Each link shall have three holes and the length of the links shall be such that the distance from the centre of the hole to the nearest edge of the flat is not less than the diameter of the hole. The corner of the links shall be rounded. All links shall be of uniform size and shape. The spacing of the links measured along the straight bar shall be the same as centre to centre distance between two consecutive crests/ troughs of the bars bent to the required profile. Each bar and link shall be continuous single piece without any joint.

10.9.3 Measurement & Rate

The measurement and rate shall be as specified in 10.8.3 and 10.8.4 respectively. In case of Rolling Shutter-cum-Grill, where the area of the grill portion is half or less than half the area of opening, it shall be measured and paid as rolling shutter and where the area of grill portion is more than half the area of opening, it shall be measured and paid as rolling grill.

10.10 STEEL DOORS, WINDOWS, VENTILATORS AND COMPOSITE UNITS (Fig. 10.4)

Hot rolled steel sections for fabrication of steel doors, windows, ventilators and fixed lights shall conform to IS 7452. Shapes weights and designations of hot rolled sections shall be as per IS 7452. Appendix 'D' indicates the purpose or the situation where the sections are normally used. Tolerance in thickness of the sections shall be + 0.2 mm. The fabricated steel doors, windows, ventilators and composite units shall confirm to IS 1038 with up-to-date amendments and shall be IS marked (IS 1038).

10.10.1 The steel doors and windows shall be according to the specified sizes and design. The size of doors and windows shall be calculated, so as to allow 1.25 cm clearance on all the four sides of opening to allow for easy fitting of doors windows and ventilators into opening. The actual sizes of doors, windows and ventilators shall not vary by more than + 1.5 mm from those given in the drawing.

10.10.2 Fabrication

10. 10.2.1.1 *Frames :* Both the fixed and openable frames shall be made of sections which have been cut to length and mitred. The corner of fixed and openable frames shall be welded to form a solid fused welded joint conforming the requirements given below. All frames shall be square and flat. The process of welding adopted shall be flush but welding or can be any other process as agreed to between the supplier and the purchaser which shall fulfil the requirements given in clause 6.1.1 of IS 1038, metal arc welding or any other suitable method. The section for glazing shall be tennoned and riveted into the frames and where they intersect the vertical tie shall be broached and horizontal tee threads through it, and the intersection closed by hydraulic pressure.

10.10.2.1.2 *Requirements of Welded Joints*

(i) **Visual Inspection Test:** When two opposite corners of the frame are cut, paint removed and inspected, the joint shall conform to the following:-
   (a) Welds should have been made all along the place of meeting the members and tack welding shall not be permitted.
   (b) Welds should have been properly grounded and
   (c) Complete cross section of the corner shall be checked up to see that the joint is completely solid and there are no cavities visible.

(ii) **Micro and Macro Examinations:** From the two opposite corners obtained for visual test, the flanges of the sections shall be cut with the help of a saw. The cut surface of the remaining portions shall be polished, etched and examined. The polished and etched faces of the weld and the base metal shall be free from cracks and cavity and reasonably free from under cutting overlaps, gross porosity and entrapped slag.

(iii) **Fillet Weld Test:** The fillet weld in the remaining portion of the joint shall be fractured by hammering. The fractured surfaces shall be free from slag inclusion porosity, crack penetration defects and fusion defects.

10.10.2.2 ***Doors :*** The hinges shall be of 50 mm projecting type, Non projecting type hinges may also be used, if approved by Engineer-in -Charge. The hinge pin shall be of electro -galvanized steel or aluminum alloy of suitable thickness and size. Door handles shall be approved by the Engineer-in-Charge. A suitable latch lock for door openable both from inside and outside shall be provided.

In the case of double doors, the first closing leaf shall be the left hand leaf locking at the door from the push side. The first closing shutter shall have a concealed steel bolt at top and bottom. The bolts shall be so constructed as not to work loose or drop by its own weight.

Single and double leaf shutter door may be provided with a three way bolting device. Where the device is provided in the case of double leaf shutters, concealed brass or steel bolts shall not be provided.

10.10.2.3 ***Windows***

(a) For fixed windows, the frames shall be fabricated as per 10.10.2.1.1.
(b) Side hung windows.

For fixing steel hinges, slots shall be cut in the fixed frame and hinges inserted inside and welded to the frame at the back. The hinges shall be of projecting type with thickness not less than 3.15 mm and length not less than 65 mm and width not more than 25 mm. Non projecting type hinges may also be allowed if approved by the Engineer- in-Charge. The diameter of hinge pins shall not be less than 6 mm. The hinge pin and washer shall be of galvanized steel or aluminum alloy of suitable thickness.

For fixing hinges to inside frame, the method described above may be adopted but the weld shall be cleaned, or the holes made in the inside frame and hinge riveted.

The handle of side hung shutters shall be pressed brass, cast brass, aluminium or steel protected against rusting and shall be mounted on a steel plate. Thickness of handle shall not be less than 3 mm in case of steel or brass and 3.5 mm in case of aluminium. The handle plate shall be welded, screwed and/ or revitted to the opening frame in such a manner that it should be fixed before the shutter is glazed and should not be easily removable after glazing.

The handle shall have a two point nose which shall engage with a brass or aluminium alloy striking plate on the fixed frame in a slightly opened position as well as closed position. The boss of handle shall incorporate a friction device to prevent the handle from dropping under its own weight and the assembly shall be so designed that the rotation of the handle may not cause it to unscrew from the pin.

The height of the handle plate in each type of standards windows will be as specified, otherwise it shall be at a height of 3/8 of the height of shutter, from its bottom. The strike plate shall be so designed and fixed in such a position in relation to the handle that with the later bearing against its stop, there shall be adequately tight fit between the casement and outer frames.

In case where no friction type hinges are provided, the windows shall be fitted with peg stays which shall be either of black oxidised steel, pressed or cast brass or as specified, 300 mm long or as specified with steel peg and locking brackets. The pegs stay shall have three holes to open the side hung casement in three different angles. The peg stay shall be of minimum thickness 2 mm in case of brass or aluminium and 1.25 mm in case of steel. Where specified friction hinges shall be provided. Side hung shutters fitted with friction hinges shall not be provided with a peg stay.

If specified, side hung shutters may be fitted with an internal removable fly proof screen in a 1.25 mm thick sheet steel frame to the outer frame of the shutter by brass turn buckles at the jambs, and brass studs at the sill to allow the screen being readily removed. The windows with removable fly proof screen shall be fitted with a through – the screen level operator at the sill level to permit the operation of the shutter through an angle of 90° without having to remove the fly proof screen. The lever shall permit keeping the shutter open in minimum three different positions.

10.10.2.4 ***Ventilators***

(a) Top Hung Ventilators

The steel butt hinges for top hung ventilators shall be riveted to the fixed frame or welded to it at the back after cutting a slot in it. Hinges to the opening frame shall be riveted or welded.
Top hung ventilators shall be provided with a peg stay with three holes which when closed shall be held tightly by the locking bracket. The locking bracket shall either be fitted to the fixed frames or to the window.

(b) Centre Hung Ventilators

Central hung ventilators shall be hung on two pairs of brass or aluminium cup pivots as specified, riveted to the inner and outer frames of ventilators to permit the ventilator shutter to swing to angle of approx 85°. The opening portion of the ventilators shall be so balanced that it remains open at any desired angle under normal weather conditions.

10.10.2.4.1 A black oxidised steel spring catch approved by the Engineer-in-Charge shall be fitted in the centre of the top of the centre hung ventilator, for the operation of ventilators. The spring catch shall be secured to the frame with M.S. screws and shall close into a mild steel or malleable iron catch plate riveted, screwed or welded to the outside of the outer window frame bar.

10.10.2.4.2 A black oxidised cord pulley wheel in galvanized mild steel brackets shall be fitted at sill of the centre hung window with mild steel screws or alternatively welded together with mild steel or malleable iron cord-eye riveted or welded to the bottom inner frame bar of the window in a position corresponding to that of pulley.

Removable fly-proof screen may be provided as specified in 10.10.2.3 (b). This shall be fitted with a through – the screen operator to enable operating and keeping the shutter open in minimum three different positions.

10.10.2.5 ***Composite Units :*** Composite Units consist of a combination of two or more units of doors, windows and ventilators etc. as the case may be. The different units shall be coupled by using coupling sections K-11B or K-12B (Ref. Appendix D) as the case may be.

Wherever the ventilators, windows and doors shall be coupled with a coupling sections, mastic cement shall be applied between the junction to make the joint water tight.

10.10.3 Glazing

10.10.3.1 Specifications described in para 9.6.4.6 shall apply. The glass panes shall have square corners and straight edges. The glass panes shall be so cut that it fits slightly loose in the frames. In doors, windows and clerestory windows of bath, WC and lavatories frosted glass panes shall be used which shall weight not less than 10.00 kg/m^2.

10.10.3.2 Glazing shall be provided on the outside of the frame unless otherwise specified. Putty of approved make conforming to IS 419 shall be used for fixing glass panes. Putty shall be applied between glass panes and glazing bars. Putty shall then be applied over the glass pane, which shall stop 2 to 3 mm from the sight line of the back rebate to enable the painting to be done upto the sight line to seal the edge of the putty to the glass. The oozed out putty shall be cleaned and from putty cut to straight line. Quantity of putty shall not be less than 185 gm/ metre of glass perimetre. Putty shall be painted within 2 to 3 weeks, after glazing is fixed to avoid its cracking.

Note: Putty may be prepared by mixing one part of white lead with three parts of finely powdered chalk and then adding boiled linseed oil to the mixture to form a stiff paste and adding varnish to the paste at the rate of 1 litre of varnish to the 18 kg paste.

10.10.3.3 Four glazing clips may be provided per glass pane for a size larger than 30 cm x 60 cm for all types, where the glass panes size exceed 80 cm x 200 cm, 6 glazing clips shall be used. In case of doors, windows and ventilators without horizontal glazing bars, the glazing clips may be spaced according to the slots, in the vertical members provided the spacing does not exceed 30 cm otherwise the spacing shall be 30 cm.

Note: Where large size glass panes are required to be used or where the door or window is located in heavily exposed situation, holes for glazing clips have to be drilled prior to fabrication and cannot be done at any later stages. Use of glazing clips shall be specified while placing the order.

10.10.3.4 Where specially stipulated, fixing of glass panes may be done with metal or wooden beading instead of mere putty. Where beading are proposed to be used, the manufacturers shall be intimated in advance to drill holes for hard screws. Usually beads shall be fixed with screws spaced not more than 10 cm from each corner and the intermediate not more than 20 cm apart. When glass panes are fixed with wooden or metal beading having mitred joints, a thin layer of putty shall be applied between glass panes and sash bars and also between glass panes and the beading. Size of M.S. beading shall be 10 x 10 mm box section manufactured from 1.6 mm thick sheet unless otherwise specified in the item. Where metal beading is specified, extra payment shall be made on this account.

10.10.4 Finishing

All steel surfaces shall be thoroughly cleaned of rust, scale and dirt. Where so specified. The steel surface shall be treated for rust proofing by the hot dip, zinc spray or electro galvanizing process. A priming coat of approved steel primer i.e. red oxide/ zinc chromate perimer conforming to IS 2074 shall be given. The fabricated steel door, windows, ventilators and composite units shall be inspected in the factory and approved by the Engineer-in-charge before priming coat is applied.

Final finishing coat shall be given to the doors, windows and ventilators after they are erected and fixed in final position. The rate shall be exclusive of final finishing coats but shall include the priming coat.

10.10.5 Fixing

10.10.5.1 Steel, doors and windows shall be so stacked as to keep them in true shape without damage. Doors, windows and ventilators shall be fixed as described below.

10.10.5.2 Opening may be flush or rebated as shown in the drawing. The opening may have rendered finish or a "fair faced" finish (i.e. without rendering as in case of marble or stone facing). Where openings are flush and with a rendered finish a clearance of 1.25 cm shall be provided between the steel frame and opening (See Fig. 10.6) . In case of external masonry finish "fair faced" and with rebated jambs, a minimum 1.25 cm clearance between frame and opening shall provided (See Fig. 10.6) opening in steel work shall be so designed that the outer flange of the door, windows, or ventilator frame section overlaps the steel surface by 10 mm (see Fig. 10.6)

Note : The sizes of Indian Standard doors, windows and ventilators, are designed for modular opening 1.25 cm larger all round than the doors, windows etc. This gap of 1.25 cm is for the purpose of fixing of doors, windows etc. In masonry opening, the gap is filled up with mastic cement and plaster after the door or windows is fixed in position. In the case of steel or timber modular opening, extra steel or timber fillets will be necessary to cover this gap of 1.25 cm.

10.10.5.3 ***Fixing in Masonry Openings***

(a) *Fixing with Lugs*

(i) Doors, windows and ventilators unit, shall not be "built in" as the work proceeds but opening shall be left out and frames fitted afterwards so that the minimum specified clearance between opening and unit frame is left alround. The size of the opening shall first be checked and cleared of obstruction, if any. The position of the unit and fixing holes shall be marked on the jamb. Necessary holes shall be made in the masonry and lugs not less than 10 cm long 15 x 3 mm size M.S flat fixed in cement concrete blocks 15 x 10 x 10 cm size of 1:3:6 mix (1 cement : 3 coarse sand:6 graded stone aggregate 20mm nominal size). The frames of units shall be set in the opening by using wooden wedges at the jamb, head and sill, (wedges shall preferably be placed near the points where a glazing bar meets the frames and be plumbed in position).

(ii) After, the frame shall be fixed with the lugs with 20 mm long and 6.3 mm dia. G.I. counter sunk machine screws and nuts. In case of flush opening which are rendered smooth, wedges shall be removed and gap between unit and the jambs shall be filled with cement mortar (Fig. 10.6)

(iii) In case of flush jamb with external "fair faced" finish the gap between the opening and frame shall be filled with mastic from inside till it oozed out on eternal face. The oozing mastic shall be cleaned and flush pointed. The internal gap shall be filled with mastic to about 1/3rd depth the rest with cement mortar (Fig. 10.6).

(iv) In case of rebated jambs and jambs finished "fair faced" externally, the mastic shall be freely applied to the inside channel of frame, jamb and sill, so as to ensure a watertight joint. After the units is firmly fixed in position surplus mastic shall be cleaned and flush pointed, as shown in Fig. 10.6.

(b) *Fixing with Screws and Plugs:* In R. C. C. work where lugs cannot be embedded due to reinforcement bars etc. rawl plugs or other approved metallic fasteners may be fixed in proper position and frame fixed to them with 60 mm galvanized cross recessed head wood screws of designation 10.

10.10.5.4 ***Fixing in Wood Work Opening :*** Opening in wood work are normally rebated and approved mastic or rubber linings shall be applied to jambs, sill and channel before fixing in position, the frame shall be set in opening using wooden wedges as specified in 10.10.5.3 and fixed to the opening with 60 mm galvanized wood screws of designation 10. Extra timber fillets of hard wood to match the adjoining work shall also be provided around the frame to close the extra gap between opening and frame (Fig. 10.6).

10.10.5.5 ***Fixing in Steel Work Opening :*** Before placing the unit frame in position approved mastic shall be applied as specified in 10.10.5.3 (a) (iv) and a mild steel or hard wood fillet shall be provided around the frame to close the extra gap between opening and frame. The unit shall then be fixed to the opening with fixing clips or with nuts and bolts as shown in the drawings or as directed by the Engineer-in-Charge (Fig. 10.6)

10.10.5.6 ***Fixing of Composite Units :*** The fixing procedure for composite units shall generally be as described under 10.10.5.1 to 10.10.5.5 except that:

Where large units shall be formed by coupling individual units together (with coupling sections), the mullions and transom shall be bedded in mastic to ensure water tightness. Mastic shall be applied liberally to the channels of the outside frame section before assembly and after coupling. All oozing out mastic shall be cut out neatly.

10.10.6 Precautions

Care shall be taken that steel doors and windows etc. are not deformed/ damaged during subsequent constructions. Particular care shall be taken that scaffolding do not rest on the steel door window frames or glazing bars.

All fittings and hinges (projecting hinges) shall be protected, preferably with alkathene sheets so that these may not be damaged during execution of work.

10.10.7 Measurement

The weight of finished section door/windows of different sizes, inclusive of all fixed /welded fittings i.e. hinges pivots, lugs, brackets striking plates etc,. shall be worked out before fixing of windows (exclusive of weight of glass panes, glazing clips, putty etc.). Sectional weight of steel members only shall be measured without weight of glass panes etc. Any loose fittings such as casement stays/fastners etc. shall be enumerated and paid for separately.

10.10.8 Rate

Rate shall include the cost of materials and labour involved in all the operations described above excluding two coats of painting but including cost of glazing and priming including the cost of projecting hinges in case of side hung doors/windows, plain hinges in case of top/ bottom hung windows / ventilators and pivots for centre hung windows/ ventilators.

Metal beading and other fittings such as peg stay and casement window fasteners etc. shall be enumerated and paid for separately.

10.11 T-IRON DOORS, WINDOWS AND VENTILATORS FRAMES.

10.11.0 T-iron doors, windows and ventilators frames shall be manufactured from uniform mild steel Tee section. The steel shall be of the grade as provided in 10.1.1 The frames shall be got fabricated in approved workshop as approved by the Chief Engineer.

10.11.1 The sizes of doors, windows and ventilator frames shall be as per drawing or as decided by the Engineer-in- Charge. MS tie bar of 10 mm dia shall be welded at bottom of the frame. The size of doors, window and ventilators shall be calculated so as to allow 12.5 mm clearance on all sides to allow an easy fittings in opening. The actual size of doors, windows and ventilator shall not vary by more than $\pm$ 2 mm than those shown in the drawings.

The size of T section used for manufacture of doors, windows and ventilators shall not be less than those specified in IS 1038 (see Fig. 10.5) unless otherwise directed by the Engineer-in-charge.

10.11.2 Fabrications

The frame shall be constructed in section which has been cut to length and mitred. The corners of the frames shall be butt welded to form a true and right angle. All frames shall be square and flat meeting the requirements stated under para 10.10.2.1.1.

The T Sections shall be mitre joined and continuously butt welded all along. The requirement of welded joints shall be as specified under para 10.10.2.1.2.

10.11.3 Fittings

Requisite number of holes shall be made in the frame for fixing of fitting. Detailed arrangement of fixing fittings shall be as shown in Fig. 10.7. All fitting shall be fillet welded to T iron frame all along the periphery of contact.

Butt hinges shall be fixed to the frame as below:

(i) MS flat of size 100 mm x 25 mm x 6 mm will be welded with fillet weld all along the periphery of contact on the rear side of the web of T iron to receive the hinges. Requisite number of holes shall be made in T iron frame and MS flat for fixing of hinges with counter sunk steel screws as shown in Fig. 10.7.

(ii) An alternate method of fixing butt hinges can be adopted by fillet welding the hinge to the T iron frame on three sided. No welding shall be done along the hinge pin to allow free movement of butt hinges as shown in Fig. 10.7.

10.11.4 Fixing Procedure

Fixing procedure for T iron doors, windows and ventilator frames in masonry opening shall be as described in 10.10.5. Fixing arrangements of shutters to such frames is shown in Fig. 10.5.

10.11.5 Measurements

T- iron door windows and ventilator frames shall be measured in running metre, along the centre line of the frame correct to a 1mm and weight calculated on the basis of standard tables. No deduction or extra payment shall be made for making holes and making arrangement for fixing fittings including packing wherever necessary. No deduction will be made for not providing tie bars in case of windows and ventilators.

10.11.6 Rate

The rate includes cost of materials and labour involved in all the operation described above. It shall include the necessary butt hinges and screws for fixing the same with frame or as specified. But it does not include the cost of other door, window and ventilator fittings.

10.12 PRESSED STEEL DOOR FRAMES (Fig. 10.8)

10.12.1 Materials

Steel door frames shall be manufactured from commercial mild steel sheet of specified thickness, conforming to IS 2062 and 4351.

Steel door frames with or without fan light shall be made in the profiles indicated in Fig. 10.8 which may be manufactured to suit doors of either type opening inwards or outwards as directed by the Engineer-in-Charge.

10.12.2 Construction

Each door frame shall consist of hinge jamb, lock jamb, head and if required angle threshold (see Fig. 10.8.) These shall be welded or rigidly fixed together by mechanical means. Where no angle threshold is required, temporary base tie shall be screwed to the feet of frames in order to form a rigid unit. Where so specified base ties shall be of pressed mild steel 1.25 mm thick adjustable to suit floor thickness of 35 or 40 mm and removable , or alternatively, threshold of mild steel angle of section 50 x 25 mm, minimum shall be provided for external doors frames.

10.12.3 Fabrication

The pressed steel door frames shall be got fabricated in an approved workshop as approved by the Chief Engineer.

10.12.3.1 ***Fixing Lugs (Fig. 10.8) :*** There shall be three adjustable lugs with split end tail to each jamb without fan light, and four for jamb with fan light.

The head of the fixing lug shall be of one of the following lengths:

(a) 98 mm long for use with profile A
(b) 120 mm long for use with profile B
(c) 160 mm long for use with profile C

The head shall be made from flat steel strip 25 mm wide and not less than 1.60 mm thick

The tail of the lugs shall be 200mm long and shall be made of steel strip not less than 40 mm wide and not less than 1 mm thick.

10.12.3.2 ***Hinges (Fig. 10.8)*** : 100 mm mild steel butt hinges shall be used. For door frames 80 cm wide and under, three hinges shall be rigidly fixed to one jamb and for door frames above 80 cm wide, four hinges shall rigidly fixed to one jamb, if it is single shutter, where the height of door shutter exceeds 2.15 metres, one additional hinge shall be provided for every 0.5 m or part thereof the additional height.

In all cases the hinges shall be so fixed that the distance from the inside of the head rebate to the top of the upper hinge is 20 cm and the distance from the bottom of the door frame to the bottom of the bottom hinge is also kept about 200 mm. The middle hinges shall be at equal distances from lower and upper hinges or as agreed to between the purchaser and the supplier. Hinges shall be made of steel 2.5 mm thick with zinc coated removable pin of 6 mm diameter. The space between the two leaves of the hinge when closed shall be 3 mm and the leaf that is not welded to the frame shall have four counter sunk holes to take No. 10 cross recessed head wood screws.

10.12.3.3 ***Mortar Guards :*** Mortar guards of thickness of main frame sheet shall be provided in accordance to provisions of IS 4351 and as instructed by Engineer-in-charge shall be provided. These shall be welded to the frame at the head of the frame for double shutter doors to make provision for bolts. These shall also be provided to the frame behind the hinges, mortice locks and latches, slots, aldrop and sliding /tower bolts.

10.12.3.4 ***Lock – Strike Plate :*** There shall be an adjustable lock- strike plate of steel complete with mortar guard to make provision for locks or latches complying with the relevant Indian Standards. (IS 4351) Lock-strike plates shall be of galvanized mild steel and fixed at 95 cm from the head of the frame.

10.12.3.5 ***Shock Absorbers :*** For side hung door there shall not be less than three buffers or rubber or other suitable material inserted in holes in the rebate. one shall be located at the centre of the lock jamb and the other two shall be at 30 cm. from top and bottom of the frame. For double leaf shutter door, two buffers shall be provided.

10.12.4 Finishing

The surface of door frame shall be thoroughly cleaned, free of rust, mill-scale dirt oil etc. either by mechanical means, for example sand or shot blasting or by chemical means such as picking. After pretreatment of the surface one coat of approved primer i.e. red oxide zinc chrome primer conforming to IS 2074. Two coats of paints as directed by the Engineer-in-charge shall be applied to the exposed surface.

10.12.5 Fixing

Frames shall be fixed up right in plumb and plane. To avoid sag or bow in width during fixing or during construction phase, temporary struts across the width preventing sides bulging inwards may be provided. Wall shall be built solid on each side and grouted at each course to ensure solid contact with frame leaving no voids behind the frame.

Three lugs shall be provided on each jamb with spacing not more than 75 cm. The temporary struts should not be removed till the masonry behind the frame is set. In case screwed base tie is provided, this should be left in position till the flooring is laid when it can be removed.

After pretreatment of the surface, one coat of steel primer and two coats, of paint, as directed by Engineer-in-charge shall be applied to the exposed surface.

10.12.6 Measurements

The length shall be measured in running metre correct to a cm along the centre line of the frames.

10.12.7 Rate

The rate shall include the cost of labour and material involved in all the operation described above including one coat of approved steel primer but excluding two coats of paint.

10.13 TUBULAR / HOLLOW SECTION TRUSSES

10.13.1 Structural Steel Tube

These shall be of:

1. Hot finished welded (HFW) type, or
2. Hot finished seamless (HFS) type, or
3. Electric resistance or induction butt welded (ERW), having carbon content less than 0.03 percent, yield stress of 21.5 kg/mm^2 (YST 210) type.

Conforming to the requirement of IS 1161. The steel tubes when analysed in accordance with the method specified in IS 228 shall show not more than 0.06 percent sulphur, and not more than 0.06 per cent phosphorous.

Tubes shall be designated by their nominal bore. These shall be light, medium or heavy as specified depending upon the wall thickness. The standard size and weights of tubes are listed in Appendix C. Hollow sections shall be as per IS 4923.

Tubes shall be clean finished and reasonably free from scale. They shall be free from cracks, surface flaws, laminations and other defects. The ends shall be cut clean and square with axis of tube, unless otherwise specified.

10.13.2 Minimum Thickness of Metals

Wall thickness of tubes used for construction exposed to weather shall be not less than 4 mm and for construction not exposed to weather it shall be not less than 3.2 mm where structures are not readily accessible for maintenance, the minimum thickness shall be 5 mm.

10.13.3 Fabrication

10.13.3.1 The component parts of the structure shall be assembled in such a manner that they are neither twisted nor otherwise damaged and be so prepared that the specified cambers, if any, are, maintained. The tubular steel work shall be painted with one coat of approved steel primer after fabrication. All fabrication and welding is to be done in an approved workshop. The joint details shall be generally as per S.P-38 of B.I.S publication.

10.13.3.2 ***Straightening :*** All material before being assembled shall be straightened, if necessary, unless required to be of curvilinear form and shall be free from twist.

10. 13.3.3 ***Bolting :*** Washers shall be specially shaped where necessary, or other means, used to give the nuts and the heads of bolts a satisfactory bearing.

In all cases, where the full area of the bolts is to be developed, the threaded portion of the bolt shall not be within the thickness of the parts bolted together and washers of appropriate thickness shall be provided to allow the nuts to be completely tightened.

10.13.3.4 ***Welding :*** Where welding is adopted, it shall be as per IS 816.

10.13.3.5 ***Caps and Bases for Columns :*** The ends of all the tubes, for columns transmitting loads through the ends, should be true and square to the axis of the tubes and should be provided with a cap or base accurately fitted to the end of the tube and screwed, welded or shrunk on. The cap or base plate should be true and square to the axis of the column.

10.13.3.6 ***Sealing of Tubes :*** When the end of a tube is not automatically sealed by virtue of its connection be welding to another member the end shall be properly and completely sealed. Before sealing, the inside of the tubes should be dry and free from loose scale.

10.13.3.7 ***Flatened Ends :*** In tubular construction the ends of tubes may be flattened or otherwise formed to provide for welded. Riveted or bolted connections provide that the methods adopted for such flattening do not injure the material. The change of sections shall be gradual.

10.13.4 Hoisting and Erection

Tubular trusses shall be hoisted and erected in position carefully, without damage to themselves, other structure, equipment and injury to workman.

The method of hoisting and erection proposed to be adopted shall be got approved from the Engineer-in-charge. The contractor shall however be fully responsible, for the work being carried out in a safe and proper manner without unduly stressing the various members. Proper equipment such as derricks, lifting tackles, winches, ropes etc. shall be used.

10.13.5 Measurements

The work as fixed in place shall be measured in running metres correct to a centimeter on their weights calculated on the basis of standard tables correct to the nearest kilogram unless otherwise specified.

Weight of cleats, brackets, packing pieces bolts nuts, washers distance pieces separators diapharam gussests (taking overall square dimensions) fish plates, etc. shall be added to the weight of respective items unless otherwise specified. No deduction shall be made for skew cuts.

10.13.6 Rate

The rate shall include the cost of labour and materials involved in all the operations described above including application of one coat of approved steel primer, i.e. red oxide zinc chrome primer conforming to IS 2074.

10.14 FAN CLAMPS (Fig. 10.9)

10.14.1 The fan clamps shall be of the following types:

(a) Fan clamp to be fixed during the laying of R.C.C. slab, shall be of type I, as shown in (Fig. 10.9) This shall be made of 16 mm M.S. bar bent to shape with its ends hooked. The overall height of the clamps shall be made to suit the depth of slab.

(b) Fan clamps for beams shall be of type II as shown in (Fig. 10.9). It shall be similar to fan clamp, type I, except that its height shall be greater depending on the depth of the beam rib.

(c) In case low ceiling heights, circular cast iron box for ceiling fan clamp shall be fixed during the laying of R.C.C. slab and shall be as shown in (Fig. 10.9). The size of cast iron box shall be 140 mm internal dia with 73 mm height, the thickness of cast iron rim shall be 4.5 mm bottom and top lid shall be of 1.5 mm thick M.S. sheet, with its top surface hacked so as to ensure proper bonding with the concrete. The lids shall be screwed into the cast iron box by means of 3.3 mm dia round head screws one each at the corners. The box can be of M.S. sheet, the

thickness of side walls can be reduced to 3 mm without effecting inner dia of the box. The fan clamp shall be made of 12mm dia M.S. bar bent to shape with its ends bent as per drawing.

10.14.2 Fixing

Holes for inserting the fan clamps in the positions shown in the drawing or as instructed by the Engineer-in-charge shall be made in the shuttering after the latter has been fixed in position. After steel reinforcement is tied, fan clamps shall be fixed with their loops truly vertical and at the correct depth from the under-side of the slab or beam. The hooked arms and the loop shall be tied to the reinforcement, either directly or through cut pieces of M.S. bars with annealed steel wire 1.6 mm or 1.00 mm thick. The clamp shall neither be disturbed out of position during concreting nor shall they be bent out of shape when shuttering of slabs or beams is removed.

The exposed portion of loops of the clamps shall be given two or more coats of paint, including priming coat, of approved steel primer as ordered by the Engineer-in-charge.

10.14.3 Measurements

Clamps of type I and 3 shall be counted in numbers. Fan clamps type II, shall be counted and paid for under fan clamps type I, but they shall in addition be paid for their extra height as determined by the depth of the beam.

10.14.4 Rate

The rate per fan clamps shall include the cost of labour and materials involved in all the operations described above. In the case of type I and 3 clamps, the rate shall apply irrespective of the thickness of the slabs.

10.15 M.S. HOLLOW RECTANGULAR DOOR FRAMES (I-TYPE SECTION*)*

10.15.1 Materials

Steel door frames shall be manufactured from commercial mild steel sheet of 1.60 mm thickness, conforming to IS 2062 and 4351.

Steel door frames shall be made in the profiles as per drawings and/or as directed by the Engineer-in-charge.

10.15.2 Construction

Each door frame shall consist of hinge jamb, lock jamb, head and if required angle threshold. These shall be welded or rigidly fixed together by mechanical means. Where no angle threshold is required, temporary base tie shall be screwed to the feet of frames in order to form a rigid unit. Where so specified base ties shall be pressed mild steel 1.60 mm thick adjustable to suit floor thickness of 35 or 40 mm and removable, or alternatively, threshold of mild steel angle of section 50 x 25 mm, minimum shall be provided for external doors frames.

10.15.3 Fabrication

The M.S hollow rectangular steel door frames shall be got fabricated in an approved workshop as approved by the Chief Engineer.

10.15.3.1 ***Fixing Lugs :*** There shall be three adjustable lugs with split end tail to each jamb.

The head of the fixing lug shall be 120 mm long and made up flat steel strip 25 mm wide and 1.60 mm thick.

10.15.3.2 Hinges 100 mm mild steel butt hinges shall be used. Floor door frames 80 cm wide and under, three hinges shall be rigidly fixed to one jamb and for frames of door above 80 cm wide, four higes shall be rigidly fixed to one jamb, if it is single shutter. Where the height of door shutter exceeds 2.15 metres, one additional hinge shall be provided for every 0.5 m or part thereof of the additional height.

In all cases the hinges shall be so fixed that the distance from the inside of the head rebate to the top of the upper hinge is 20 cm and the distance from the bottom of the door frame to the bottom of the bottom hinge is also kept about 200 mm. The middle hinges shall be at equal distance from lower and upper hinges or as agreed to between the purchaser and the supplier. Hinges shall be made of steel 2.5 mm thick with zinc coated removable pin of 6 mm diameter. The space between the two leaves of the hinge when closed shall be 3 mm and the leaf that is not welded to the frame shall have four counter sunk holes to take Number-10 cross recessed head wood screws.

10.15.3.3 ***Aldrops, Sliding Bolts and Tower Bolts :*** Provisions shall be made for aldrops, sliding bolts and tower bolts in the frames as per the positions given by the purchaser. Necessary mortar guards/metallic or nylon bushes shall be provided inside the frames for aldrops, sliding bolts and tower bolts.

10.15.3.4 ***Lock Strike Plate :*** Provision shall be made to fix lock stricke plates of mortise locks or latches, complying with the relevant Indian Standards. A slot suitable for lock stricke plate shall be pierced into the rebate of the frame and necessary fixing arrangement and mortar guard from the inside of the frame shall be provided.

10.15.3.5 ***Shock Absorbers :*** For side- hung door there shall be not less than three buffers of rubber or other suitable material inserted in holes in the rebate and one shall be located at the centre of the lock jamb of frame and other two shall be 300 mm from top and bottom of the frame. For double leaf doors two buffers shall be provided.

10.15.4 Finishing

The surface of door frame shall be thoroughly cleaned, free of rust, mill –scale dirt, oil etc. either by mechanical means, for example sand or shot blasting or by chemical means such as picking. After pretreatment of the surface one coat of approved primer i.e. red oxide zinc chrome primer conforming to IS 2074. Two coats of paints as directed by the Engineer-in-Charge shall be applied to the exposed surface.

10.15.5 Fixing

Frames shall be fixed up right in plumb and plane. To avoid sag or bow in width during fixing or during construction phase, temporary struts across the width preventing sides bulging inwards may be provided. Wall shall be built solid on each side and grouted at each course to ensure solid contact with frame leaving no voids behind the frame.

Three lugs shall be provided on each jamb with spacing not more than 75 cm the temporary struts should not be removed till the masonry behind the frame is set. In case screwed base tie is provided, this should be left in position till the flooring is laid when it can be removed.

After pretreatment of the surface one coat of steel primer and two coats, of paint, as directed by Engineer-in-charge shall be applied to the exposed surface.

10.15.6 Measurements

The length shall be measured in running metre correct to a cm. along the centre line of the frames.

10.15.7 Rate

The rate shall include the cost of labour and material involved in all the operation described above including one coat of approved steel primer but excluding two coats of paint.

10.16 FACTORY MADE GLAZED STEEL DOORS, WINDOWS AND VENTILATORS

10.16.0 Specifications for this item to be same as for standard steel glazed doors, windows and ventilators as mentioned in para 10.10, except that Doors, windows and ventilators to be manufactured in a workshop, approved by the Chief engineer. Also owner of the workshop shall have a valid ISI license for manufacture of doors, windows and ventilators.

10.17 STEEL WORK WELDED IN BUILT-UP SECTIONS USING STRUCTURAL STEEL

(A) In Stringers, Treads, Landing etc. of Stair cases including use of Chequred Plate wherever required

(B) In Grating, Frames, Guard Bar, Ladder, Railings, Brackete, Gates and similar work.

10.17.1 General specifications for these items to be same as for steel work welded in built-up sections as mentioned in para 10.4 except that steel used for fabrication of these items to be of type used for structural use/purposes.

10.17.2 Steel members used for fabricating these items to be designed structurally to withstanding the all loads to be carried out by the members during erection, fixing and functional use in designed life. Work to be executed as per structural drawings.

10.18 STEEL WORK WELDED IN BUILT-UP SECTIONS FOR HAND RAIL USING M.S. TUBULAR/ ERW TUBULAR PIPES AND G.I. PIPES

10.18.1 General specifications to be same as for steel work welded in built-up section as mentioned in para 10.4.

10.18.2.1 Hot finished welded (HFW) Hot finished seamless (HFS) and electric resistance welded tube shall conform to IS 1161.

10.18.2.2 G.I. pipes used for Hand rail to be conforming to IS 1239-Part I for medium grade. GI pipes to be screwed and socketed type and of required nominal bore.

10.18.2.3 Galvanising of GI pipes shall conform to IS 4736.

10.18.2.4 All screwed tubes and socket of GI pipes shall have pipe threads conforming to the requirements of IS 554.

10.18.2.5 The fittings for GI pipes to be conforming to IS 1239 (Part-II).

10.8.3 Measurement of Hand Rail of M.S. Tubular/E.R.W Tubular Pipes

The work as fixed in place shall be measured in running metres correct to a centimeter and their weights calculated on the basis of standard tables correct to the nearest kilogram or actual weight whichever is less unless otherwise specified.

10.19 DASH FASTENERS

These dash fasteners shall be of approved manufacture and shall be fabricated from the carbon steel.

10.19.1 The Grade 6.8 means:

(a) The first figure indicates the 1/100 of nominal tensile strength in N/mm^2.

(b) The second figure indicates 10 times the ratio between lower yield stress and nominal tensile strength.

The yield strength 480 N/mm^2 means the 6.8 grade shall have the tensile strength of 600 N/mm^2.

The lead of a thread is the distance travelled parallel to the axis in one rotation of a part in relation to a fixed mating part. In single threads, the lead is equal to the pitch. A double thread, it has two ridges starting 180Ú apart. The lead is twice the pitch. A triple thread, it has three ridges starting 120Ú apart. The lead is three times the pitch.

10.19.2 Fixing

According to the size (diameter & length) of the dash fasteners, the holes shall be done with precise location for fixing in frame, Masonry/concrete etc. The minimum distance between holes not less than 2.5 times diameter of the fastener.

10.19.3 Measurements

Dash fasteners of each size shall be counted in numbers.

10.19.4 Rate

The rate shall include the cost of materials and labour involved in all the operations described above. Nothing extra shall be paid for drilling of hole in frame, Masonry/concrete etc. nor anything deducted for these from the measurement of frame, Masonry/concrete etc.

10.20 STAINLESS STEEL RAILING

The stainless steel of 304 grade of as per IS 6911 : 2017 shall be used for further fabrication of railing as per Architectural Design.

10.20.1

(a) Stainless steel of 304 grade is most common in 300 series of Austenitic stainless steel.

(b) It is still sometimes referred to by its old name 18/8 which is derived from the nominal composition of type 304 being 18% chromium and 8% nickel.

(c) Fabrication of all stainless steel sections should be done only with tools dedicated to stainless steel materials. Tooling and work surfaces must be thoroughly cleaned before use. These precautions are necessary to avoid cross contamination of stainless steel by easily corroded metals that may discolour the surface of the fabricated product. Some specific hints are as under:

  (i) Remove all moisture by blowing with dry air or heating with a torch.

  (ii) Eliminate organic contaminates like oil, paints, anti-spatter compounds, grease, pencil marks, cutting compounds, adhesive from protective paper, soap used for leak testing etc.

  (iii) Stainless steels cannot be flame cut with a torch. Acceptable results are achieved with an arch plasma cutter.

  (iv) Be particularly careful to avoid zinc contamination. Do not use brushes or tools previously used on galvanized steel.

  (v) Use only stainless steel wire brushes and use these brushes only on stainless steel.

10.20.2 Fixing

Fixing with railing with necessary accessories & stainless steel dash fasteners, stainless steel bolts etc. of required size, on the top of the floor or the side of waist slab with suitable arrangement as per approval of Engineer-in-charge.

10.20.3 Measurements

Only weight of stainless steel members shall be considered in kg, excluding fixing accessories such as nuts, bolts, fasteners etc.

10.20.4 Rate

The rate shall include the cost of materials and labour involved in all the operations described above. Nothing extra shall be paid for fixing arrangements i.e. drilling, nut & bolts etc.

10.21 FLY PROOF WIRE GAUZE

Wire gauze/Wire Cloth which shall generally conform to IS 1568 shall be regularly woven with equally spaced galvanised mild steel wires in both warp and weft directions. The wire cloth shall be properly selvedged by one or more wires in each edge.

The following wire gauze shall be used :

(i) Galvanised mild steel wire gauze of 1.40mm average aperture width woven with 0.63mm nominal dia shall be used.

(ii) Stainless steel (Grade 304) gauze of 0.5 mm dia wire and 1.4mm aperture on both sides.

The wire gauze shall be bent at right angles in the inner face of steel frame of stiles and rails, turned back and fixed tight with blue tacks at about 75mm centres, fixed alternately in the two faces of the inner face of frame. Over this, M.S. Flat of size 15x3 mm with nuts & bolts fixed alternately in the two faces of the frame at about 75mm centres.

10.21.1 Measurement

The length and breadth of finished wire gauze on inner face of frame shall be measured correct to the nearest cm and area worked out in square metres correct to two places of decimal.

10.21.2 Rates

The rate includes cost of all operation described above.

10.22 GLASS PANES WITH PUTTY AND GLAZING CLIPS

Glazing in the steel door, windows, clerestory windows shall be provided with glass weight of which shall be not less than density 10 kg/sqm or 13.5 kg/sqm for the specific thickness 4.0 mm or 5.5 mm respectively. Glass panels shall be fixed by providing a thin layer of putty conforming to IS 419 applied between glass pane and all along the length of the rebate and also between glass panes and beading.

10.22.1 Putty can be prepared by mixing one part of white lead with three parts of finely powdered chalk and then adding boiled linseed oil to the mixture to form a stiff paste and adding varnish to the paste at the rate of 1 litre of varnish to 18 kg of paste. Fixing of glass panes without beading shall not be permitted. Glazing shall be done after the shutters have been finished.

10.22.2 Panels of shutters shall be flat and well sanded to a smooth and level surface.

Four glazing clips may be provided per glass pane for a size larger than 30 cm x 60 cm for all types, where the glass panes size exceed 80 cm x 200 cm, 6 glazing clips shall be used. In case of doors, windows and ventilators without horizontal glazing bars, the glazing clips may be spaced according to the slots, in the vertical members provided the spacing does not exceed 30 cm otherwise the spacing shall be 30 cm.

Note: Where large size glass panes are required to be used or where the door or window is located in heavily exposed situation, holes for glazing clips have to be drilled prior to fabrication and cannot be done at any later stages. Use of glazing clips shall be specified while placing the order.

10.22.3 Where specially stipulated, fixing of glass panes may be done with metal or wooden beading instead of mere putty. Where beading are proposed to be used, the manufactures shall be intimated in advance to drill holes for hard screws. Usually beads shall be fixed with screws spaced not more than 10 cm from each corner and the intermediate not more than 20 cm apart. When glass panes are fixed with wooden or metal beading having mitred joints, a thin layer of putty shall be applied between glass panes and sash bars and also between glass panes and the beading.

Size of M.S. beading shall be 10 x 10 mm box section manufactured from 1.6mmthick sheet unless otherwise specified in the item.

Where metal beading is specified, extra payment shall be made on this account.

10.22.4 Measurement

The length and breadth of glass pane shall be measured correct to the nearest cm and area worked out in square metres correct to two places of decimal.

10.22.5 Rate

The rate includes cost of all the operation described above.

10.23 ANGLE IRON FRAMES FOR DOORS, WINDOWS AND VENTILATORS

Mild steel equal angle sections 35 x 35x 5 mm for fabrication of steel doors, windows and ventilators shall conform to IS 808. The MS Flat of size 35 x 5 mm if used for fabrication shall confirm to IS 1730.

10.23.1 The steel doors, windows and ventilators shall be according to the specified sizes and design. The size of doors and windows shall be calculated, so as to allow 1.25 cm clearance on all the four sides of opening to allow for easy fitting of doors windows and ventilators into opening, The actual sizes of doors, windows and ventilators shall not vary by more than +1.5mm from those given in the drawing.

10.23.2 Fabrication

Frames shall be made of sections which have been cut to length and mitred. The corner of frames shall be welded to form a solid fused welded joint conforming the requirements given below. All frames shall be square and flat. The process of welding adopted shall be flush but welding or can be any other process as agreed to between the supplier and the purchaser which shall fulfil the requirements given in clause 6.1.1 of IS 1038, metal arc welding or any other suitable method.

10.23.3 Requirements of Welded Joints

(i) Visual Inspection Test : When two opposite corners of the frame are cut, paint removed and inspected the joint shall conform to the following:-

(a) Welds should have been made all along the place of meeting the members and tack welding shall not be permitted.

(b) Welds should have been properly grounded and

(c) Complete cross section of the corner shall be checked up to see that the joint is completely solid and there are no cavities visible.

(d) Micro and Macro Examinations:

From the two opposite corners obtained for visual test, the flanges of the sections shall be cut with the help of a saw. The cut surface of the remaining portions shall be polished, etched and examined. The polished and etched faces of the weld and the base metal shall be free from cracks and cavity and reasonably free from under cutting overlaps, gross porosity and entrapped slag.

(ii) Fillet Weld Test : The fillet weld in the remaining portion of the joint shall be fractured by hammering. The fractured surfaces shall be free from slag inclusion porosity, crack penetration defects and fusion defects.

10.23.4 Priming Coat

All surfaces which are to be painted, oiled or otherwise treated shall be dry and thoroughly cleaned to remove all loose scale and loose rust. A priming coat of approved steel primer such as Red Oxide/Zinc Chromate primer conforming to IS 2074 shall be applied before fixing.

10.23.5 Fixing

Frame places in position carefully without any damage to itself and other building work and injury to workmen. The frame shall be fixed to existing T-Iron frame or to wall with help of Dash fastener upto the satisfaction of the Engineer-in-charge.

10.23.6 Measurements

The work as fixed in place shall be measured in running metres correct to a millimetre and weights calculated on the basis of standard tables correct to the nearest kilogram. The standard weight of steel sections shall conform to IS 808 with tolerance in sizes as per IS 1852. Tolerance in weight is given in Table 10.3. Steel sections shall be acceptable within tolerance limits. Payment for steel sections shall be made as per actual weight within tolerances. Sections having weight on higher side than permissible tolerance may be acceptable but payment shall be made on the basis of standard weight only. Steel sections having weight variations lower side than permissible variation shall not be acceptable.

10.23.7 Rate

Rate includes the cost of labour and materials required for all the operations described above except the dash fastener paid separately if frame is directly fixed to wall by dash fasteners. It shall include the necessary butt hinges and screws for fixing the same with frame or as specified.

APPENDIX A

MECHANICAL PROPERTIES AND CHEMICAL COMPOSITION OF STEEL

TABLE 10.1
Chemical Composition
(Clause 10.1.1)

Grade Designation	*Quality*	*Ladle analysis, Percent, Max*					*Carbon Equivalent (CE), Max*	*Method of Dexodiation*[1]
		C	*Mn.*	*S*	*P*	*Si*		
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
E 165 (Fe 290)	-	0.25	1.25	0.045	0.045	-	-	Semi-killed or killed
E 250 (Fe 410 W)	A	0.23	1.50	0.045	0.045	0.40	0.42	Semi-killed or killed
E 250 (Fe 410 W)	B	0.22	1.50	0.045	0.045	0.40	0.41	Killed
E 250 (Fe 410 W)	C	0.20	1.50	0.040	0.040	0.40	0.39	Killed
E 300 (Fe 440)	-	0.20	1.30	0.045	0.045	0.45	0.40	Semi-killed or killed
E 350 (Fe 490)	-	0.20	1.50	0.045	0.045	0.45	0.42	Semi-killed or killed
E 410(Fe 540)	-	0.20	1.60	0.045	0.045	0.45	0.44	Semi-killed or killed
E 450 (Fe 570)	D	0.22	1.60	0.045	0.045	0.45	0.46	Semi killed or killed
E 450 (Fe 590)	E	0.22	1.80	0.045	0.045	0.45	0.48	Semi killed or killed

Notes:

1. Carbon equivalent (CE) based on ladle analysis = $\frac{Mn}{C+6} + \frac{(Cr+Mo+V)}{5} + \frac{(Ni+Cu)}{15}$
2. When the steel is killed by aluminium alone, the total aluminium content shall not be less than 0.02 per cent. When the steel is killed by silicon alone, the silicon content shall not be less than 0.10 per cent. When the steel is silicon-aluminium killed, the silicon content shall not be less than 0.30 per cent and total aluminium content shall not be less than 0.01 per cent.
3. Microalloying element like Nb, V, Ti and B shall be added singly or in combination. Total microalloying element shall not be more than 0.25.
4. New grades designation system based on yield stress has been adopted, simultaneously old designations have also been given in parentheses.
5. Steel of qualities A, B and C are generally suitable for welding processes. The weldability increases from quality A to C.
6. Copper may be present between 0.20 to 0.35 per cent as mutually agreed to between the purchaser and the manufacturer. The copper bearing quality shall be designated with a suffix Cu, for example, E 250 Cu. In case of product analysis the copper content shall be between 0.17 and 0.38 per cent.
7. Nitrogen content of steel shall not exceed 0.012 per cent which shall be ensured by the manufacturer by occasional check analysis. For micro alloyed steel this is to be reduced to 0.009 per cent.
8. The steel, if required may be treated with rare earth element for better formability.
9. Lower limits for carbon equivalent and closer limits for other elements may be mutually agreed to between the purchaser and the manufacturer.
10. Incidental element-Elements not quoted in Table 1 shall not be intentionally added to steel without the agreement of the purchaser, other than for the purpose of finishing the heat. All reasonable precautions shall be taken to prevent the addition from scrap or other materials used in manufacture of such elements which affect the hardenability, mechanical properties and applicability.

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1. "To be supplied subject to the agreement between the purchaser and the manufacturer".

TABLE 10.2
Mechanical Properties
(Clause 10.1.1)

Grade Designation	*Quality*	*Tensile strength Min. MPa*	*Yield stress, ReH Min. MPa*			*Percentage elongation at Guage length Lo 5.65 √SO Min.*	*Internal Bend Diameter Min.)*		*Charpy V-Notch Impact Energy Min. J*	
			<20	*20-40*	*>40*		*≤ 25*	*>25*	*at Room Temp.*	*At 20°C*
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
E 165 (Fe 290)	-	290	165			23	2t	-	-	-
E 250 (Fe 410 W)	A	410	250	240	230	23	3t	2t	-	-
E 250 (Fe 410 W)	B	410	250	240	230	23	2t	3t	27 (See Note 3)	
E 250 (Fe 410 W)	C	410	250	240	230	23	2t	3t	27 (See Note 3)	
E 300 (Fe 440)	-	440	300	290	280	22	2t	3t	50	30
E 350 (Fe 490)	-	490	350	330	320	22	2t	3t	50	25
E 410 (Fe 540)	-	540	410	390	380	20	2t	3t	50	25
E450 (Fe 570)	D	570	450	430	420	20	2t	3t	45	20
E 450 (Fe 590)	E	590	450	430	420	20	2t	3t	45	20

1 1 MPa= 1MN/m^2= 0.102 kgf/mm^2=144.4 psi
2 Temperature of Charpy impact values will be subject to mutual agreement.
3 The more stringent requirements than those given above may be as agreed to between the purchaser and the manufacturer**.**

TABLE 10.3
(Clause 10.2.4 &10.3.5)

Sl. No.	*Steel Section*	*Tolerance in weight per meter percentage*		*Standard weight as per IS*
		Plus Side	*Minus Side*	
(i)	Beams and columns (RS joists)	(a) Beams ≤ 200 mm (+) 4	(-) 1	IS 808
		(b) > 200 mm 2.5	2.5	
(ii)	Channels	2.5	2.5	IS 808
(iii)	Equal and unequal leg Angles			
	(a) upto 3 mm thickness	5	5	IS 808
	(b) Over 3 mm thickness	5	3	
(iv)	Tee bars			
	(a) Web thickness upto 3 mm	5	5	IS 1173
	(b) Web thickness above 3 mm	2.5	2.5	
(v)	Bulb angles	2.5	2.5	IS 1252
(vi)	Bars in straight length			
	Upto and including 10 mm	7	7	IS 1732
	Over 10 mm and upto and including 16 mm	5	5	
	Over 16 mm	3	3	
(vii)	Bars in coils	Weight tolerance is not applicable		
(viii)	Flats			
	Upto 3 mm thickness	5	5	
	Over 3 mm thickness	5	3	
(ix)	Plates	5	2.5	IS 1730
(x)	Strips	10	10	IS 1730
	Consignment in straight length			
	(i) upto 5 tons	7	7	IS 1730
	(ii) Above 5 tons	5	5	
(xi)	Sheets			
	Thickness			
	Over in mm	Upto and including in mm	Tolerance on calculated weight (Percent)	IS 1730
	-	1.25 mm	± 9	
	1.25 mm	1.60	+ 8	
	1.6	4.00	+ 7	

APPENDIX B

WELDING PROCESS

(Clause 10.4.2.4)

(a) The work shall be positioned for downward welding wherever possible.
(b) Arc length voltage and amperage shall be suited to the thickness of material, type of groove and other circumstances of the work. The welding current and electrode sizes for different types of joints shall be as per IS 9595.
(c) The sequence of welding shall be such as will avoid undue distortion and minimize residual shrinkage stresses. Recommendation of IS 9595 shall be followed.

Process of Welding

The electrode manipulation during welding shall be such as to ensure that:

(1) The parent metal is in a fused stage when the filler metal makes contact with it.

(2) The weld metal does not overflow upon any unfused parent metal forming overlapping.

(3) The parent metal is not under-cut along the weld toes.

(4) The flowing metal floats, the slag, the oxides, and the gas bubbles to the surface behind the advancing pool. In case any of these requirements is unattainable by manipulation, the current shall be adjusted or the electrode size changed.

Each time the arc is started the electrode shall be moved in such a way that the fusion of base metal at the starting point is assured. At the completion of a run the movement of electrode shall be slowed down to fill the arc crater.

After every interruption of the arc except at completion of a run, the arc shall be restarted ahead of the previous deposit and then move back to fill the crater or such alternative technique shall be used as will ensure complete filling of the crater, or complete fusion between the new and old deposit and the base metal at the point of junction, and result in continuity of weld, Before welding operation is completed, all traces of slag shall be removed from the deposit, by chipping if necessary, and the deposit and the adjoining base metal shall be wire brushed and cleaned at all points. The requirements shall apply not only to successive layers, but also to successive beads, and to the over lapping area wherever a junction is made on starting a new electrode.

(5) The welds shall be free from cracks, discontinuity in welding and other defects such as (i) under-size (ii) over-size, (iii) under-cutting and (iv) over-cutting in the case of fillet welds and defects (ii), (iii) & (iv) in the case of butt welds.

All defective welds which shall be considered harmful to the structural strength shall be cut out and rewelded.

In case of welded butt joints in steel of thickness upto 50mm the weld joint shall be subjected to radiographic examination as described in IS 1182.

All welds shall be cleaned of slag and other deposits after completion. Till the work is inspected and approved painting shall not be done. The surface to be painted shall be cleaned of spatter, rust, loose scale, oil and dirt.

APPENDIX C

STEEL TUBES FOR STRUCTURAL PURPOSES

(Clause 10.13.1)

Nominal Bore (mm)	*Outside Diameter (mm)*	*Class*	*Wall Thickness (mm)*	*Weight (kg/m)*
15	21.3	H	3.2	1.44
20	26.9	H	3.2	1.87
25	33.7	M	3.2	2.41
		H	4.0	2.93
32	42.4	L	2.60	2.54
		M	3.2	3.10
		H	4.00	3.79
40	48.3	L	2.90	3.23
		M	3.2	3.56
		H	4.0	4.37
50	60.3	L-1	2.9	4.08
		M	3.6	5.03
		H	4.5	6.19
65	76.1	L	3.2	5.71
		M	3.6	6.42
		H	4.50	7.93
80	88.9	L	3.2	6.72
		M	4.00	8.36
		H	4.8	9.9
90	101.6	L	3.6	8.7
		M	4.0	9.63
		H	4.8	11.50
100	114.3	L	3.6	9.75
		M	4.5	12.2
		H	5.4	14.5
110	127.0	L	4.5	13.6
		M	4.8	14.50
		H	5.4	16.2
125	139.7	L	4.50	15.00
		M	4.8	15.90
		H	5.4	17.90
135	152.4	L	4.50	16.40
		M	4.8	17.50
		H	5.40	19.60
150	165.1	L	4.50	17.80
		M	4.8	18.90
		H	5.40	21.30
150	168.3	L	4.50	18.20
		M	4.8	19.40
		H-1	5.40	21.70
		H-2	6.3	25.20
175	193.7	L	4.8	22.40
		M	5.40	25.10
		H	5.9	27.30
200	219.1	L	4.8	25.40
		M	5.60	29.50
		H	5.90	31.00
225	244.5	H	5.90	34.70
250	273	H	5.90	38.90
300	323.90	H	6.30	49.30
350	355.60	H	8.00	68.60

L means Light M means Medium H means Heavy

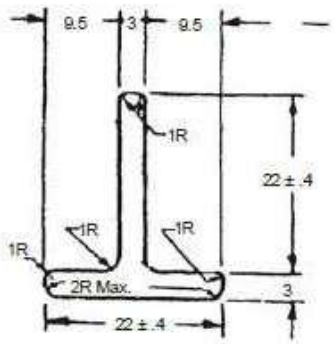
APPENDIX D

SHAPES, WEIGHTS AND DESIGNATION OF MS ROLLED STEEL SECTION

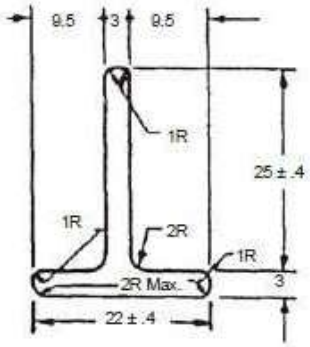
Designation	*Wt kg/m*	*Situation of Use of Section*
T2	1.036	Vertical and horizontal glazing bars for doors and shashes : windows, ventilators glazing bars for door side lights sub dividing bars for fixed length, sash bars for doors, windows and ventilators wheel steel aluminium or wooden beading is used for fixing glasses.
T3	1.14	Vertical glazing bar for FZ 7 frame
T6	0.839	Vertical and horizontal glazing bar for standard windows and ventilators.
F2	1.46	Inner frames for open-in windows.
F3	2.28	Outer frames for open-in windows.
F5	1.55	(a) Inner and middle frames in centre-hung ventilators
		(b) F5 is some times used as inner frames for open-out windows. Also used as inner frame for bottom hung ventilators
		(c) F8 is also used as outer frame for bottom hung ventilators.
F4B	2.28	Central mullion (meeting bar for shutters) for windows and ventilators using F7D as inner frames, outer frames for open-in windows in rainy areas, subdividing bars for openable windows and top-hung ventilators.
F7D	1.419	Inner and outer frames for windows and top hung ventilators, for inner frames for centre-hung ventilators and outer frames for door sidelights.
FX6	2.52	Inner frame for doors
FZ7	1.90	Used as outer frame for industrial shashes. Also used for outer frame for wooden doors
FX8	2.31	Outer frames for doors
FZ5	2.52	Inner frames for doors
K11B	1.80	(a) Vertical coupling mullion for standard windows
		(b) Can be used as horizontal coupling bar when openable windows are to be coupled above fixed ones or between two fixed windows.
		(c) Can also be used as horizontal coupling mullion where windows are not exposed to weather.
K12 B	2.30	Horizontal coupling mullion, also known as weather bar, Especially used when the coupled unit is exposed to rain.

APPENDIX D

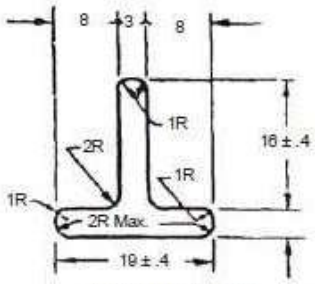
SHAPES



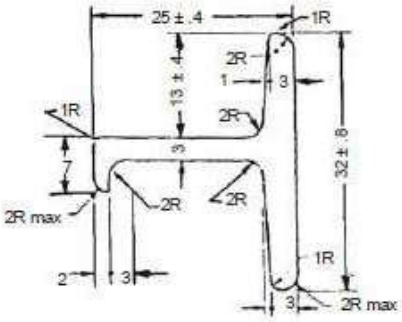
WEIGHT 1.038 Kg/m
T2



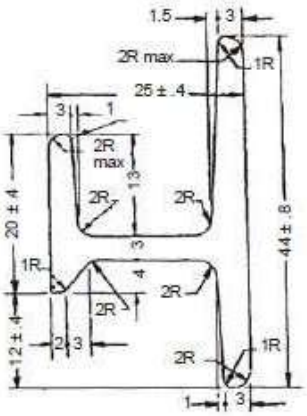
WEIGHT 1.14 Kg/m
T3



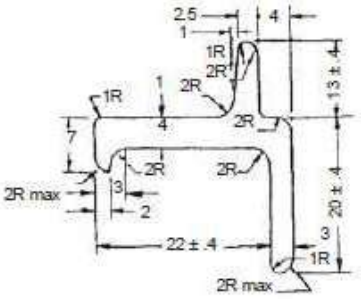
WEIGHT 0.839 Kg/m
T6
All dimensions in millimetres



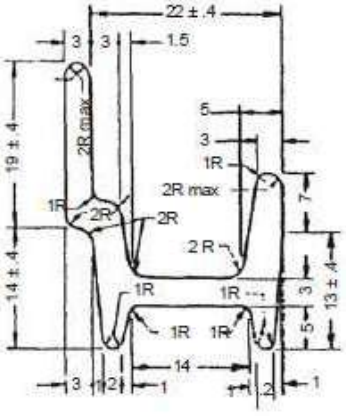
WEIGHT 1.46 Kg/m
F2



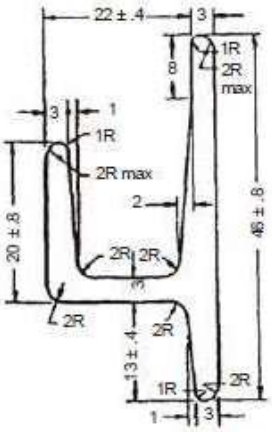
WEIGHT 2.28 kg/m
F3
All dimensions in millimetres



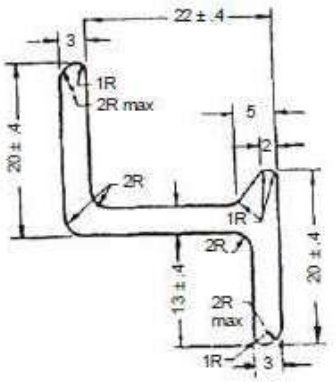
WEIGHT 1.55 kg/m
F5



WEIGHT 1.92 kg/m
F 8
All dimensions in millimetres



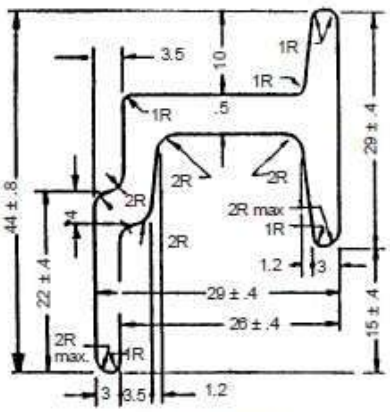
WEIGHT 2.28 kg/m
F4B



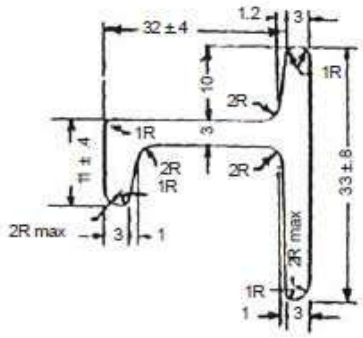
WEIGHT 1.419 kg/m
F7D
All dimensions in millimetres

APPENDIX D

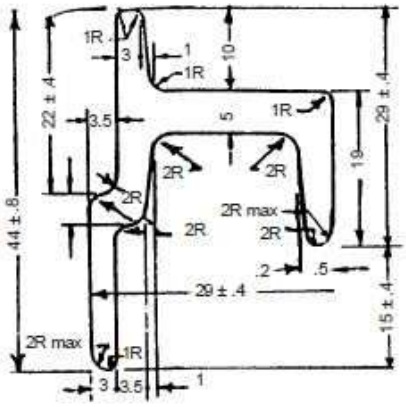
SHAPES



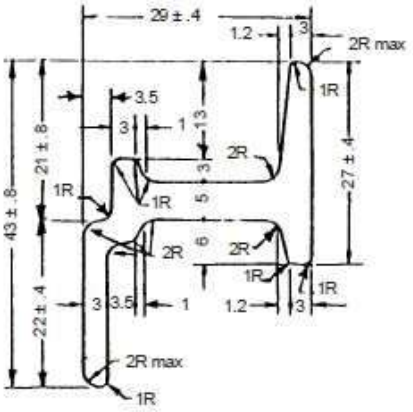
WEIGHT 2.52 kg/m
FX6



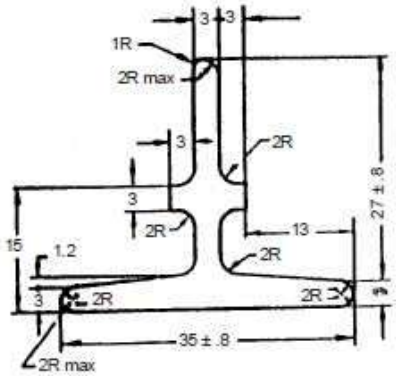
WEIGHT 1.90 kg/m
FZ7
All dimensions in millimetres



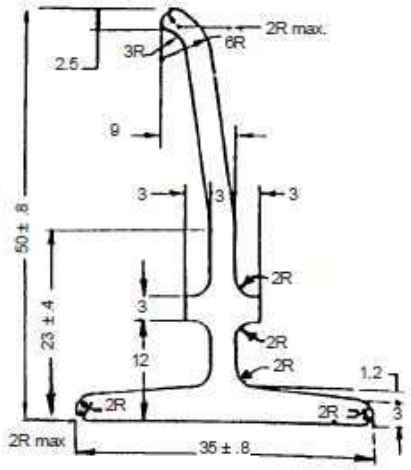
WEIGHT 2.52 kg/m
FZ5
All dimensions in millimetres



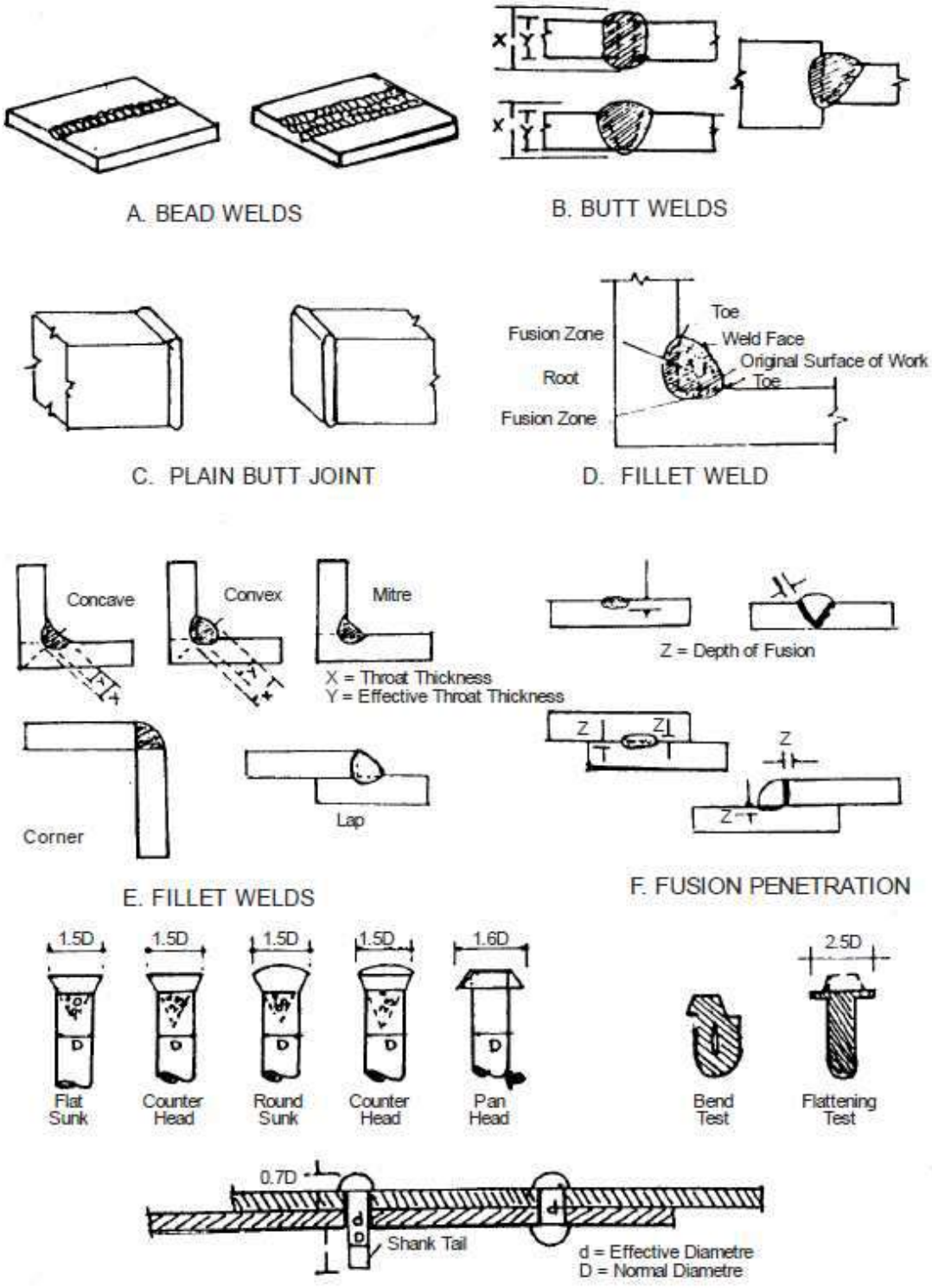
WEIGHT 2.31 kg/m
FX8



WEIGHT 1.80 kg/m
K11B



WEIGHT 2.30 kg/m K12B

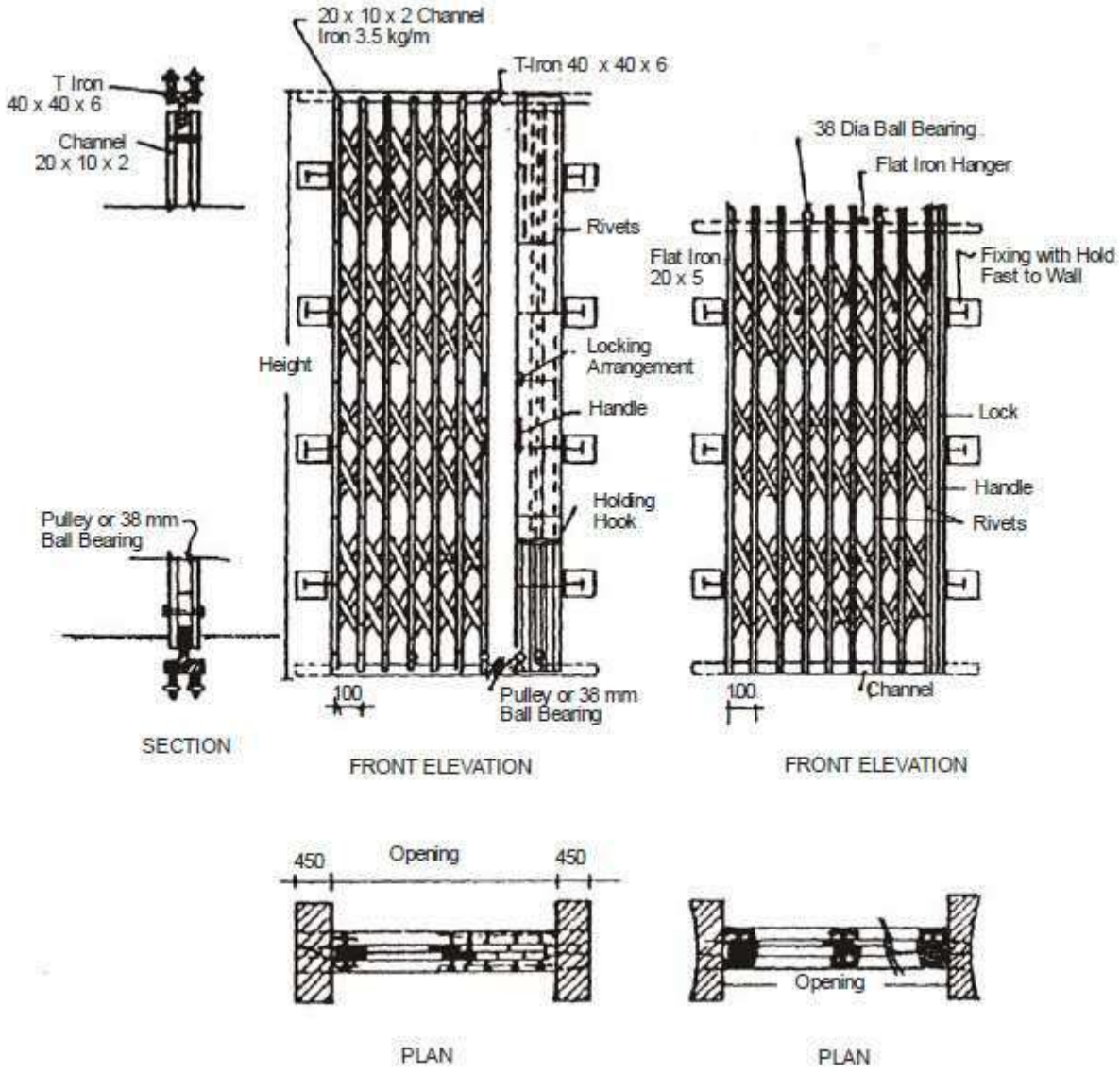


Drawing not to Scale

Fig. 10.1 : Welds and Rivets

COLLAPSIBLE STEEL GATE

Sub Head : Steel Work
Clause : 10.5

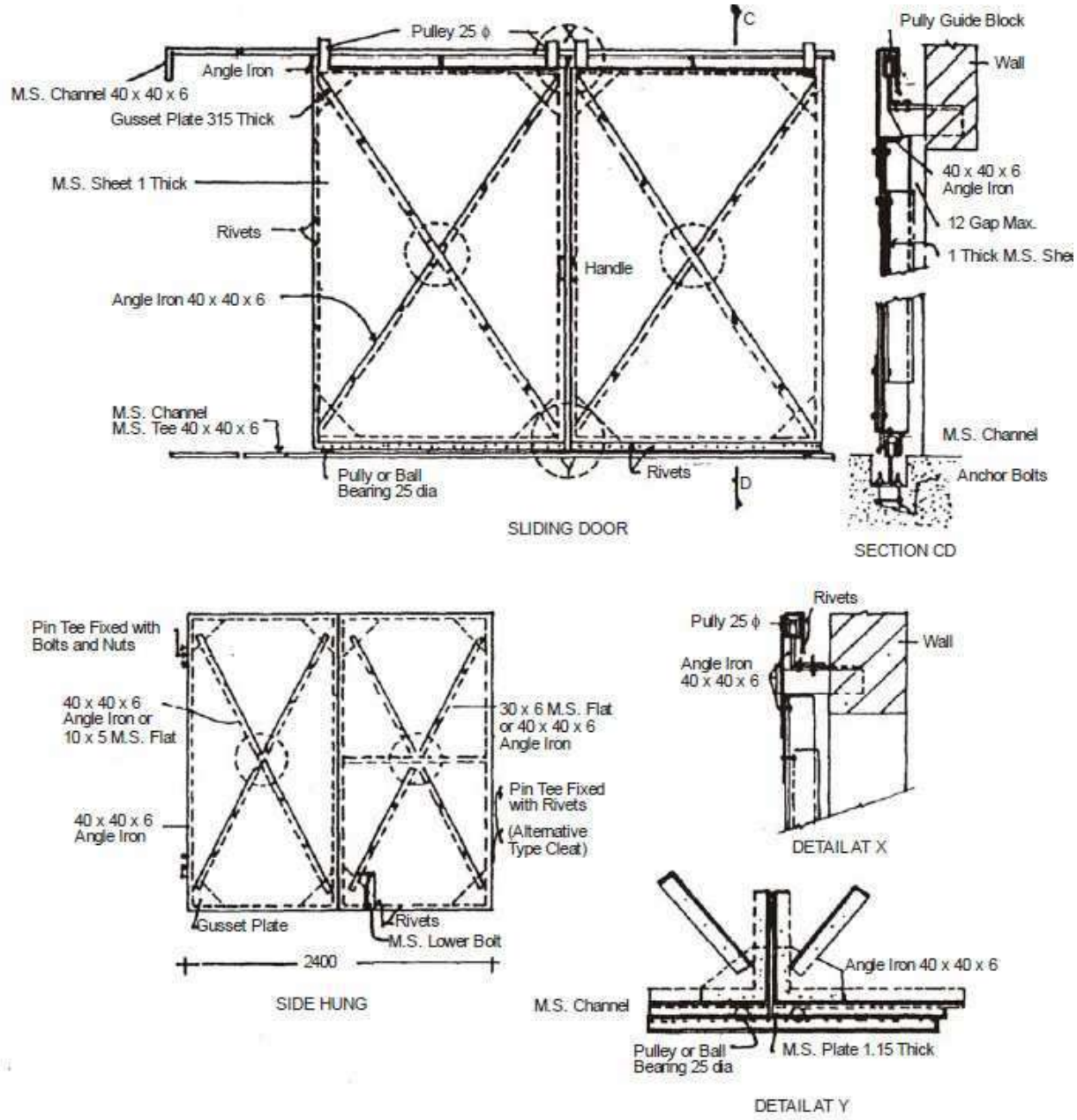


Drawing not to Scale
All dimensions are in mm

Fig. 10.2 : Collapsible Steel Gate

TYPICAL M.S. SHEET SHUTTERS

Sub Head : Steel Work
Clause : 10.6 & 10.7

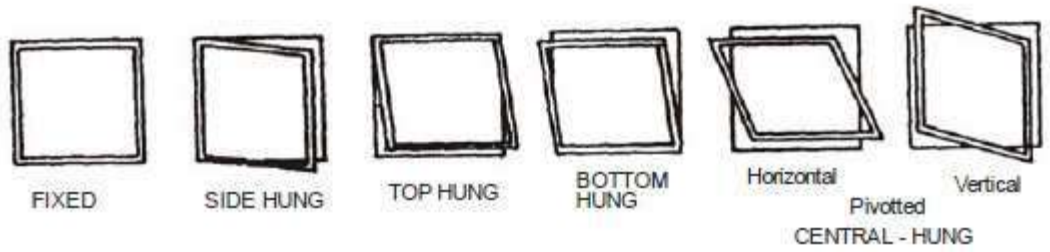


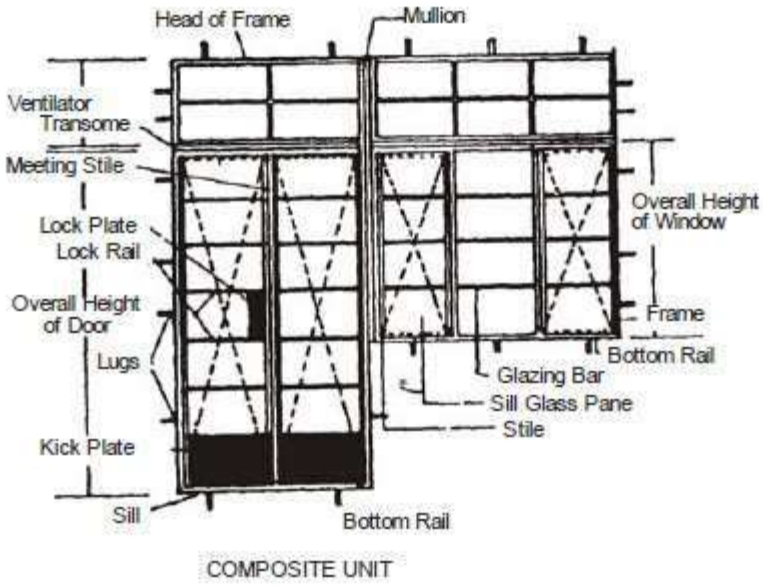
Drawing not to Scale
All dimensions are in mm

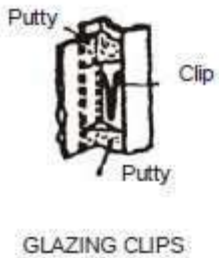
Fig. 10.3 : Typical M.S. Sheet Shutters

STEEL DOORS, WINDOWS AND VENTILATORS

Sub Head : Steel Work
Clause : 10.10







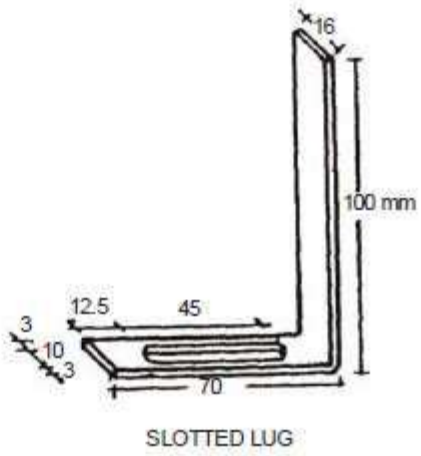
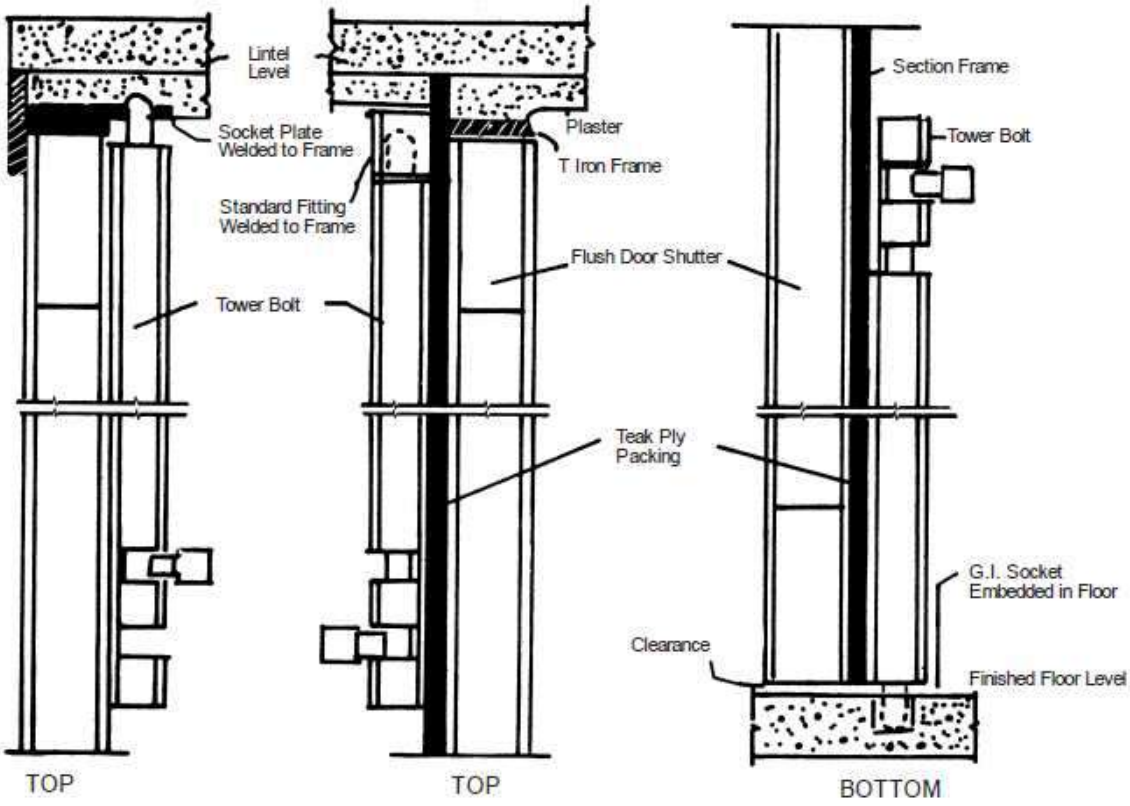


Fig. 10.4 : Steel Doors, Windows and Ventilators

T-IRON DOOR, WINDOW FRAMES

Sub Head : Steel Work
Clause : 10.11



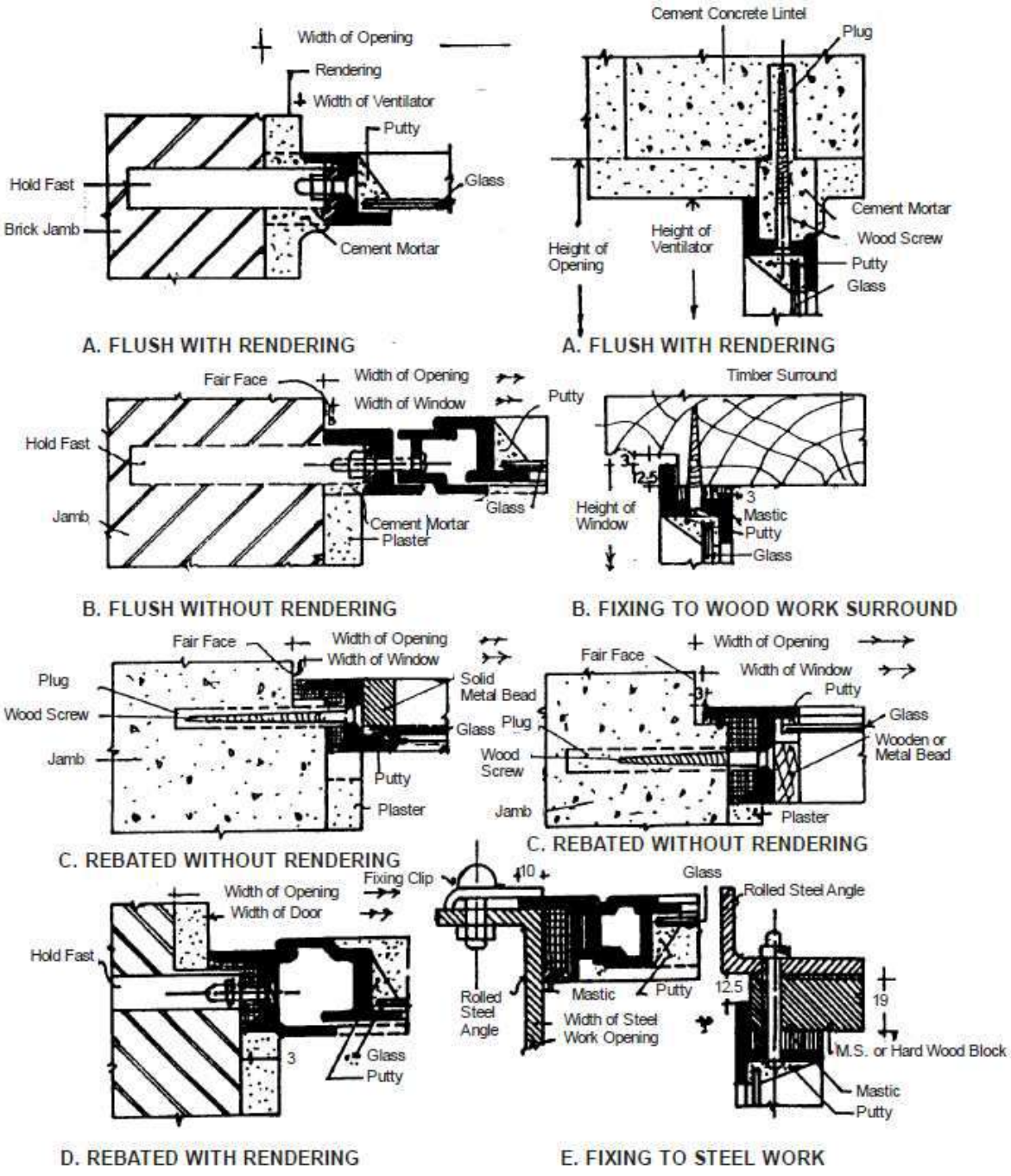
FIXING TOWER BOLT TO SHUTTERS

Drawing not to Scale

Fig. 10.5 : T-Iron Door, Window Frames

STEEL DOORS, WINDOWS & VENTILATORS

Sub Head : Steel Work
Clause : 10.10

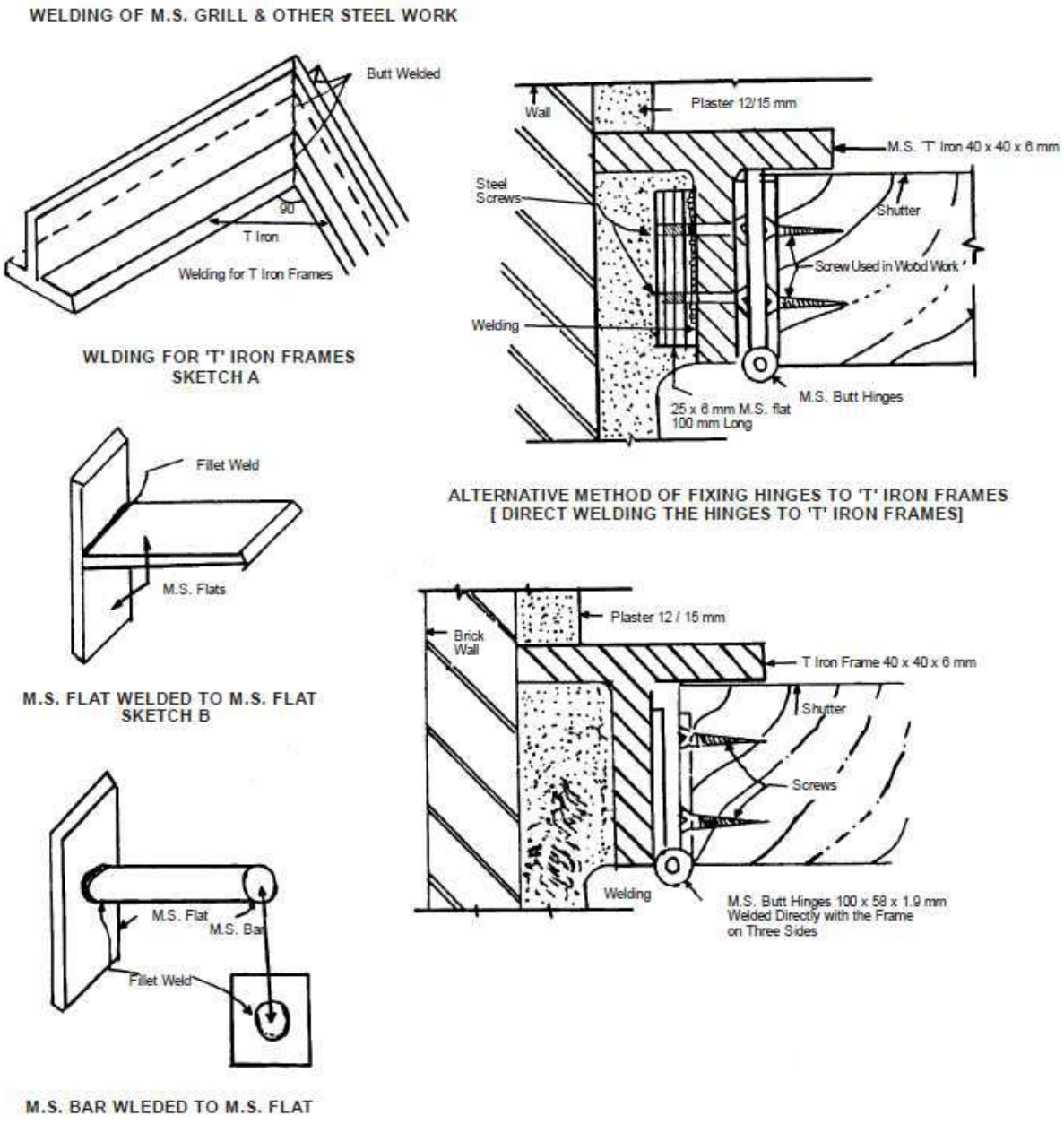


Drawing not to Scale

Fig. 10.6 : Steel Doors, Windows & Ventilators

FIXING BUTT HINGES TO T-IRON FRAME WITH M.S. FLAT WELDED TO FRAME

Sub Head : Steel Work
Clause : 10.11

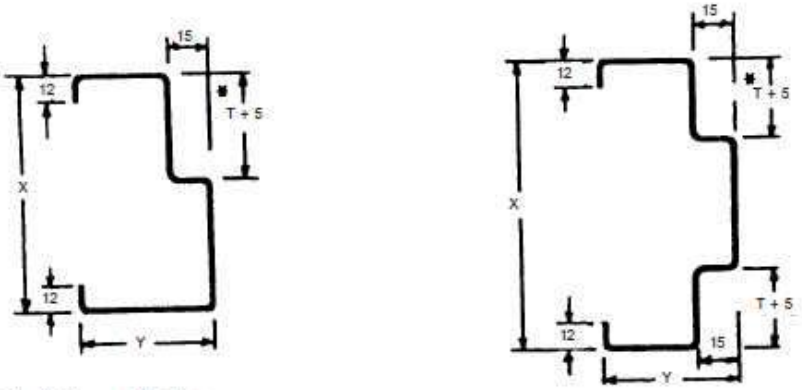


Drawing not to Scale

Fig. 10.7 : Fixing Butt Hinges to T-Iron Frame with M.S. Flat Welded to Frame

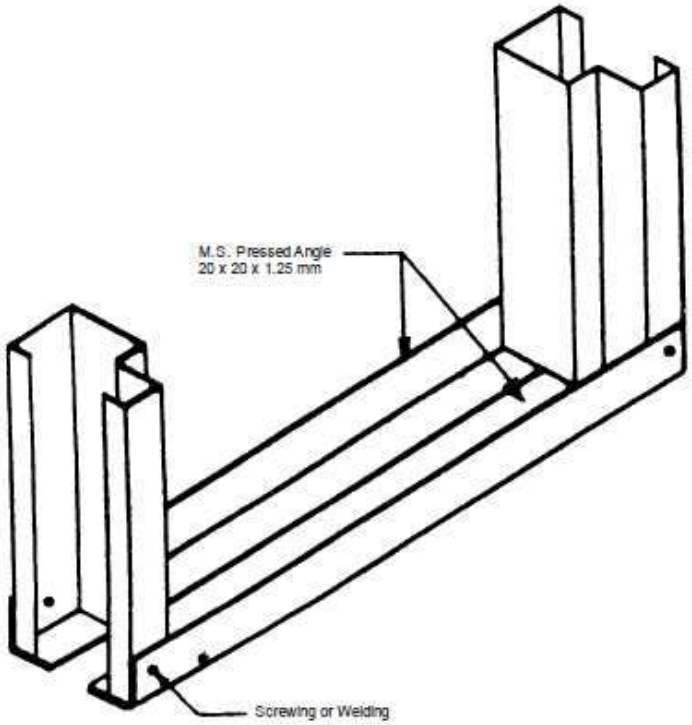
PRESSED STEEL DOOR & WINDOW FRAMES

Sub Head : Steel Work
Clause : 10.12



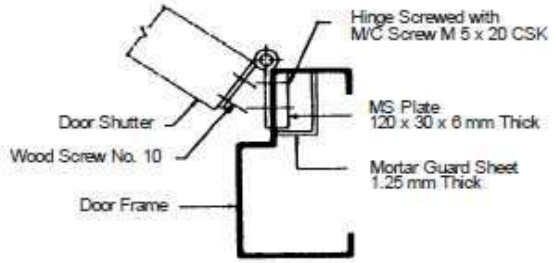
Note : (1) *T is the thickness of the Shutter.
(2) X and Y are as per Table 2 of I.S. Code 4351.
(3) All dimensions in millimetres.

PROFILES OF PRESSED STEEL DOOR FRAMES

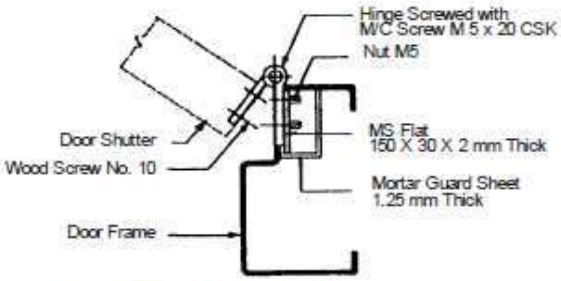


ARRANGEMENT AT BASE OF DOOR FRAME

Fig. 10.8 : Pressed Steel Door & Window Frames

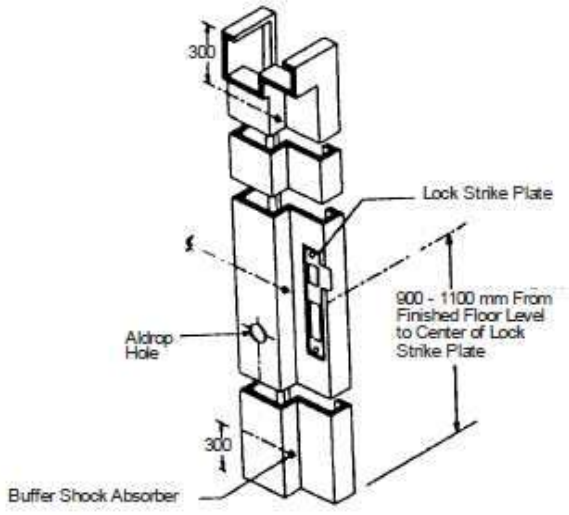


FIXING OF HINGE TO THE FRAME - SCREWED TO THE M.S. FLAT

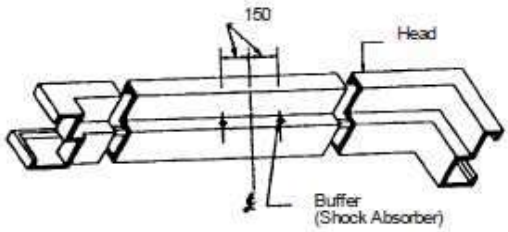


FIXING OF HINGE TO THE FRAME - SCREWED TO THE NUT

FIXING OF HINGE TO THE FRAME



SIDE HUNG DOOR FRAME



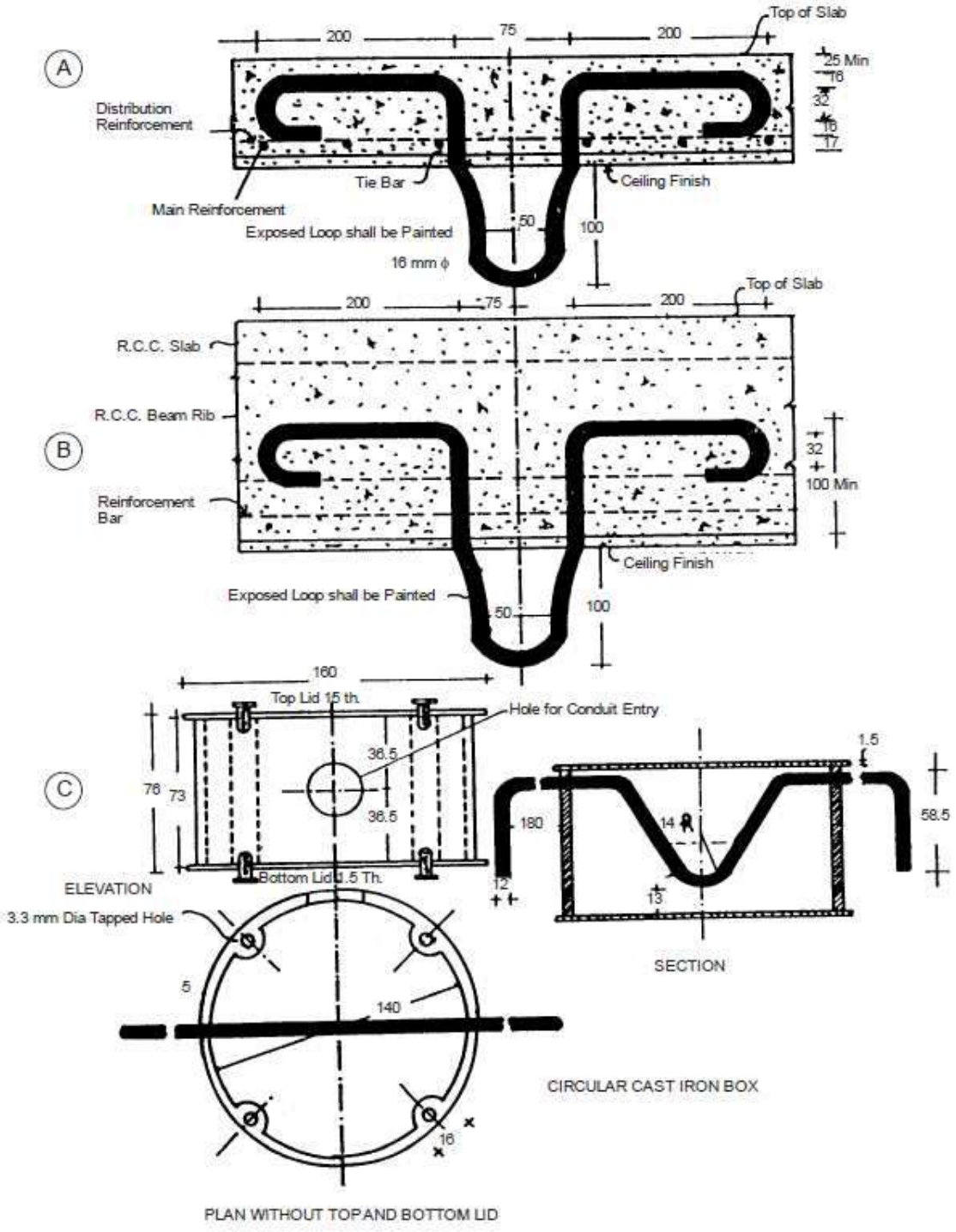
DOUBLE LEAF DOOR FRAME

Drawing not to Scale
All dimensions in millimeters

Fig. 10.8 (Contd.) : Location of Shock Absorbers, Lock-Strike Plate and Aldrop

FAN CLAMPS

Sub Head : Steel Work
Clause : 10.14



Drawing not to Scale
All dimensions in millimeters

Fig. 10.9 : Fan Clamps

SUB HEAD : 11.0

FLOORING

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LIST OF MANDATORY TESTS

Material	*Clause*	*Test*	*Field/ Laboratory Test*	*Test Procedure*	*Min. quantity of material for carrying out the test*	*Frequency of testing*
1.	*2.*	*3.*	*4.*	*5.*	*6.*	*7.*
Terrazzo Tiles	11.10.1 & 11.11.1	1. Transverse strength 2. Water absorption 3. Abrasion test	Laboratory	I S: 1237	5000 Nos. (no testing need be done if total number of tiles of all types of all sizes from all Manufacturers used in a work is less than 5000 Nos)	One test for every 10,000 Nos. or part thereof for each type and size from a single manufacturer. (One test to be done even if the number of terrazo tiles of any type and size from a single manufactur- ers is less than 5000 Nos. provided the total number of terrazo tiles of all types and sizes from all manufacturers used in a work exceed 5000 Nos
Pressed Ceramic tiles (for floor)	11.4,11.5& 11.16	1. Dimensions and surface quality 2. Physical properties 3. Chemical properties	Laboratory	I S: 13630	3000 Nos.	3000 Nos. or part ereof

LIST OF BUREAU OF INDIAN STANDARDS CODES

S.No.	*IS No.*	*Subject*
1.	IS 269	Specification for 33 grade ordinary portland Cement
2.	IS 401	Code of practice for preservation of timber
3.	IS 451	Technical supply conditions for wood screws
4.	IS 455	Specification for portland slag cement
5.	IS 661	Code of practice for thermal insulation of cold storages
6.	IS 702	Specification for industrial bitumen
7.	IS 1124	Method of test for determination of water absortion, apparent specific gravity and porosity of natural building stones
8.	IS 1130	Specification for marble (blocks, slabs and tiles)
9.	IS 1141	Code of practice for Seasoning of timber
10.	IS 1200-(Part XI)	Method of measurement of Building and Civil Engineering work (Part 11) paving, floor finishes, dado and skirting
11.	IS 1237- Edition 2.3	Specification for cement concrete flooring tiles
12.	IS 1322	Specification for bitumen felts for water proofing and damp-proofing
13.	IS 1443	Code of practice for laying and finishing of cement concrete flooring tiles
14.	IS 1489 (Part-I)	Specification for portland pozzolana cement (Part-I) flyash based
15.	IS 1489-(Part II)	Specification for Portland pozzolana cement (Part II) calcined clay based
16.	IS 1580	Specification for bituminous compounds for water proofing and caulking purpose
17.	IS 2114	Code of practice for laying in-situ terrazzo floor finish
18.	IS 2571	Code of practice for laying in-situ cement concrete flooring
19.	IS 3622	Specification for sand stone (Slab & Tiles)
20.	IS 3670	Code of practice for construction of timber floors
21.	IS 4457	Acid and/or alkali Resistant tiles.
22.	IS 5318	Code of practice for laying of hard wood parquet and wood block floors
23.	IS 5766	Code of practice for laying of burnt clay brick floor
24.	IS 8041	Specification for rapid hardening portland cement

25.	IS 8042	Specification for white portland cement
26.	IS 8043	Specification for hydrophobic portland cement
27.	IS 8112	Specification for 43 grade ordinary portland cement
28.	IS 12330	Specification for sulphate resisting portland cement.
29.	IS: 13630 (Part-1 to 15)	Methods of Testing of ceramic tiles
30.	IS 13712	Specification for ceramic tiles; definition, classification characteristic and marking
31.	IS 15622	Specification for pressed ceramic tile

11.0 FLOORING

11.1 BRICK ON EDGE FLOORING

11.1.1 Bricks

Bricks of Specified class designations shall be used. These shall conform to the specifications described in Subhead 6.0. Broken bricks shall not be used in flooring except for closing the line. The bricks shall be laid on edge.

11.1.2 Mortar

The mortar used shall be as specified (in case of dry bricks flooring fine sand shall be filled in the joints).

11.1.3 Base Concrete

11.1.3.1 Flooring shall be laid on base concrete where so provided. The base concrete shall be provided with the slope required for the flooring. Floors in verandah, courtyard kitchens, baths shall have slope ranging from 1 : 36 to 1 : 48 depending upon locations as decided by the Engineer-in-Charge. Floors in water closet portion shall have slope of 1 : 30 or as decided by the Engineer-in-Charge to drain off washing water. Plinth masonry off-set shall be depressed so as to allow the base concrete to rest on it.

11.1.3.2 If the base is of lean cement concrete, the flooring shall commence within 48 hours of the laying of base, failing which, the surface of base shall be roughened with steel wire brushes without disturbing the concrete. Before laying the flooring the base shall be wetted and smeared with a coat of cement slurry at 2 kg of cement spread over an area of one sqm so as to get a good bond between sub-grade and flooring.

11.1.3.3 Where base concrete is not provided, the earth below shall be properly sloped, watered, rammed and consolidated. Before laying the flooring, it shall be moistened.

11.1.4 Soaking of Bricks

Bricks required for flooring shall be perfectly soaked in stacks before use, by profusely spraying clean water at regular intervals for a period of not less than six hours so as to keep them wet to the satisfaction of the Engineer-in-Charge. (In case the joints are to be filled with sand, the bricks need not be soaked).

11.1.5 Laying

11.1.5.1 The bricks shall be laid on the edge, diagonal herring bone bond, or other pattern as specified or directed by the Engineer-in-Charge.

11.1.5.2 Bricks shall be laid on edge on 12 mm thick mortar of specified ratio bed and each brick shall be properly bedded and set home by gentle tapping with trowel handle or wooden mallet. Its inside face shall be buttered with mortar, before the next brick is laid and pressed against it.

11.1.5.3 On completion of a portion of flooring, the vertical joints shall be fully filled from the top with mortar. During laying, the surface of the flooring shall be frequently checked with a straight edge of length at least 2 m, so as to obtain a true plain surface with the required slope.

11.1.6 Joints

Bricks shall be so laid that all joints are full of mortar. The thickness of joints shall not exceed 1.0 cm for brick work with bricks of any class designation. All face joints shall be raked to a minimum depth of 15 mm by raking tool during the progress of work when the mortar is still green so as to provide proper key for the plaster or pointing to be done. Where plastering or pointing is not required to be done, the joints shall be struck flush and finished at the time of laying. The face of brick work shall be cleaned on the same day on which brick work is done and all mortar droppings removed promptly.

11.1.7 Curing

Brick work shall be protected from rain by suitable covering when the mortar is green. Brick work in cement mortar, shall be kept constantly moist on all faces for a minimum period of seven days. Brick work carried out shall be suitably marked indicating the date on which the work is done so as to keep a watch on the curing period.

11.1.8 Measurements

Length and breadth of the flooring shall be measured correct to a cm and area shall be calculated in square metres correct to two places of decimal. Length and breadth shall be measured before laying skirting, dado or wall plaster. No deduction shall be made nor extra paid for voids not exceeding 0.20 sqm. Deduction for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 sqm.

Brick flooring when laid in diagonal herring bone bond or other pattern as specified or directed by the Engineer-in-Charge shall be measured separately.

11.1.9 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above, including application of cement slurry on base concrete or RCC slab and cleaning of base. Base concrete shall be paid for separately.

11.1.10 Dry Brick Flooring

All provisions of para's 11.1.1 to 11.1.8 will be applicable except that bricks need not be soaked. Bricks will be laid on a bed of 12 mm thick mud mortar laid to required slope. The joints shall be as thin as possible and not exceeding 5 mm which will be filled with fine sand. No curing is to be done.

11.1.10.1 ***Rate:*** The rate shall include the cost of all materials and labour involved in all the operations described above.

11.2 CEMENT CONCRETE FLOORING

11.2.1 Cement Concrete

Cement concrete of specified mix grade shall be used and it shall generally conform to the specifications described under sub head 4.0 .

11.2.2 Base Concrete

11.2.2.1 Flooring shall be laid on base concrete where so provided. The base concrete shall be provided with the slopes required for the flooring. Flooring in verandah, Courtyard, kitchens & baths shall have slope ranging from 1 : 48 to 1 : 60 depending upon location and as decided by the Engineer-in- Charge. Floors in water closet portion shall have slope of 1:30 or as decided by the Engineer -in-Charge to drain off washing water. Further, necessary drop in flooring in bath, WC, kitchen near floor traps ranging from 6 mm to 10 mm will also be provided to avoid spread of water. Necessary margin to accommodate this drop shall be made in base concrete. Plinth masonry off set shall be depressed so as to allow the base concrete to rest on it.

11.2.2.2 The flooring shall be commenced preferably within 48 hours of the laying of base concrete. The surface of the base shall be roughened with steel wire brushes without disturbing the concrete. Immediately before laying the flooring, the base shall be wetted and a coat of cement slurry @ 2 kg of cement spread over an area of one sqm so as to get a good bond between the base and concrete floor.

11.2.2.3 If the cement concrete flooring is to be laid directly on the RCC slab, the top surface of RCC slab shall be cleaned and the laitance shall be removed and a coat of cement slurry @ 2 kg of cement spread over an area of one sqm so as to get a good bond between the base and concrete floor.

11.2.3 Thickness

The thickness of floor shall be as specified in the description of the item.

11.2.4 Laying

11.2.4.1 ***Panels :*** Flooring of specified thickness shall be laid in the pattern including the border as given in the drawings or as directed by the Engineer-in-Charge. The border panels shall not exceed 450 mm in width and the joints in the border shall be in line with panel joints. The panels shall be of uniform size and no dimension of a panel shall exceed 2 m and the area of a panel shall not be more than 2 sqm. The joints of borders at corners shall be mitred for provision of strips.

11.2.4.2 ***Laying of Flooring with Strips :*** Normally cement concrete flooring shall be laid in one operation using glass/aluminium/PVC/brass strips/stainless steel strips or any other strips as required as per drawing or instructions of the Engineer-in-Charge, at the junction of two panels. This method ensures uniformity in colour of all the panels and straightness at the junction of the panels. 4 mm thick glass strips or 2 mm PVC strips or 2 mm aluminium or brass strips shall be fixed with their tops at proper level, giving required slopes. Use of glass and metallic strips shall be avoided in areas exposed to sun. Cost of providing and fixing strips shall be paid for separately.

Concreting : Cement concrete shall be placed in the panels and be levelled with the help of straight edge and trowel and beaten with thapy or mason's trowel. The blows shall be fairly heavy in the beginning but as consolidation takes place, light rapid strokes shall be given. Beating shall cease as soon as the surface is found covered with a thin layer of cream of mortar. The evenness of the surface shall be tested with straight edge. Surface of flooring be true to required slopes. While laying concrete, care shall be taken to see that the strips are not damaged/disturbed by the labourers. The tops of strips shall be visible clearly after finishing with cement slurry.

11.2.4.3 ***Laying of Flooring without Strips :*** Laying of cement concrete flooring in alternate panels may be allowed by the Engineer-in-Charge in case strips are not to be provided.

Shuttering : The panels shall be bounded by angle iron or flats. The angle iron/flat shall have the same depth as the concrete flooring. These shall be fixed in position, with their top at proper level giving required slopes. The surface of the angle iron or flats, to come in contact with concrete shall be smeared with soap solution or non-sticking oil (Form oil or raw linseed oil) before concreting. The flooring shall butt against the unplastered masonry wall.

Concreting : The concreting shall be done in the manner described under 11.2.4.2. The angle iron/ flats used for shuttering, shall be removed on the next day of the laying of cement concrete. The ends thus exposed shall be repaired, if damaged with cement mortar 1 : 2 (1 cement : 2 coarse sand) and allowed to set for minimum period of 24 hours. The alternate panels shall then be cleaned of dust, mortar, droppings etc. and concrete laid. While laying concrete, care shall be taken to see that the edges of the previously laid panels are not damaged and fresh mortar is not splashed over them. The joints between the panels should come out as fine straight lines.

11.2.5 Finishing

11.2.5.1 The finishing of the surface shall follow immediately after the cessation of beating. The surface shall be left for some time, till moisture disappears from it or surplus water can be mopped up. Use of dry cement or cement and sand mixture stiffening the concrete to absorb excessive moisture shall not be permitted. Excessive trowelling shall be avoided.

11.2.5.2 Fresh cement shall be mixed with water to form a thick slurry and spreaded @ 2 kg of cement over an area of one sqm of flooring while the flooring concrete is still green. The cement slurry shall then be properly processed and finished smooth.

11.2.5.3 The edges of sunk floors shall be finished and rounded with cement mortar 1:2 (1 cement : 2 coarse sand) and finished with a floating coat of neat cement.

11.2.5.4 The junctions of floor with wall plaster, dado or skirting shall be rounded off where so specified.

11.2.5.5 The men engaged on finishing operations shall be provided with raised wooden platform to sit on so as to prevent damage to new work.

11.2.6 Curing

The curing shall be done for a minimum period of ten days. Curing shall not be commenced until the top layer has hardened. Covering with empty gunnies bag shall be avoided as the colour of the flooring is likely to be bleached due to the remanents of cement dust from the bags.

11.2.7 Precautions

Flooring in lavatories and bath room shall be laid only after fixing of water closet and squatting pans and floor traps. Traps shall be plugged while laying the floors and opened after the floors are cured and cleaned. Any damage done to W.C.'s squatting pans and floor traps during the execution of work shall be made good.

During cold weather, concreting shall not be done when the temperature falls below 4°C. The concrete placed shall be protected against frost by suitable covering. Concrete damaged by frost shall be removed and work redone. During hot weather, precautions shall be taken to see that the temperature of wet concrete does not exceed 38° C. No concreting shall be laid within half an hour of the closing time of the day, unless permitted by the Engineer-in-Charge. To facilitate rounding of junction of skirting, dado and floor, the skirting/dado shall be laid along with the border or adjacent panels of floor.

11.2.8 Measurement

Length and breadth shall be measured before laying skirting, dado or wall plaster. No deduction shall be made nor extra paid for voids not exceeding 0.20 sqm. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 sqm.

The flooring done either with strips (in one operation) or without strips (in alternate panels) shall be treated as same and measured together.

11.2.9 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above including application of cement slurry on RCC slab or on base concrete including roughening and cleaning the surface but excluding the cost of strips which shall be paid separately under relevant item. Nosing of steps where provided shall be paid for separately in running metre. Nothing extra shall be paid for laying the floor at different levels in the same room or courtyard and rounding off edges of sunk floors. In case the flooring is laid in alternate panels, nothing extra shall be paid towards the cost of shuttering used for this purpose.

11.3 CEMENT CONCRETE FLOORING WITH METALLIC HARDENER TOPPING

11.3.0 Wherever floors are required to withstand heavy wear and tear, use of floor hardener shall be avoided as far as possible by using richer mixes of concrete, unless the use of a metallic hardner is justified on the basis of cost. Where metallic hardener topping is used, it shall be 12 mm thick.

11.3.1 Metallic Hardening Compound

The compound shall be of approved quality consisting of uniformally graded iron particles, free from non-ferrous metal particles, oil, grease sand, soluble alkaline compounds. Where so directed by the Engineer-in-Charge it shall be tested as described in Appendix A.

11.3.2 Base Concrete

It shall be as specified in 11.2.2.

11.3.3 Under Layer

Cement concrete flooring of specified thickness and mix (mentioned in item for under layer) shall be laid as under layer (11.2.1 and 11.2.4). The top surface shall be roughened with brushes while the concrete is still green and the forms/strips shall be kept projecting up 12 mm over the concrete surface, to receive the metallic hardening compound topping.

11.3.4 Topping

This shall consist of 12 mm thick layer of mix 1:2 (1 cement : 2 stone aggregate 6 mm nominal size) by volume or as otherwise specified with which metallic hardening compound is mixed in the ratio of 1 : 4 (1 metallic concrete hardener : 4 cement) by weight. Metallic hardener shall be dry mixed thoroughly with cement on a clean dry pacca platform. This dry mixture shall be mixed with stone aggregate 6 mm nominal size or as otherwise specified in the ratio of 1 : 2 (1 cement : 2 stone aggregate) and well turned over. Just enough water shall then be added to this dry mix as required for floor concrete.

The mixture so obtained shall be laid in 12 mm thickness, on cement concrete floor within 2 to 4 hours of its laying. The topping shall be laid true to provide a uniform and even surface. It shall be firmly pressed into the bottom concrete so as to have good bond with it. After the initial set has started, the surface shall be finished smooth and true to slope with steel floats.

The junction of floor with wall plaster, dado or skirting and finishing operations shall be dealt with as described in 11.2.5.

The men engaged on finishing operations shall be provided with raised wooden platform to sit on, so as to prevent damage to new work.

11.3.5 The specifications for curing, precautions to be taken, 'Measurements' and 'Rates' shall be as specified in 11.2.

11.4 CEMENT PLASTER IN RISERS OF STEPS, SKIRTING, DADO

11.4.0 Plaster at the bottom of wall not exceeding 30 cm in height above the floor shall be classified as skirting. It shall be flush with wall plaster or projecting out uniformly by 6 mm from the wall plaster, as specified. The work shall be preferably carried out simultaneously with the laying of floor. It's corners and junctions with floor shall be finished neatly as specified.

11.4.1 Thickness

The thickness of the plaster specified shall be measured exclusive of the thickness of key i.e. grooves or open joints in brick work. The average thickness shall not be less than the specified thickness. The average thickness should be regulated at the time of plastering by keeping suitable thickness of the gauges. Extra thickness required in rounding of corners at junctions of wall shall be ignored.

11.4.2 Preparation of Wall Surface

The joints shall be raked out to a depth of at least 15 mm in masonry walls. In case of concrete walls, the surfaces shall be roughened by hacking. The surface shall be cleaned thoroughly, washed with water and kept wet before skirting is commenced.

11.4.3 Application

Skirting with specified mortar and to specifed thickness shall be laid immediately after the surface is prepared. It shall be laid along with the border or adjacent panels of floor. The joints in skirting shall be kept true and straight in continuation of the line of joints in borders or adjacent panels. The skirting shall be finished smooth with top truly horizontal and joints truly vertical except where otherwise indicated.

11.4.4 Finishing

The finishing of surface shall be done simultaneously with the borders or the adjacent panels of floor. The cement to be applied in the form of slurry for smooth finishing shall be at the rate of 2 kg of cement per litre of water applied over an area of 1 sqm.

Where skirting is flush with plaster, a groove 10 mm wide and upto 5 mm deep shall be provided in plaster at the junction of skirting with plaster.

11.4.5 Curing

Curing shall be commenced on the next day of plastering when the plaster has hardened sufficiently and shall be continued for a minimum period of 7 days.

11.4.6 Measurement

Length and height shall be measured correct to a cm and its area shall be calculated in sqm correct to two places of decimals for a specified the thickness. Length shall be measured as the finished length of skirting. Height shall be measured from the finished level of floor correct to 5 mm.

11.4.7 Rate

Rate shall include the cost of all materials and labour involved in all the operations described above.

11.5 CEMENT CONCRETE PAVEMENT IN COURTYARD AND TERRACE ETC.

11. 5.1 Specifications described in 11.2.1, 11.2.2.1, 11.2.3, 11.2.4, 11.2.6 and 11.2.7 shall hold good as far as applicable except that :

(i) The panels shall be of uniform size and no dimension of a panel shall exceed 1.25 m and the area of panel should not exceed 1.25 sqm for the thickness of panels upto 50 mm.
(ii) Concreting shall be done in alternate panels only and no glass/asbestos strips shall be provided.

11.5.2 Finishing

The finishing of the surface shall follow immediately after the cessation of beating. The surface shall be left for some-time, till moisture disappears from it or surplus water can be mopped up.

Use of dry cement or cement and sand mix on the surface to stiffen the concrete or to absorb excessive moisture shall not be permitted. Excessive trowelling shall be avoided. When the surface becomes fairly stiff, it shall be finished rough with wooden floats or where so specified chequered uniformly by pressing a piece of expanded metal of approved size.

11.5.3 Measurements

Same as 11.2.8 except that the volume will be calculated in cum nearest to two decimal places.

11.5.4 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above except the base concrete below flooring which shall be paid for separately. Chequering to pattern shall be paid for separately unless otherwise specified.

11.6 TERRAZO (MARBLE CHIPS) FLOORING LAID IN SITU

11.6.1 Under Layer

Cement concrete of specified mix shall be used and the specifications given under sub head 4.0 shall apply. The panels shall be of uniform size, not exceeding 2 sqm in area or 2 m in length for inside situations. In exposed situations, the length of any side of the panel shall not be more than 1.25 metre. Cement slurry @ 2.00 kg per sqm shall be applied before laying of under layer over the base cement concrete/RCC base.

11.6.2 Fixing of Strips

4 mm thick glass strips or 2 mm thick PVC strips/aluminium strips/brass strips / stainless steel strips/copper strips unless otherwise specified shall be fixed with their top at proper level to required slope. Strips of stone or marble or of any other material of specified thickness can also be used if specifically required. Use of glass and metallic strips shall be avoided in areas exposed to sun. The fixing and laying shall be as specified in para 11.2.4.2.

11.6.3 Top Layer

11.6.3.1 ***Mortar :*** The mix for terrazo shall consist of cement with or without pigment, marble powder, marble aggregate (marble chips) and water. The cement and marble powder shall be mixed in the proportion of three parts of cement to one part marble powder by weight. For every part of cement marble powder mix, the proportion of aggregate by volume shall be as shown in Table 1.

The marble chips shall be white or pink Makrana, black Bhainslana, Chittoor black, Jaisalmer Yellow, Baroda green, Dehradun white, Chittoor pink, yellow Patam cherala (Madras), grey Gadu (Surat), Chittoor green and yellow and Alwar black or as specified. It shall be hard, sound, dense and homogenous in texture with crystaline and coarse grains. It shall be uniform in colour and free from stains, cracks, decay and weathering. The maximum thickness of the top layer for various sizes of marble aggregates (marble chips) shall be as shown in Table 11.1 below:

TABLE 11.1

Grade No	*Size of Aggregates in (mm)*	*Proportion of Aggregates to Binder Mix*	*Minimum Thickness of Top Layer (mm)*
00	1—2	1.75: 1	6
0	2—4	1.75: 1	6
1	4—7	1.75: 1	9
2	7—10	1.5: 1	12

Where aggregate of size larger than 10 mm are used, the minimum thickness of topping shall not be less than one and one third times the maximum size of the chips. Where large size chips such as 20 mm or 25 mm are used, they shall be used only with a flat shape and bedded on the flat face so as to keep the minimum thickness of wearing layer.

Before starting the work, the contractor shall get the sample of marble chips approved from the Engineer -in -Charge. This shall be done in advance by mixing different colour marble chips and panel samples of minimum 1 m x 1 m size shall be prepared and got approved from the Engineer-in -charge before laying of flooring. The cement to be used shall be ordinary grey cement, white cement, cement with admixture of colouring matter of approved quality in the ratio specified in the description of the item in the ratio to get the required shade as ordered by the Engineer-in-Charge. Colouring materials where specified shall be mixed dry thoroughly with the cement and marble powder and then marble chips added and mixed as specified above. The full quantity of dry mixture of mortar required for a room shall be prepared in a lot in order to ensure a uniform colour. This mixture shall be stored in a dry place and well covered and protected from moisture. The dry mortar shall be mixed with water in the usual way as and when required. The mixed mortar shall be homogenous and stiff and contain just sufficient water to make it workable.

The terrazo topping shall be laid while the under layer is still plastic, but has hardened sufficiently to prevent cement from rising to the surface. This is normally achieved between 18 to 24 hours after the under layer has been laid. A cement slurry preferably of the same colour as the topping shall be brushed on the surface immediately before laying is commenced. It shall be laid to a uniform thickness slightly more than that specified in order to get the specified finished thickness after rubbing. The surface of the top layer shall be trowelled over, pressed and brought true to required level by a straight edge and steel floats in such a manner that the maximum amount of marble chips come up and are spread uniformly over the surface.

11.6.3.2 ***Curing, Polishing and Finishing :*** The surface shall be left dry for air-curing for a duration of 12 to 18 hours depending on atmospheric temperature conditions. It shall then be cured by allowing water to stand in pools over it for a priod of not less than 4 days.

The grinding and polishing may be commenced not before 2 days from the time of completion of laying for manual grinding and not before 7 days for maching grinding. For polishing by machines, the surface shall be watered and ground evenly with machine fitted with special rapid cutting grit blocks (carborundum stone) of coarse grade (No. 60) till the marble chips are evenly exposed and the floor is smooth. After the first grinding, the surface shall be thoroughly washed to remove all grinding mud and covered with a grout of cement and colouring matter in same mix and proportion as the topping in order to fill any pin holes that appear. The surface shall be allowed to dry for 24 hours and wet cured for 4 days and then rubbed with machine fitted with fine grit blocks (No. 120). Curing shall be done by ponding of water between panels formed with fine sand. The surface is cleaned and repaired as before and allowed to cure again for 3 to 5 days. Finally the third grinding shall be done with machine fitted with mere fine grade grit blocks (No. 320) to get even and smooth surface without pin holes. The finished surface should show the marble chips evenly exposed.

Where use of machine for polishing is not feasible or possible, rubbing and polishing shall be done by hand, in the same manner as specified for machine polishing except that carborundum stone of coarse grade (No. 60) shall be used for the 1st rubbing, stone of medium grade (No. 80) for second rubbing and stone of fine grade (No. 120) for final rubbing polishing.

After the final polish either by machine or by hand, oxalic acid shall be dusted over the surface @ 33 gm per square metre sprinkled with water and rubbed hard with a nemdah block (Pad of Woolen rags). The following day, the floor shall be wiped with a moist rag and dried with a soft cloth and finished clean.

Curing shall be done by suitable means such as laying moist sawdust or ponding water.

11.6.4 Precautions

Flooring in lavatories and bathrooms shall be laid after fixing of water closet and squatting pans and floor traps. Traps shall be plugged, while laying the floors and opened after the floors are cured and cleaned. Any damage done to WC's squatting pans and floor traps during the execution of work shall be made good.

During cold weather, concreting shall not be done when the temperature falls below 4°C. The concrete placed shall be protected against frost by suitable coverings. Concrete damaged by frost shall be removed and work redone. During hot weather, precautions shall be taken to see that the temperature of wet concrete does not exceed 38°C. No concreting shall be laid within half an hour of the closing time of the day, unless permitted by the Engineer-in-Charge.

11.6.5 Measurements

11.6.5.1 Length and breadth shall be measured correct to a cm before laying skirting, dado or wall plaster. The area as laid shall be calculated in sqm correct to two decimal places.

The thickness of the under layer shall be measured correct to a cm. The thickness of top layer shall not be less than that specified.

No deduction shall be made, nor extra paid for voids not exceeding 0.20 square metre. Deduction for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square metre. Nothing extra shall be paid for laying the floor at different levels in the same room or courtyard.

11.6.5.2 Terrazo (Marble Chips) flooring laid as floor borders, margins and similar bands upto 30 cm width and on staircase treads shall be measured under the item of terrazo flooring but extra shall be paid

for such work. This extra in the case of staircase treads shall include the cost of forming the nosing also. However, moulded nosing shall be paid for staircase treads etc. extra in running metres except where otherwise stated, returned moulded ends and angles to mouldings shall be included in the description. Extra shall also be paid for laying flooring in narrow bands not exceeding 7.5 cm in width and such bands shall be measured in running metres for this purpose.

11.6.5.3 Dividing strips inserted in terrazo to form bays, patterns shall be described stating the materials, its width and thickness and measured in running metres.

11.6.5.4 Special surface finishes to treads, risers and the ends of concrete steps and the like shall be measured separately and given in square metres and shall include form work, if required.

11.6.6 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above including cleaning of surface of RCC slab or base concrete and application of cement slurry but shall not include the cost of base concrete and cost of providing and fixing strips of glass or aluminium or of any other material used for making panels, which shall be paid for separately.

11.7 TERRAZO (MARBLE CHIPS) SKIRTING IN SITU

11.7.1 Under Coat

The under coat of skirting shall be of cement plaster of the thickness and mix described in the item. Specifications given under 11.4.0, 11.4.1 and 11.4.2 shall apply. As regards application, the work shall be carried out in the manner described in para 11.4.3 except that the under coat shall be finished rough with a scratching tool to form a key for the top coat.

11.7.2 Top Coat

The specifications as in para 11.6.3 shall hold good as far as applicable and shall include cutting to line and fair finish to top edges of terrazo and polishing.

11.7.3 Thickness

The thickness of the bottom and top coats shall be as specified. The total thickness of skirting specified is of the total thickness of plaster including top coat as measured from the unplastered face of the masonry. Average thickness of the under coat shall not be less than 6 mm and minimum thickness over any portion of the surface shall not be less than 4 mm. The thickness of top coat shall not be less than the thickness specified.

11.7.4 Measurements

Length and height shall be measured correct to a cm and its area shall be calculated in sqm correct to two places of decimal. Length shall be measured as finished length of skirting. Height shall be measured from the finished level of floor correct to 5 mm where the height of skirting does not exceed 30 cm and when the height exceeds 30 cm it shall be measured correct to a cm.

11.7.5 Rates

The rate shall include the cost of all materials and labour involved in all the operations described above.

11.8 WAX POLISHING

11.8.1 Application, Polishing and Precautions

Wax polish shall be of approved brand and manufacture and in sealed containers. It shall be applied in uniform layer to the dry surface of the floor/skirting.

11.8.2 When the layer of the wax is stiffened and surface of floor is saturated with the polish, polishing shall be resorted with machine fitted with bobs (pad of rags) and shall be done until shades of all chips have appeared and glossy surface is obtained.

11.8.3 The fresh polished floor surface shall be spreaded with dry saw dust to a thickness of about 12 mm uniformly. After the surplus wax has been soaked from the floor surface the saw dust shall be removed**.**

11.8.4 Measurements

Length and breadth shall be measured correct to a cm and its area shall be calculated in sqm correct to two places of decimal.

11.8.5 Rates

The rate shall include the cost of all materials and labour involved in all the operations described above.

11.9 CRAZY MARBLE FLOORING (Fig. 11.1)

11.9.1 Base Concrete

Crazy marble stone flooring shall be laid on cement concrete base. The base concrete shall be provided with slope required for the flooring in verandahs and courtyards to drain off washing and rain water. The surface of base shall be roughened with steel wire brushes, without disturbing the concrete, wetted and smeared with a floating cost of cement slurry at 2 kg of cement spread over an area of one sqm so as to get a good bond between base and flooring.

Before laying the flooring on RCC slabs, the laitance shall be removed, the surface of slab hacked and a coat of cement slurry at rate of 2 kg of cement spread over an area of one sqm shall be applied so as to get a good bond between RCC slab and floor.

11.9.2 Under Layer

The under layer of crazy marble flooring shall be of cement concrete of thickness 25 mm or as specified. The mix shall normally be 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 12.5 mm nominal size) by volume unless otherwise specified. It shall conform to the specifications given under para 4.2 of sub-head 'Cement Concrete'.

11.9.3 Top Layer

The mix of crazy marble stone flooring shall consist of white cement with or without pigment, marble powder, marble chips of 00 Nos. and marble stone pieces and water. The marble stone pieces shall be hard, sound, dense and homogenous in texture with crystaline and coarse grains. It shall be uniform in colour and free from stains, cracks, decay and weathering. Before starting the work the contractor shall get the sample of marble stone approved by the Engineer- in-Charge. The marble stone pieces shall be of sizes as approved by the Engineer-in-Charge but the thickness shall be according to the overall thickness specified which could be achieved when laid over the under layer as specified. Thus for 50 mm thick floor, the thickness of marble pieces will be 25 mm while for 40 mm thick floor, the thickness will be 15 mm.

The white cement and marble powder shall be mixed in proportion of three parts of cement and one part of marble powder by weight, and the proportion of marble chips to binder mix by volume shall be 7 parts of marble chips to 4 parts of binder mix. The marble chips shall be as specified. It shall be hard, sound, dense and homogeneous in texture. It shall be uniform in colour and free from stains, cracks decay and weathering.

11.9.4 Laying

A coat of cement slurry at the rate of 2 kg of cement per sqm of area shall be spread and then the marble stone pieces shall be set by hand in such a manner that the top surface of all the set marble stones shall be true to the required level and slopes. After fixing the stones, the cement marble chips mixture shall be filled in between the gaps of laid marble stone pieces. The filled surface then shall be trowelled over, pressed and brought to the level of the laid marble stone pieces.

11.9.5 Polishing

Curing and Finishing shall be as described in 11.6.3.2.

11.9.6 Precautions

Flooring in lavatories and bathrooms shall be laid after fixing of water closet and squatting pans and floor traps. Traps shall be plugged, while laying the floors and opened after the floors are cured and cleaned.

11.9.7 Measurements

Length and breadth shall be measured correct to a cm before skirting, dado or wall plaster and it shall be calculated in sqm correct to two decimal places. No deduction shall be made nor extra paid for voids not exceeding 0.20 square metre. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square metre. Nothing extra shall be paid for laying floor at different levels in the same room or courtyards.

11.9.8 Rate

The rates shall include the cost of all materials and labour involved in all the operations described above including the cost of cleaning of RCC slab surface and applying the cement slurry, but it shall not include the cost of base concrete.

11.10 TERRAZO TILE FLOORING

11.10.1 Terrazo Tiles

Terrazo tiles shall generally conform to IS 1237-Edition 2.3. Requirements and methods of testing of tiles are described in Appendix B. Unless otherwise specified, the tiles shall be supplied with initial grinding and grouting of wearing layer.

The size of tiles shall be as given in Table 11.2 or as shown in the drawings or as required by the Engineer-in-Charge. Half tiles for use with the full tiles shall be such as to make two half tiles when joined together, match with the dimensions of one full tile.

TABLE 11.2

Length Nominal	*Breadth Nominal*	*Thickness not less than*
200 mm	200 mm	20 mm
250 mm	250 mm	22 mm
300 mm	300 mm	25 mm

11.10.1.1 ***Tolerance :*** Tolerances on length and breadth shall be plus or minus one millimetre, and tolerance on thickness shall be plus 5 mm. The variation of dimensions in any one delivery of tiles shall not exceed 1 mm on length and breadth and 3 mm on thickness.

11.10.1.2 The tiles shall be manufactured in a factory under pressure process subjected to hydraulic pressure of not less than 140 kg per square centimetre and shall be given the initial grinding with machine and grouting of the wearing layer before delivery to site. The wearing layer shall be free from projections, depressions, cracks, holes, cavities and other blemishes. The edges of wearing layer may be rounded.

11.10.1.3 The proportion of cement to aggregate in the backing of tiles shall be not leaner than 1:3 by weight. Where colouring material is used in the wearing layer, it shall not exceed 10 per cent by weight of cement used in the mix.

11.10.1.4 The finished thickness of the upper layer shall not be less than 5 mm for size of marble chips ranging from the smallest upto 6 mm and also, not less than 5 mm for size of marble chips ranging from the smallest upto 12 mm, and not less than 6 mm for size of marble chips varying from the smallest upto 20 mm.

11.10.2 Laying

11.10.2.1 Base concrete or RCC slab on which the tiles are to be laid shall be cleaned, wetted and mopped. The bedding for the tiles shall be with cement mortar of specified proportion and in conformity with provisions in relevant para of chapter on 'Mortar'.

Cement mortar 1:4 (1 Cement : 4 coarse sand) bedding shall be used. Average thickness of the bedding mortar shall be 20 mm and the thickness at any place shall not be less than 10 mm.

11.10.2.2 Cement mortar bedding shall be spread, tamped and corrected to proper levels and allowed to harden for a day before the tiles are set. If cement mortar is laid in bedding the terrazo tiles, these shall be set immediately after laying the mortar. Over this bedding neat grey cement slurry of honey like consistency shall be spread at the rate of 4.4 kg of cement per square metre over such an area as would accommodate about twenty tiles. Tiles shall be washed clean and shall be fixed in this grout one after another, each tile being gently tapped with a wooden mallet till it is properly bedded, and in level with the adjoining tiles. The joints shall be kept as thin as possible not exceeding 1 mm and in straight lines or to suit the required pattern. The joints shall be properly cleaned before filling with cement grout of matching colour.

11.10.2.3 The surface of the flooring during laying shall be frequently checked with a straight edge of length at least 2 metre, so as to obtain a true surface with the required slope.

11.10.2.4 Where full tiles or half tiles can not be fixed, tiles shall be cut (sawn) from full tiles to the required size and their edges rubbed smooth to ensure a straight and true joint.

11.10.2.5 Tiles which are fixed in the floor adjoining the wall shall enter not less than 12 mm under the plaster, skirting or dado. The junction between wall plaster and tile work shall be finished neatly and without waviness.

11.10.2.6 After the tiles have been laid, surplus cement grout that may have come out of the joints shall be cleared off.

11.10.3 Curing, Polishing and Finishing

11.10.3.1 The day after the tiles are laid all joints shall be cleaned of the grey cement grout with a wire brush or trowel to a depth of 5 mm and all dust and loose mortar removed and cleaned. Joints shall then be grouted with grey or white cement mixed with or without pigment to match the shape of the topping of the wearing layer of the tiles. The same cement slurry shall be applied to the entire surface of the tiles in a thin coat with a view to protect the surface from abrasive damage and fill the pin holes that may exist on the surface.

11.10.3.2 The floor shall then be kept wet for a minimum period of 7 days. The surface shall thereafter be grounded evenly with machine fitted with coarse grade grit block (No. 60) . Water shall be used profusely during grinding. After grinding the surface shall be thoroughly washed to remove all grinding mud, cleaned and mopped. It shall then be covered with a thin coat of grey or white cement, mixed with or without pigment to match the colour of the topping of the wearing surface in order to fill any pin hole that appear. The surface shall be again cured. The second grinding shall then be carried out with machine fitted with fine grade grit block (No. 120).

11. 10.3.3 The final grinding with machine fitted with the finest grade grit blocks (No. 320) shall be carried out the day after the second grinding described in the preceding para or before handing over the floor, as ordered by the Engineer-in-Charge.

11.10.3.4 For small areas or where circumstances so require, hand grinding/polishing with hand grinder may be permitted in lieu of machine polishing after laying. For hand polishing the following carborundum stones, shall be used:

1st grinding — coarse grade stone (No. 60)

Second grinding — medium grade (No. 80)

Final grinding — fine grade (No. 120)

In all other respects, the process shall be similar as for machine polishing.

11.10.3.5 After the final polish, oxalic acid shall be dusted over the surface at the rate of 33 gm per square metre sprinkled with water and rubbed hard with a 'namdah' block (pad of woollen rags) . The following day the floor shall be wiped with a moist rag and dried with a soft cloth and finished clean.

11.10.3.6 If any tile is disturbed or damaged, it shall be refitted or replaced, properly jointed and polished.

The finished floor shall not sound hollow when tapped with a wooden mallet.

11.10.4 Measurements

11.10.4.1 Terrazo tiles flooring with tiles manufactured from ordinary grey cement without pigment and coloured terrazo tile flooring shall be measured separately according to para 11.6.5 Terrazo tile flooring shall be measured as laid in square metre correct to two places of decimal. For length and breadth dimensions correct to a cm before laying skirting, dado or wall plaster shall be taken. No deduction shall be made nor extra paid for voids not exceeding 0.20 sqm. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square metre. Nothing extra shall be paid for use of cut tiles nor for laying the floor at different levels in the same room or courtyard.

11.10.4.2 Terrazo tile flooring laid in floor borders and similar band shall be measured under the item of terrazo tile flooring. Nothing extra shall be paid in respect of these and similar bands formed of half size or multiplies of half size standard tiles or other uncut tiles.

11.10.4.3 Treads of stairs and steps paved with tiles without nosing, shall also be measured under flooring. Moulded nosing shall be paid in running metre except where otherwise stated, returned moulded ends and angles to mouldings shall be included in the description. Extra shall, however, be paid for such areas where the width of treads does not exceed 30 cm.

11.10.5 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above. Where cement mortar bedding is used in place of lime mortar the rate will be adjusted accordingly.

11.11 TERRAZO TILES IN RISERS OF STEPS, SKIRTING AND DADO

11.11.1 The terrazo tiles shall be as specified in 11.10.1, as far as applicable. The minimum finished thickness of tiles shall, however, be 12 mm. The finished thickness of the upper layer shall be not less than 5 mm for size of marble chips from the smallest upto 12 mm and not less than 6 mm for size of chips varying from the smallest upto 20 mm. Where the bigger sized chips are used the tiles shall be not less than 20 mm thick. The requirements of transverse strength tests specified in Appendix B, shall not apply when the tiles used are less than 20 mm thick.

11.11.2 Preparation of Surface

The specification for this shall be same as specified in 11.4.2.

11.11.3 Laying

12 mm thick plaster of cement mortar 1:3 (1 cement : 3 coarse sand) or mix as specified, shall then be applied and allowed to harden. The plaster shall then be roughened with wire brushes or by scratching diagonal lines 2 mm deep at approximately 7.5 cm centres both ways. The back of tiles shall be buttered with a coat of grey cement slurry and edges with grey or white cement slurry with or without pigments to match the shade of tiles, and set in the bedding mortar. These shall be tamped and corrected to proper planes and lines. The tiles shall be set in the required pattern and butt jointed. The joints shall be as fine as possible. Top of skirting or dado shall be truly horizontal with projection from finish wall surface not more than tile thickness and joints truly vertical except where otherwise indicated.

The risers of steps, skirting or dado shall rest on the top of the tread or flooring. Where full size tiles cannot be fixed, the tiles shall be cut (sawn) to the required size and their edges rubbed smooth.

11.11.4 Curing, Polishing and Finishing

The specifications as in 11.10.3 shall hold good as far as applicable. Polishing shall be done only with hand.

11.11.5 Measurements

The thickness of the skirting shall be as stated. Length shall be measured along the finished face of riser, skirting or dado correct to a cm. Height shall be measured from the finished level of tread or floor to the top (the underside of tread in the case of steps). This shall be measured correct to 5 mm in case of risers and skirting (not exceeding 30 cm in height). In case of heights more than 30 cm, as in the case of dado and on walls, the height shall be measured correct to a cm and such work shall be paid for separately. The area shall be calculated in square metre, correct to two places of decimal.

Where the height of risers, skirting or dado does not admit of full size or other finished size tiles and the tiles are to be cut (sawn), nothing extra shall be paid for the same.

11.11.6 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above.

Nothing extra shall be payable for use of cut (sawn) tiles to suit the size of risers, skirting, portions of dado etc.

11.12 CHEQUERED TILE FLOORING

11.12.1 Chequered Tiles

The tiles shall be of nominal sizes such as 20 × 20 cm, 25 × 25 cm and 30 × 30 cm or of standard sizes with equal sides. The size of tiles to be used shall be as shown in drawings or as required by the Engineer-in- Charge. The centre to centre distance of chequers shall not be less than 2.5 cm and not more than 5 cm.

The overall thickness of the tiles shall not be less than 30 mm. The grooves in the chequers shall be uniform and straight. The depth of the grooves shall not be less than 3 mm. The chequered tiles shall be cement tiles, or terrazo tiles as specified in the description of the item. The thickness of the upper layer, measured from the top of the chequers shall not be less than 6 mm.

The terrazo tiles shall be given the first grinding with machine before delivery to site.

The tiles shall conform to the specifications for plain cement concrete or terrazo tiles in respect of method of manufacture and the mix of the backing and wearing layers.

11.12.2 Laying, curing, Polishing and Finishing shall be as specified in 11.10.2 and 11.10.3 except that the polishing of the tiles and the chequer grooves, after laying, may be done by hand. Special care shall be taken to polish the grooves in such a manner as to get a uniform section and that their finish shall match with the finish of flat portion of the tiles. Cement concrete tiles normally do not require polishing but where polishing is required the same shall be done as described above.

11.12.3 Measurement and Rate: Shall be as specified in 11.10.4 and 11.10.5.

11.13 CHEQUERED TILES IN STAIR TREADS (FIG. 11.2)

11.13.1 Chequered Tiles

The specifications for tiles shall be as specified in 11.12.1 except in the following respects :

(1) The length of the tiles including nosing shall be as specified.

(2) The nosing edge of the tile shall be rounded.

(3) The minimum thickness of the tile shall be 30 mm.

(4) The front portion of the tile for a minimum length of 75 mm from and including the nosing shall have grooves running parallel to the nosing and at centres not exceeding 25 mm. Beyond that the tiles shall have the normal chequer pattern.

(5) The nosing shall also have the same wearing layer as the top.

11.13.2 Preparation of Surface and Laying

11.13.2.1 RCC or brick work in treads on which the tiles are to be laid shall be cleaned wetted and mopped. The bedding for tiles shall be with cement mortar 1:4 (1 cement : 4 coarse sand) or of specified mix. The minimum thickness of bedding mortar at any place shall be 10 mm. Bedding mortar shall be spread, tamped and corrected to proper levels. After laying bedding mortar, neat grey cement slurry of honey like consistency shall be spread over the mortar at the rate of 4.4 kg of cement per square metre over each tread. Tiles shall be washed cleaned and shall be fixed in this grout butting one at another. Each tile being gently tapped with a wooden mallet till it is properly bedded, and is in level and line with the adjoining tiles. The joints shall be kept as thin as possible and in straight lines. The surface shall be checked with a straight edge during laying to obtain a true surface.

11.13.2.2 The square end of the tile shall, as far as possible butt against the riser face of the concrete or brick tread and in any case shall be embedded under the side wall plaster, skirting or dado and under the riser tile or other finish to a depth of not less than 10 mm.

11.13.2.3 Where full size tiles cannot be fixed, these shall be cut (sawn) to the required size (along the groove of the chequers where the cut edge is exposed) and used. The cut in the case of embedded edges will be neat and true while the cut in the case of exposed edges shall in addition be rubbed smooth to ensure a straight and true joints.

11.13.2.4 After the tiles have been laid surplus cement grout shall be cleaned off.

11.13.3 Curing, Polishing and Finishing

The specifications shall be as described in 11.10.3 except that polishing of the treads nosing and chequered grooves, after laying, may be done by hand in the same manner as specified under terrazo tile flooring. Special care shall be taken to polish the nosing and the grooves in such a manner as to get a uniform, section for the grooves and the nosing and their finish shall match with the finish of the flat portion of the tiles.

11.13.4 Measurements

Chequred tiles on stair treads shall be measured in square metre correct to two places of decimal. Length shall be measured correct to a cm before laying skirting, dado or wall plaster. Width shall be measured correct to a cm from the outer edge of the nosing, as laid, before providing the riser. In the case of the edge tiles of the landing and wide steps, width shall be measured upto the near edge of the chequered stair tread tiles. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square metre.

11.13.5 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above.

Nothing extra shall be payable for cutting the tiles to suit the size of treads and also for nosing.

11.14 ACID OR ALKALI RESISTANT TILES

11.14.0 Manufacture and Finish

The tiles shall be of vitreous ware and free from deleterious substances. The iron oxide content allowable in the raw material shall not exceed two percent. The tiles shall be vitrified at the temperature of 1100 ^{0}C and above and shall be kept unglazed. The finished, tile, when fractured shall appear fine grained in texture, dense and homogenous. The tiles shall be sound, true to shope, flat and free from flows and manufacturing defects affecting their utility.

The tiles shall be conforming to IS 4457. The tiles to be tested for water absorption, compressive strength, acid resistance as per IS 4457. Sampling procedure for acceptance tests and criteria for conformity to be as per IS 4457. The tiles shall be of required colour.

11.14.1 Dimensions and Tolerances

Ceramic unglazed vitreous acid-resistant tiles shall be made in three sizes namely 98.5 X 98.5 mm, 148.5 X 148.5 mm and 198.5 X 198.5 mm. They shall be available in the following thickness: 35, 30, 25, 20 and 15 mm. The depth of the grooves on the under side of the tile shall not exceed 3 mm. Tolerance on length, breadth and thickness of tiles shall be $\pm$ 2 percent.

11.14.2 Shape

The tiles shall be square shaped. Half tiles rectangular in shape shall also be available. Half tiles for use with full tiles shall have dimensions which shall be such as to make two half tiles, when joined together, match with the dimension of full tile. The shape of tiles other than square shall be as agreed to between the purchaser and the manufacturer. Tiles shall be checked for squareness and warp as per IS 4457.

11.14.3 Performance Requirements

The tiles when tested in accordance with method given in IS 4457, shall conform to be requirement specified in the code (IS 4457).

11.14.4 Loss in Abrasion

The maximum percentage of loss in abrasion of the ceramic unglazed vitreous acid resistant tiles determined in accordance with the procedure laid down in IS 1237, shall be as mentioned in IS 4457.

11.14.5 Marking

Tiles shall be legibly marked on the back with the name of the manufacturer or his trade mark. Manufacturer's batch number and year of manufacture.

Each tile may also be marked with the ISI certification mark.

11.14.6 Preparation of Surface and Laying

Preparation of surface and laying to be according to para 11.15.4, except the cement used to be acid and or alkali resistant cement and cement mortar to be used to be acid and or Alkali resistant mortar. Thickness of bedding of mortar for flooring to be 10 mm or specified on the item and for dado/skirting to be 12 mm or specified on item.

11.14.7 Pointing and Finishing

As per para 11.15.5, except that cement used for pointing to be acid and or alkali resistant cement.

11.14.8 Measurements

As per para 11.15.6.

11.14.9 Rate

The rate for flooring shall include the cost of all materials and labor in volved in all the operations described above. For tiles of sizes upto 0.16 Sqm, unless otherwise specified in the description of the item. Nothing extra shall be paid for the use of cost (Sawn) tiles in the work.

11.15 PRESSED CERAMIC TILE FLOORING

11.15.1 Pressed Ceramic Tiles

The tiles shall be of approved make and shall generally conform to IS 15622. They shall be flat, and true to shape and free from blisters crazing, chips, welts, crawling or other imperfections detracting from their appearance. The tiles shall be tested as per IS 13630.

Classification and Characteristics of pressed ceramic tiles shall be as per IS 13712.

The tiles shall be square or rectangular of nominal size. Table 1,3,5, and 7 of IS 15622 give the modular preferred sizes and table 2,4,6 and 8 give the most common non modular sizes. Thickness shall be specified by the manufacturer. It includes the profiles on the visible face and on the rear side. Manufacturer/supplier and party shall choose the work size of tiles in order to allow a nominal joint width upto 2mm for unrectified floor tiles and upto 1mm for rectified floor tiles. The joint in case of spacer lug tile shall be as per spacer. The tiles shall conform to table10 of IS 15622 with water absorption 3 to 6% (Group BII).

The top surface of the tiles shall be glazed. Glaze shall be either glossy or matt as specified. The underside of the tiles shall not have glaze on more than 5% of the area in order that the tile may adhere properly to the base. The edges of the tiles shall be preferably free from glaze. However, any glaze if unavoidable, shall be permissible on only upto 50 per cent of the surface area of the edges.

11.15.2 Coloured Tiles

Only the glaze shall be coloured as specified. The sizes and specifications shall be the same as for the white glazed tiles.

11.15.3 Decorative Tiles

The type and size of the decorative tiles shall be as follows :

(i) **Decorated white back ground tiles**
The size of these tiles shall be as per IS 15622.

(ii) **Decorated and having coloured back-ground**
The sizes of the tiles shall be as per IS 15622.

11.15.4 Preparation of Surface and Laying

11.15.4.1 Base concrete or the RCC slab on which the tiles are to be laid shall be cleaned, wetted and mopped. The bedding for the tile shall be with cement mortar 1:4 (1 cement : 4 coarse sand) or as specified. The average thickness of the bedding shall be 20 mm or as specified while the thickness under any portion of the tiles shall not be less than 10 mm.

11.15.4.2 Mortar shall be spread, tamped and corrected to proper levels and allowed to harden sufficiently to offer a fairly rigid cushion for the tiles to be set and to enable the mason to place wooden plank across and squat on it.

11.15.4.3 Over this mortar bedding neat grey cement slurry of honey like consistency shall be spread at the rate of 3.3 kg of cement per square metre over an area upto one square metre. Tiles shall be soaked in water washed clean and shall be fixed in this grout one after another, each tile gently being tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. The joints shall be kept as thin as possible and in straight lines or to suit the required pattern.

11.15.4.4 The surface of the flooring during laying shall be frequently checked with a straight edge about 2 m long, so as to obtain a true surface with the required slope. In bath, toilet W.C. kitchen and balcony/verandah flooring, suitable tile drop or as shown in drawing will be given in addition to required slope to avoid spread of water. Further tile drop will also be provided near floor trap.

11.15.4.5 Where full size tiles cannot be fixed these shall be cut (sawn) to the required size, and their edge rubbed smooth to ensure straight and true joints.

Tiles which are fixed in the floor adjoining the wall shall enter not less than 10 mm under the plaster, skirting or dado.

11.15.4.6 After tiles have been laid surplus cement slurry shall be cleaned off.

11.15.5 Pointing and Finishing

The joints shall be cleaned off the grey cement slurry with wire/coir brush or trowel to a depth of 2 mm to 3 mm and all dust and loose mortar removed. Joints shall then be flush pointed with white cement added with pigment if required to match the colour of tiles. Where spacer lug tiles are provided, the half the depth of joint shall be filled with polysulphide or as specified on top with under filling with cement grout without the lugs remaining exposed. The floor shall then be kept wet for 7 days. After curing, the surface shall be washed and finished clean. The finished floor shall not sound hollow when tapped with a wooden mallet.

11.15.6 Measurements

Length and breadth shall be measured correct to a cm before laying skirting, dado or wall plaster and the area calculated in square metre correct to two places of decimal. Where coves are used at the junctions, the length and breadth shall be measured between the lower edges of the coves.

No deduction shall be made nor extra paid for voids not exceeding 0.20 square metre. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square metre.

Areas, where glazed tiles or different types of decorative tiles are used will be measured separately.

11.15.7 Rate

The rate for flooring shall include the cost of all materials and labour involved in all the operations described above, For tiles of sizes upto 0.16 sqm. unless otherwise specified in the description of the item. Nothing extra shall be paid for the use of cut (sawn) tiles in the work.

Extra over and above the normal rate for white tiles shall be paid where coloured or any other type of decorative tiles have been used.

11.15A Pendulum Test for skid resistance

In case of skid resistance test, Pendulum should be done for dry and wet condition. The criteria of Pendulum reading for various types of flooring material for dry wet conditions is given in Table No. 11.3.

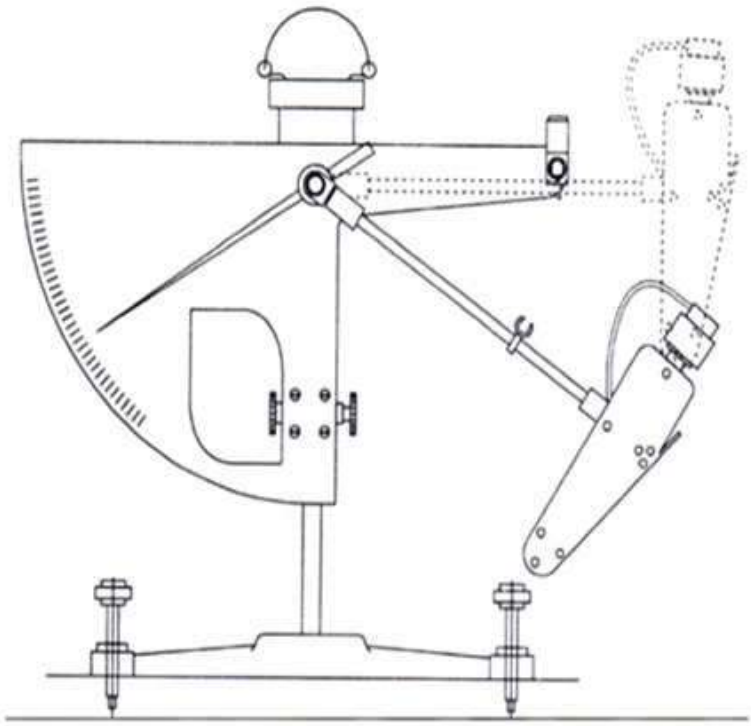
This test consists of Pendulum shaped apparatus that is allowed to fall from certain angle so that it rubs against the surface that is being tested. A four S rubber cap is fitted on its end & it is allowed to fall in a per pendulum arc depending upon the height reached after rubbing against the tested surface, a value is obtained that will be use to classify its slip resistance, is interpreted follows:-

Table No. 11.3

S. No	*Classification of flooring*	*Pendulum Reading (Range)*	*Remarks*
A.	Dry Areas	25 to 35	For all type of flooring material tested in dry condition
B.	Wet Areas	35 to 64	-do-

Note:

1. Dry areas – All spaces in residential building except toilet and kitchen.
2. Wet areas – Toilet and Kitchen in residential building, swimming pool, public places, etc.



Pendulum Test Method

11.16 PRESSED CERAMIC TILE FLOORING (VITRIFIED TILE FLOORING)

11.16.1 Operations as described in 11.15.1 to 11.15.6 shall be followed except the tiles shall conform to Table 12 of IS 15622 (Tiles with water absorption E d" 0.08 per cent Group BIa) and the joint thickness in flooring shall not be more than 1mm.

11.16.2 Rate

The rate for flooring shall include the cost of all materials and labour involved in all the operations described above. Nothing extra shall be paid for the use of cut (sawn) tiles in the work.

11.17 FIXING OF TILE FLOORING WITH CEMENT BASED HIGH POLYMER MODIFIED QUICK SET ADHESIVE (WATER BASED)

11.17.1 When tile flooring is to be laid over the existing flooring without dismantling old flooring it can be laid with adhesive. The old flooring shall be thoroughly cleaned and checked for undulations, if any shall be rectified with cement mortar 1:3 (1 cement: 3 coarse sand). Old cement concrete surface shall be hacked and cleaned off to have proper bond with the old surface.

11.17.2 High polymer modified quick set tile adhesive (conforming to IS 15477) shall be thoroughly mixed with water and a paste of zero slump shall be prepared so that it can be used with in 1.5 to 2 hours. It shall be spread over an area not more than one sqm at one time. Average thickness of adhesive shall be 3 mm The adhesive so spreaded shall be combed using suitable trowel. Tiles shall be pressed firmly in to the position with slight twisting action checking it simultaneously to ensure good contact gently being tapped with wooden mallet till it is properly backed with adjoining tiles. The tiles shall be fixed within 20 minutes of application of adhesive. The surplus adhesive from the joints, surface of the tiles shall be immediately cleaned.

11.17.3 The surface of the flooring shall be frequently checked during laying with straight edge of above 2m long so as to attain a true surface with required slope.

11.17.4 Where spacer lugs tiles are provided these shall be filled with grout with lugs remaining exposed.

11.17.5 Where full size tile can not be fixed these shall be cut (sawn) to the required size and edges rubbed smooth to ensure straight and true joints. Tiles which are fixed in floor adjoining to wall shall enter not less than 10 mm under plaster, skirting or dado.

11.17.6 Finishing: para 11.15.5 shall apply.

11.17.7 Measurements: para 11.15.6 shall apply.

11.17.8 Rate

Provisions of para 11.15.7 and 11.16.2 shall apply.

11.18 Clause shifted to Sub Head 8 (Cladding work) as clause no 8.19

11.19 MARBLE STONE FLOORING

11.19.1 Marble Stone

It shall be as specified in sub head 8.0.

11.19.2 Dressing of Slabs

Every stone shall be cut to the required size and shape, fine chisel dressed on all sides to the full depth so that a straight edge laid along the side of the stone shall be fully in contact with it. The top surface shall also be fine chisel dressed to remove all waviness. In case machine cut slabs are used, fine chiesel dressing of machine cut surface need not be done provided a straight edge laid any where along the machine cut surfaces is in contact with every point on it. The sides and top surface of slabs shall be machine rubbed or table rubbed with coarse sand before paving. All angles and edges of the marble slabs shall be true, square and free from chippings and the surface shall be true and plane.

The thickness of the slabs shall be 18, 30 or 40 mm as specified in the description of the item. Tolerance of + 3% shall be allowed for the thickness. In respect of length and breadth of slabs a tolerance of $\pm$ 2% shall be allowed.

11.19.3 Laying

11.19.3.1 Base concrete or the RCC slab on which the slabs are to be laid shall be cleaned, wetted and mopped. The bedding for the slabs shall be with cement mortar 1:4 (1 cement : 4 coarse sand) or as given in the description of the item.

11.19.3.2 The average thickness of the bedding mortar under the slab shall be 20 mm and the thickness at any place under the slab shall be not less than 12 mm.

11.19.3.3 The slabs shall be laid in the following manner:

Mortar of the specified mix shall be spread under the area of each slab, roughly to the average thickness specified in the item. The slab shall be washed clean before laying. It shall be laid on top, pressed, tapped with wooden mallet and brought to level with the adjoining slabs. It shall be lifted and laid aside. The top surface of the mortar shall then be corrected by adding fresh mortar at hollows. The mortar is allowed to harden a bit and cement slurry of honey like consistency shall be spread over the same at the rate of 4.4 kg of cement per sqm. The edges of the slab already paved shall be buttered with grey or white cement with or without admixture of pigment to match the shade of the marble slabs as given in the description of the item.

The slab to be paved shall then be lowered gently back in position and tapped with wooden mallet till it is properly bedded in level with and close to the adjoining slabs with as fine a joint as possible. Subsequent slabs shall be laid in the same manner. After each slab has been laid, surplus cement on the surface of the slabs shall be cleaned off. The flooring shall be cured for a minimum period of seven days. The surface of the flooring as laid shall be true to levels, and, slopes as instructed by the Engineer-in-Charge. Joint thickness shall not be more than 1 mm.

Due care shall be taken to match the grains of slabs which shall be selected judiciously having uniform pattern of Veins/streaks or as directed by the Engineer-in-Charge.

11.19.3.4 The slabs shall be matched as shown in drawings or as instructed by the Engineer-in-Charge.

11.19.3.5 Slabs which are fixed in the floor adjoining the wall shall enter not less than 12 mm under the plaster skirting or dado. The junction between wall plaster and floor shall be finished neatly and without waviness.

11.19.3.6 Marble slabs flooring shall also be laid in combination with other stones and/or in simple regular pattern/design as described in item of work and/or drawing.

11.19.4 Polishing and Finishing

Slight unevenness at the meeting edges of slabs shall then be removed by fine chiselling and finished in the same manner as specified in 11.10.3 except that cement slurry with or without pigments shall not be applied on the surface before each polishing.

11.19.5 Measurements

Marble stone flooring with different kind of marble shall be measured separately and in square metre correct to two places of decimal. Length and breadth shall be measured correct to a cm before laying skirting, dado or wall plaster. **In the case of radially dressed or circular stone used in the work, the dimensions of the circumscribing rectangle of the dressed stone, shall be measured correct to a centimeter.** No deduction shall be made nor extra paid for voids not exceeding 0.20 square metre. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square metre. Nothing extra shall be paid for laying the floor at different levels in the same room. Steps and treads of stairs paved with marble stone slabs shall also be measured under the item of Marble Stone flooring. Extra shall, however, be paid for such areas where the width of treads does not exceed 30 cm. Nosing for treads shall be measured in running metre and paid for extra. The width of treads shall be measured from the outer edge of the nosing, as laid, before providing the riser.

11.19.6 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above. However, extra shall be paid for making special type of pattern/design/flowers as per drawings. No deductions shall be made in rate even if flooring is done without any pattern/design.

11.20 MARBLE STONE IN RISERS OF STEPS AND SKIRTING

11.20.1 Marble Stone Slabs and Dressing of Slabs shall be as specified in 11.19.1 and 11.19.2 except that the thickness of slabs shall be 18 mm. A tolerance of $\pm$ 3% mm shall be allowed, unless otherwise specified in the description of the item.

11.20.2 Preparation of Surface

It shall be as specified in 11.18.2 where necessary, the wall surface shall be cut uniformly to the requisite depth so that the skirting face shall have the projection from the finished face of wall as shown in drawings or as required by the Engineer-in-Charge. In no case the skirting should project by more than thickness of stone.

11.20.3 Laying

The risers of steps and skirting shall be in grey or white cement admixed with or without pigment to match the shade of the stone, as specified in the description of the item, with the line of the slab at such a distance from the wall that the average width of the gap shall be 12 mm and at no place the width shall be less than 10 mm, if necessary, the slabs shall be held in position by temporary M.S. hooks fixed into the wall at suitable intervals. The skirting or riser face shall be checked for plane and plumb and corrected. The joints shall thus be left to harden then the rear of the skirting or riser slab shall be packed with cement mortar 1:3 (1 cement : 3 coarse sand) or other mix as specified in the description of the item. The fixing hooks shall be removed after the mortar filling the gap has acquired sufficient strength.

The joints shall be as fine as possible but not more than 1 mm. The top line of skirting and risers shall be truly horizontal and joints truly vertical, except where otherwise indicated.

The risers and skirting slab shall be matched as shown in drawings or as instructed by the Engineer-in-Charge.

11.20.4 Curing, Polishing and Finishing

It shall be as specified in 11.11.4 as far as applicable, except that cement slurry with or without pigment shall not be applied on the surface and polishing shall be done only with hand. The face and top of skirting shall be polished.

11.20.5 Measurements

Length shall be measured along the finished face of riser or skirting, correct to a cm. Height shall be measured from the finished level of tread or floor, to the top (the underside of tread, in the case of steps) correct to 0.5 cm. The areas shall be calculated in square metre correct to two places of decimal.

Dado and lining of pillars etc. shall be measured as 'Marble work in wall lining. If the thickness is upto 25 mm or as "Marble Work" in Jambs, walls, columns and other plain work' if the thickness is more.

11.20.6 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above.

11.21 KOTA STONE FLOORING

11.21.1 Kota Stone Slabs

The slabs shall be of selected quality, hard, sound, dense and homogeneous in texture free from cracks, decay, weathering and flaws. They shall be hand or machine cut to the requisite thickness. They shall be of the colour indicated in the drawings or as instructed by the Engineer-in-Charge.

The slabs shall have the top (exposed) face polished before being brought to site, unless otherwise specified. The slabs shall conform to the size required. Before starting the work the contractor shall get the samples of slabs approved by the Engineer-in-Charge.

11.21.2 Dressing

Every slab shall be cut to the required size and shape and fine chisel dressed on the sides to the full depth so that a straight edge laid along the side of the stone shall be in full contact with it. The sides (edges) shall be table rubbed with coarse sand or machine rubbed before paving. All angles and edges of the slabs shall be true, square and free from chippings and the surface shall be true and plane.

The thickness of the slab after it is dressed shall be 20, 25, 30 or 40 mm as specified in the description of the item. Tolerance of ±2 mm shall be allowed for the thickness. In respect of length and breadth of slabs Tolerance of ± 5 mm for hand cut slabs and ± 2 mm for machine cut slabs shall be allowed.

11.21.3 Preparation of Surface and Laying

The specification shall be as described in 11.19.3 except that the edges of the slabs to be jointed shall be buttered with grey cement, with admixture of pigment to match the shade of the slab. The thickness of the joints should be minimum as possible. In any location, it shall not exceed 1 mm.

11.21.4 Polishing and Finishing

The specifications shall be as described in 11.19.3 except that (a) first polishing with coarse grade carborundum stone shall not be done, (b) cement slurry with or without pigment shall not be applied on the surface before polishing.

11.21.5 Measurements and Rates

These shall be as described in paras 11.19.5 and 11.19.6.

11.22 KOTA STONE IN RISERS OF STEPS, SKIRTING AND DADO

11.22.1 Kota Stone Slabs and Dressing shall be as specified in 11.21.1 and 11.21.2 except that the thickness of the slabs shall be 25 mm or as specified in the description of the item. The slabs may be of uniform size if required.

11.22.2 Preparation of surface shall be as specified in 11.20.2.

11.22.3 Laying shall be as specified in 11.20.3 except that the joints of the slabs shall be set in grey cement mixed with pigment to match the shade of the slabs.

11.22.4 Curing, Polishing and Finishing shall be as specified in 11.20.4 except that first polishing with coarse grade carborundum stone shall not be done.

11.22.5 Measurements

Length shall be measured along the finished face of riser, skirting or dado correct to a cm. Height shall be measured from the finished level of tread of floor to the top (the underside of tread in the case of steps). This shall be measured correct to a mm in the case of risers of steps and skirting and correct to a cm in the case of dado. The area shall be calculated in square metre correct to two places of decimal.

Lining of pillars etc. shall also be measured under this item.

11.22.6 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above.

11.23 RED OR WHITE FINE DRESSED SAND STONE FLOORING

11.23.1 Stone Slabs

The slabs shall be red or white as specified in the description of the item. The stone slabs shall be hard, sound, durable and tough, free from cracks, decay and weathering. In case of red sand stone,

white patches or streaks shall not be allowed. However, scattered spots upto 10 mm diameter will be permitted. Before starting the work the contractor shall get samples of slabs approved by the Engineer-in-Charge.

The slabs shall be hand or machine cut to the requisite thickness along planes parallel to the natural bed of stone and should be of uniform size if required.

11.23.2 Dressing of Slabs

Every slab shall be cut to the required size and shape and chisel dressed on all sides to a minimum depth of 20 mm. The top and the joints shall be fine tooled so that straight edge laid along the face is fully in contact with it. In case machine cut stones are used, chisel dressing and fine tooling of machine cut surface need not be done provided a straight edge laid anywhere along the machine cut surface is in contact with every point on it.

The thickness of the slabs after dressing shall be 40 mm or as specified in the description of item with a permissible tolerance of ± 2 mm.

11.23.3 Laying

11.23.3.1 Base concrete on which the slabs are to be laid shall be cleaned, wetted and mopped. The bedding for the slabs shall be with cement mortar 1:5 (1 cement : 5 coarse sand) or as given in the description of the item.

11.23.3.2 The average thickness of the bedding mortar under the slabs shall be 20 mm and the thickness at any place under the slabs shall not be less than 12 mm.

11.23.3.3 The slab shall be laid in the following manner:

Mortar of specified mix shall be spreaded under each slab. The slab shall be washed clean before laying. It shall then be laid on top, pressed and larried, so that all hollows underneath get filled and surplus mortar works up through the joints. The top shall be tapped with a wooden mallet and brought to level and close to the adjoining slabs, with thickness of joint not exceeding 5 mm. Subsequent slabs shall be laid in the same manner. After laying each slab surplus mortar on the surface of slabs shall be cleaned off and joints finished flush.

11.23.3.4 In case pointing with other mortar mix is specified, the joint shall be left raked out uniformly and to a depth of not less than 12 mm when the mortar is still green. The pointing shall be cured for a minimum period of 7 days. The surface of the flooring as laid shall be true to levels and slopes as instructed by the Engineer-in-Charge.

11.23.3.5 Slabs which are fixed in the floor adjoining the wall shall enter not less than 12 mm under the plaster, skirting or dado. The junction between wall plaster skirting and floor shall be finished neatly and without waviness.

11.23.3.6 The finished floor shall not sound hollow when tapped with wooden mallet.

11.23.4 Finishing

In case of chisel dressed stone flooring slight unevenness, if any existing between the edges of slabs at joints shall then be removed by chiselling in a slant.

11.23.5 Measurements

These shall be as specified in para 11.19.5.

11.23.6 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above. Where pointing is to be done, this will be paid extra unless specifically included in the description of the item.

11.24 RED OR WHITE FINE DRESSED AND RUBBED SAND STONE FLOORING

11.24.1 Stone Slabs shall be as specified in 11.23.1.

11.24.2 Dressing

The specifications for dressing the top surface and the sides shall be as described in 11.23.2. In addition the dressed top and sides shall be table rubbed with coarse grade carborundum stone before paving, to obtain a perfectly true and smooth surface free from chisel marks.

The thickness of the slabs after dressing shall be as specified with a permissible tolerance of ± 2 mm.

11.24.3 Laying

The slabs shall be laid with 3 mm thick or 5 mm thick joints as specified in the description of the item.

Where the joints are to be limited to 3 mm thickness, the slabs shall be laid as specified in 11.19.3 except that the bedding mortar shall be as specified in 11.23.3 and sides of the slabs to be jointed shall be buttered with cement mortar 1:2 (1 cement : 2 stone dust) admixed with pigment to match the shade of the slab.

Where the slabs are to be laid with 5 mm thick joints, the specifications for laying shall be as described in 11.23.3.

11.24.4 Finishing shall be as specified in 11.23.4 except that chisel marks and unevenness shall be removed by rubbing with coarse grade carborundum stone.

11.24.5 Measurement and Rate shall be as specified in 11.23.5 and 11.23.6.

11.25 WOODEN FLOORING

11.25.0 Seasoning and Preservation

All timber used for timber floors shall be thoroughly seasoned in accordance with IS 1141. After seasoning the timber shall be treated with preservative in accordance with IS 401. Seasoning and preservative treatment shall be paid for separately unless otherwise specifically included in the description of the item of flooring.

11.25.1 Supporting Joists

Main beams and joists of the class of wood sections specified in the description of the item for beams and joists, or as instructed by the Engineer-in-Charge shall be fixed in position to dead levels. The width of the joints shall not be less than 50 mm. The arrangement and spacing of beams joists etc. shall be as per design furnished.

11.25.2 Boards

It shall be of the class of timber and thickness specified in the description of the item. The timber shall be as specified in para 9.1. Only selected boards of uniform width shall be used. Unless otherwise specified or shown in the drawings, the width of boards selected shall not be less than 100 mm nor more than 150 mm. The same width of boards shall not be maintained throughout except where the width of the room is not an exact multiple of the boards. In the latter case, the difference shall be equally adjusted between the two end boards (adjacent to walls). The length of the boards shall not exceed 3 metre anywhere. Ordinarily, the minimum length of boards shall be such that the boards shall rest at least on three supports, except where otherwise required by the pattern specified in the drawings or as directed by the Engineer-in-Charge.

The boards shall be planed true on the top face only unless otherwise specified in the description of the item. Where the bottom face is exposed and it is also required to be planed, then such planing shall be paid for extra.

Unless otherwise described in the item, the longitudinal joints of planks shall be tongued and grooved to a minimum depth of 12 mm while the heading joints shall be of the square butt type and shall occur over the centre line of the supporting joists. Heading joists in adjacent boards shall be placed over the same joists.

11.25.3 Iron Screws

Iron screws shall be of the slotted counter sunk head type, of length not less than the thickness of planks plus 25 mm, subject to a minimum of 40 mm, and of designation No. 9 conforming to IS 451.

11.25.4 Fixing

The joists on which the planks shall be fixed shall be checked and corrected to levels. The end boards shall be accurately fixed with the sides parallel and close to the walls. Each adjoining board shall be carefully jointed and shall be tightened in position and screwed. For fixing the boards to the joists, two screws shall be used at each end of the boards and one screw at each of the intermediate joists in a zig zag manner. The screws shall be countersunk and screw holes filled with approved stopping.

The junction between timber flooring and adjacent flooring shall be formed by inserting a metal strip (brass or aluminium) at the junction. The metal strip shall be fixed to the end of the planks by screws. The strips shall be paid for extra.

The flooring shall be truly level and plane. The joints shall be truly parallel and or perpendicular to the walls, unless otherwise specified.

The floor shall be planed in both directions and made perfectly even, true and smooth.

Note : No wood of any kind shall be placed within 60 cm of any fire place or flue. Provision shall be made for ventilation in the space below the floor in case of ground floor and between floor and top of ceiling in the case of upper floors. Such arrangements shall be paid for separately.

11.25.5 Finishing

The surface of the floor shall be bees waxed or finished otherwise as directed by the Engineer-in-Charge. The lower face shall be painted or treated with wood preservative as directed. The finishing shall be paid for separately unless specifically included in description of the flooring item.

11.25.6 Measurements

Length and breadth of superficial area of the finished work shall be measured correct to a cm. The area shall be calculated in square metre correct to two places of decimal. No deduction shall be made nor extra paid for voids not exceeding 0.20 square metre. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square metre.

11.25.7 Rate

The rate shall include the cost of the labour and materials involved in all the operations described above, with the exceptions noted in the relevant sub-paras.

11.26 WOOD BLOCK FLOORING

11.26.1 Wood Blocks

The wood blocks shall be of the class of timber specified in the description of the item and shall be in accordance with the .general specifications for 'Wood Work' given under para 9.1. The size of blocks shall be as shown in the drawings. The longitudinal edges of the blocks shall be dovetailed grooved near the bottom. The blocks shall be truly rectangular in shape with clean sharp edges and true faces. The top and sides shall be planed true. The thickness of the blocks shall be 38 mm unless otherwise specified. The timber used for making the blocks shall be thoroughly seasoned in accordance with IS 1141. After seasoning, the timber shall be treated with preservatives in accordance with IS 401.

11.26.2 Base Concrete

The specifications shall be same as in 11.2.2.

11.26.3 Levelling Concrete

The levelling layer of concrete shall be of cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 stone aggregate 10 mm nominal size) by volume unless otherwise described in the item. Its thickness shall be 25 mm. Cement concrete shall be placed in position and levelled up with the help of a straight

edge and trowel. It shall then be beaten with wooden 'Thappy' or a mason's trowel till the cream comes up. The surface shall be finished with a wooden float to give a sand paper finish, plane and true to level. The finished level of the concrete shall be lower than the proposed finished level of the flooring by the specified thickness of the wooden blocks plus a minimum of 1.5 mm. The levelling layer shall be cured for a weak and then allowed to dry thoroughly, before paving with wood blocks.

11.26.4 Laying

The wood blocks shall be first laid 'dry' to the margin and pattern shown in the drawings or as directed by the Engineer-in -Charge. The blocks shall fit closely and sides and end shall be corrected by further planing if necessary to get closed and even joints. After the blocks have been fitted and matched they shall be removed and stacked in such a way as to facilitate their repaving in the same order.

The surface of the levelling course shall be thoroughly cleaned and a small area of the surface shall be coated with a thin layer of a hot bitumen such as blown type petroleum bitumen grade 85/25 of IS 702 or other equivalents, applied at a temperature of not less than 180° C and at the rate of 2.45 kg per square metre. The wood blocks shall then be taken in turn serially and be dipped in the same hot bitumen for about half their depth so as to coat thoroughly the bottom and part of the sides and quickly set and pressed into place to required patterns, on the previously coated concrete surface so that the dovetailed grooves at the edges of the blocks get filled up with bitumen. The joints of the work shall be very thin and fine.

When all the blocks shall have been set in position, the surface shall be cleaned of any bitumen droppings and planed or machined level and smooth.

The floor shall then be given a final smooth finish by rubbing down with sand paper.

Note: No wood of any kind shall be placed within 60 cm of any fire place or flue.

11.26.5 Finishing

The floor shall be Bees waxed or polished with ready made wax polish or given any other finish as required.

11.26.6 Measurements

Length and breadth of superficial areas of the finished work shall be measured correct to a cm. The area shall be calculated in square metre correct to two places of decimal. No deduction shall be made nor extra paid for voids not exceeding 0.20 square metre. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square metre.

11.26.7 Rate

The rate shall include the cost of all labour and materials involved in all the operations described above but shall not include the cost of base concrete bees waxing or other finishing unless otherwise specifically described in the item.

11.27 TURF PAVER

11.27.1 Turf Paver is used primarily for the creation of grass or gravel access pathways for heavy emergency vehicles and stabilization of areas such as overflow parking, home driveways, golf buggy and equestrian dressage arenas and paths, helicopter landing pads and boat parking rams. It also serves as a stabilizer for mild slopes and functions as an erosion control measure.

It is a high strength plastic module designed to contain and stabilize grass or decorative gravel with the ability to withstand heavy loads imposed by emergency vehicles such as fire trucks. It replaces asphalt and concrete to create permeable surfaces that may be turfed or planted with ground cover and enable these areas to blend into the aesthetics of their surroundings.

It consists of a network of sturdy porous cells which prevents soil compaction. It has top and bottom notches with a large open base that allow root and plant runners to spread freely for vigorous root development and promote healthy plant growth.

Advantages

(i) Supports heavy vehicular load
(ii) Does not hinder root and runner growth

(iii) Reduces erosion and soil migration
(iv) Easily installed and removed
(v) Conforms to uneven surfaces
(vi) Supports Green Building Certification

11.27.2 Applications

Fire engine access lanes, Pedestrian pathways, Residential driveways, Overflow & street shoulder parking areas, Golf buggy paths & Racetrack infields and pit areas 150 mm thick compacted bid of 20 mm nominal size stone aggregate shall be prepared by ramming and consolidation. 150 mm thick jamuna sand shall be spreaded, rammed and consolidated including watering and finishing smooth etc. as per direction of Engineer-in-Charge. The turf paver shall then be laid on finished smooth surface.

11.27.3 Technical Specifications

Description	Specification
Material	Polypropylene
Dimensions	500 mm x 500 mm
Height	40 mm
Cell Size (diagonal)	70 mm
Weight	4.3 kg/m^2 (Tolerance= (-) 1%)
Compressive Strength (unfilled)	150 t/m^2 (Tolerance= (-) 1%)
Compressive Strength (sand filled)	3000 t/m^2 (Tolerance= (-) 1%)
Service Temperature	-30 °C to 80 °C
Biological Resistance	Unaffected by moulds and algae
Chemical Resistance	Resistant to rot, oils, acids, alkalis, bitumen and naturally occurring soil chemicals

11.27.5 Measurements

Length and breadth correct to a cm of Turf paver surface shall be measured and area shall be calculated in sqm correct to two places of decimal.

11.27.6 Rates

The rate for Turf paver shall include the cost of all materials and labour involved in all operations described above. Nothing extra shall be paid.

11.28 BORDER TILES

11.28.1 Border tiles may be use to frame, highlight, and add a decorative edge finish to an area for perfection. Border tiles are often used in kitchens and bathrooms.

The preparation of surfaces, laying, curing and finishing shall be as described under clause 8.19.

11.28.2 Measurement

The length of border tile shall be measured in running metre correct upto a cm.

11.29 EPOXY BASED GROUTING FOR TILES

11.29.1 Epoxy Grout

Grout is the material that is used to fill the space between adjacent tiles and support the joints.

The Epoxy grout consists of mix of 0.70 kg of organic coated filler of desired shade and mixing of 0.10 kg of hardener and 0.20 kg of resin per kg.. They have very low water absorption, higher compressive strength and are resistant to staining and easy to maintain. Epoxy grout is a waterless mix formed by mixing a base material (part A) and a hardener (part B). These components are mixed at site just prior to grouting.

Generally, epoxy grouts require no additional sealer to protect the surface.

11.29.2 Application process

Surface preparation

It shall be ensured that tiles are firmly set and adhesive or mortar is completely dry for 24 hours. All spacers, pegs, ropes and string shall be removed and joints be cleaned by removing free loose dirt particles.

11.29.3 Preparing mix and application

The complete unit Part A (Base) and Part B (Hardener) shall be properly mixed in given ratio. The desired colour of grout shall be obtained by mixing required quantity of colour with base to ensure homogeneity.

The grout shall be pressed firmly by using a hard rubber squeeze into joints ensuring that joints are completely filled. Excess grout material shall be removed from joints and surface by moving squeeze on grout line after 22 to 25 minutes. The damp sponge shall be used in circular motion on tile surface to achieve the flush joint. After completion of work the grout haze shall be cleaned with clean water or soap solution. The suitable rubber gloves shall be used to avoid skin contact during application.

11.29.4 Measurement

Length and breadth of grouted tile area shall be measured correct to a cm and the area shall be calculated in sqm correct to two places of decimal.

11.29.5 Rates

The rate shall include the cost of all materials and labour involved in all operations described above. Nothing extra shall be paid.

11.30 ITALIAN MARBLE STONE FLOORING

Italian marbles Quarried and processed in Italy and these marble raw stones are imported from Italy to India. Italian marble is famous for rendering a high sheen and visual appeal to the ambiance in which it is installed. It is available all over world.

Italian Marble gives the rich appearance to the house floor, walls, Kitchen, rooms and bathroom with its beautiful colour and special lusters. Because of its elegant visual it is commonly used for the decorative purpose in buildings.

11.30.1 Italian Marble Stone

The Italian marble details shall be as specified in sub head 8.0. Other details such as dressing of slabs, laying ,polishing , finishing, measurements and rates shall be as specified in clause 11.19 with Italian marble stone in place of Indian marble stone.

11.31 FLAMED FINISH GRANITE STONE FLOORING

The process is often referred to as a “flamed” or “thermal” finish and can be best described as creating a textured look. To achieve the style, an intense flame is held at the stone’s wet surface. While firing it, the surface becomes so hot it bursts and a layer flakes away to reveal a rough, even texture.

It is especially used at a location of high importance to have a great finish for designs requiring a modern aesthetic.

11.31.1 Flamed Finish Granite Stone

Other granite details shall be as specified in sub head 8.0 . The flamed finish granite stone details shall be as specified in sub head 8.0. Other details such as dressing of slabs, laying ,polishing , finishing, measurements and rates shall be as specified in clause 11.19 with flamed finish granite stone in place of Indian marble stone.

APPENDIX A

ABRASION TEST FOR CONCRETE HARDENING COMPOUNDS

(Clause 11.3.1)

A-1 Preparation of Sample

25 mm cylinder shall be prepared in ratio 1:2 mix (1 cement: 2 grades stone aggregate 6 mm nominal size by weight) one each with and without the admixture of concrete hardening compound. The concrete hardening compound shall be used in the proportion by weight of cement as recommended by the firm. The cylinder shall be placed inside a damp box for 24 hours and then cured in water for 27 days. After that, they shall be subject to abrasion test on 'Dorry Type Avery Abrasion Testing Machine, using Emery powder No 80 as the abrasing medium under the condition given in para A-2 below:

A-2 Conditions of Test

(a) Area of rubbing surface shall be same in both the cylinders.

(b) Age of cylinder	28 days
(c) Duration of Test	60 minutes
(d) Total distance traverse During rubbing	About 2.4 km
(e) Pressure on rubbing surface	0.04 kg/cm^2

A-3 Results of Tests

The following observations shall be made in both the cases.

(a) Composition of the Test specimen

(b) Mean thickness rubbed away

(c) Percentage loss in weight

A-4 Remarks

Percentage loss in weight in the case of cylinders with concrete hardening compound, should not be more than 40% of the percentage loss in the case of cylinder without concrete hardening compound.

APPENDIX B

TEST REQUIREMENTS AND PROCEDURE FOR TESTING "PRE-CAST CEMENT CONCRETE/ TERRAZO TILES"

(Clause 11.10.1 & 11.11.1)

B-1 Sampling

The tiles required of carrying out test described below shall be taken by 'random sampling'. Each tile sample shall be marked to identify the consignement from which it was selected.

Minimum quantity of tiles for carrying out the test and frequency of test shall be as specified in the list of Mandatory Test. The number of tiles selected for each mandatory test shall be as follows"

(a) For conformity to requirements on shape and dimensions, wearing layer, and general quality - 12 tiles
(b) For wet transverse strength test - 6 tiles
(c) For resistance to wear test - 6 tiles
(d) For water absorption test - 6 tiles

Note: (1) The tests on the tiles shall not be carried out earlier than 28 days from the date of manufacture.

(2) The tiles selected for (a) may as well after verification of requirements, be used for (b).

B-2 Flatness of the Tiles Surface

The tiles when tested according to procedure laid down in IS 1237 edition 2.3, the amount of concavity and convexity shall not exceed 1 mm.

B-3 Perpendicularity

When tested in accordance with the procedure laid down in IS 1237 edition 2.3, the longest gap between the arm of the square and edge of the tile shall not exceed 2 per cent of the length of edge.

B-4 Straightness

When tested as per IS 1237 edition 2.3, the gap between the thread and the plane of tile shall not exceed 1 percent of the length of edge.

B-5 Water Absoption

When tested the average water absoption shall not exceed 10 per cent.

B-6 Wet Transverse Strength Test

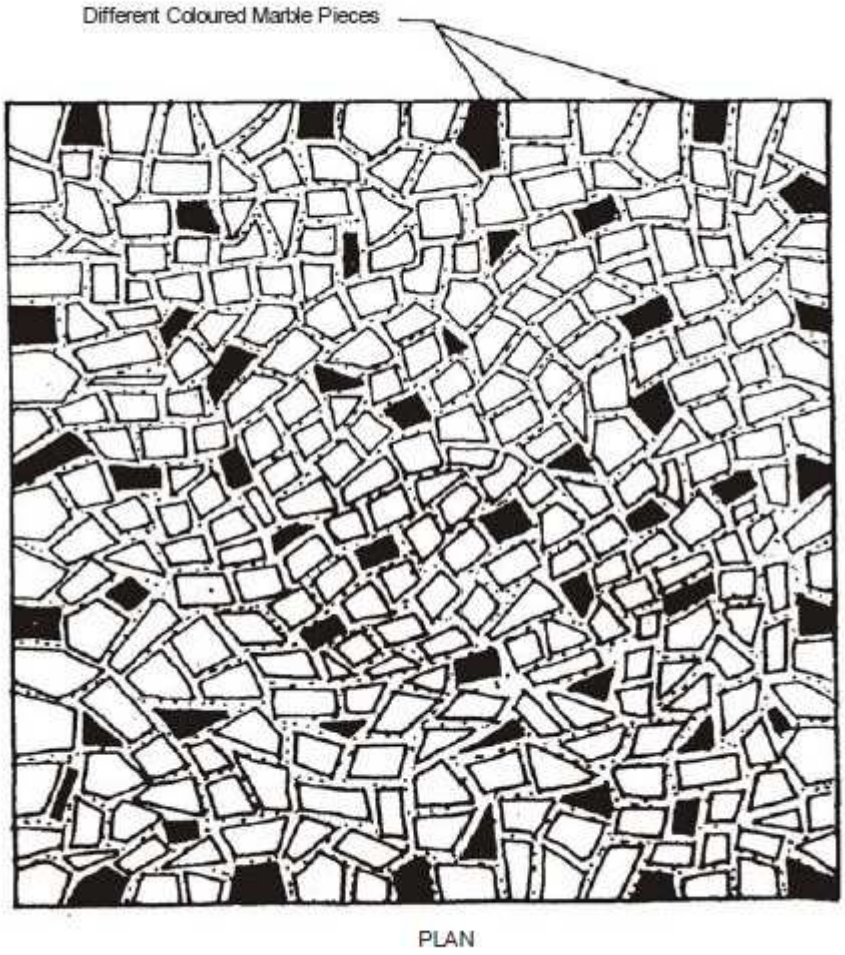
Six full size tiles shall be tested for the determination of wet transverse strength. When tested according to the procedure laid down in IS 1237 edition 2.3, the average wet transverse strength shall not be less than 3 N/mm^2 (30 kgf/cm^2)

B-7 Resistance to Wear Test

When tested according to IS 1237 edition 2.3, average wear shall not exceed 3.5 mm and the wear on any individual specimen shall not exceed 4 mm, for general purpose tiles. And 2 mm and 2.5 mm of average wear on any individual specimen, respectively for heavy duty floor tiles.

CRAZY MARBLE FLOORING

Sub Head : Flooring
Clause : 11.9

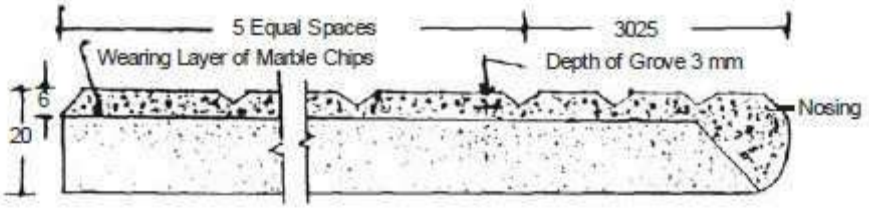


Drawing not to scale

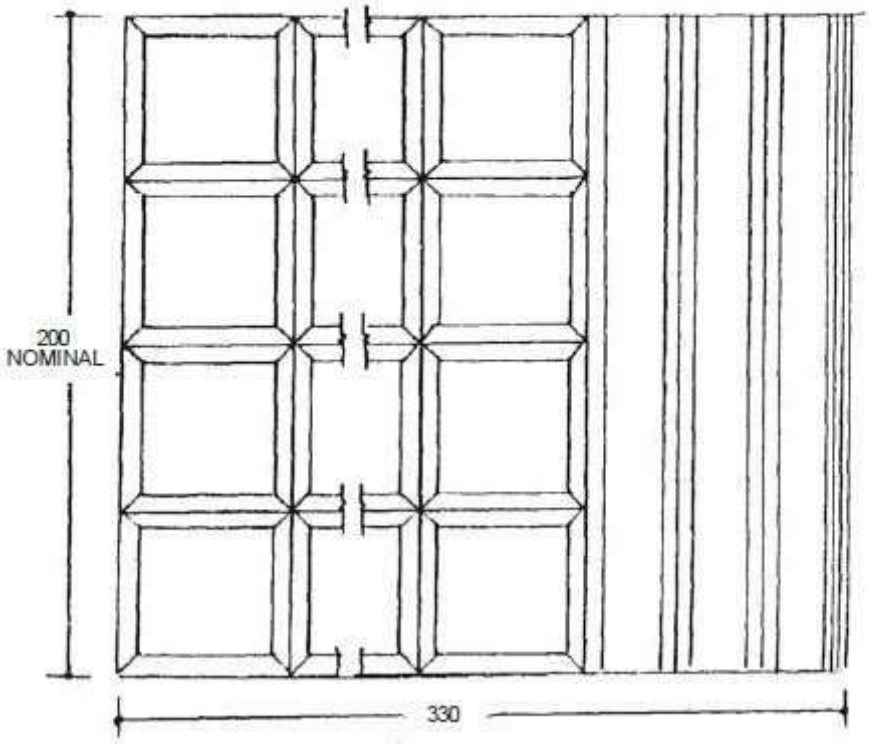
Fig. 11.1 : Crazy Marble Flooring

CHEQURED TERRAZO TILES

Sub Head : Flooring
Clause : 11.13



SIDE ELEVATION



PLAN
TILE FOR STAIR TREADS

Drawing not to Scale
All Dimensions are in mm

Fig. 11.2 : Chequered Terrazo Tiles

SUB HEAD : 12.0

ROOFING

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LIST OF BUREAU OF INDIAN STANDARDS CODES

S. No.	*BIS. No.*	*Subject*
1.	IS 73	Specification for paving Bitumen
2.	IS 277	Galvanised steel sheets (plain and corrugated)
3	IS 651	Glazed stoneware pipes and fittings
4.	IS 702	Specification for industrial bitumen
5.	IS 1199	Methods of sampling and analysis of concrete
6.	IS 1200 (PT.IX)	Method of measurements of building and civil engineering works Part - 9 Roof covering (including cladding)
7.	IS 1200 (PTX)	Method of measurements of building and civil engineering works: Part -10 ceiling and lining
8	IS 1230	Cast iron rain water pipes and fitting
9.	IS 1367 (PT -13)	Technical supply conditions for threaded steel fasteners pt.13 hot dip galvanized coating on threaded fasteners
10	IS 2095 (PT-1)	Gypsum plaster boards (Pt.1) plain Gypsum plaster boards
11.	IS 2115	Code of practice for flat roof finish: mud phuska
12.	IS 2633	Method of testing uniformity of coating on zinc coated articles
13.	IS 2645	Specification for integral water proofing compounds for cement mortar
		and concrete
14.	IS 3007 (PT.1)	Code of practice for laying of asbestos cement sheets: part- 1 corrugated sheets
15.	IS 3007 (PT.2)	Code of practice for laying of asbestos cement sheets part- 2 semi-corrugated sheets
16.	IS 3087	Particle boards of wood and other lignocellulogic materials (medium density) for general purposes - specifications
17.	IS 3144	Methods of test for mineral wool thermal insulation materials
18.	IS 3346	Method of the determination of thermal conductivity of thermal insulation materials
19.	IS 3348	Specification for fibre insulation boards
20.	IS 3384	Specification for bitumen primer for water proofing and damp proofing
21.	IS 4671	Expanded polystyrene for thermal insulation purposes
22	IS 5382	Specification for rubber sealing rings for gas mains, water mains and sewers
23.	IS 5688	Methods of test of performed block type and pipe covering type thermal insulations
24.	IS 6598	Cellular concrete for thermal insulation

25.	IS 7193	Specification for glass fibre base coal tarpitch & bitumen felts (Amendment I)
26.	IS 8183	Bonded mineral wool
27.	IS 10192	Specifications for synthetic resin bonded glass fibre (SRBGF) for electrical purposes.
28.	IS 13592	Unplasticised polyvinyl chloride (UPVC) pipes for soil and Waste discharge system for inside and outside building.
29.	IS 14753	Specifications for polymethyl Methacrylate (PMMA) (Arylic) sheets
30	IS 14862	Fibre cement flat sheets - specifications
31	IS 14871	Specifications for products in fibre reinforced cement - Long corrugated or Asymmetrical section sheets and fittings for roofing and cladding.

12.0 ROOFING

12.0 TERMINOLOGY

12.0.1 Accessories

Purpose made fittings, such as apron flashing pieces, barge boards, bottom glazing flashing, corner piece (corner flashing), eaves filler pieces, expansion joints, hip capping, hip tile or cap, ridge capping, ridge finials, roof lights, ventilators, with which the roof is furnished.

12.0.2 Eaves

The lower edge of the inclined roof.

12.0.3 Finial

A decorative fitting used at the Junction of ridges and hips to form a water proof covering and at the top of conical, pyramidal, or dome roofs.

12.0.4 Flashing

A strip of impervious material, usually metal used to exclude water from the junction between a roof covering and another part of the structure.

12.0.5 Gable

Part of wall above the general eaves level at tie end of ridged or partially hipped roof.

12.0.6 Gutter

Any form of roof water channel.

12.0.7 Hip

The outer angle (more than 180 degree) formed by the inclined ridge between two intersecting roof slopes.

12.0.8 Pitch

12.0.8.1 The angle of inclination with the horizontal of the rafters or substructure surface on which the roof coverings are laid.

12.0.8.2 In patent glazing, the angle at which the plane of a stretch of glazing is inclined to the horizontal.

12.0.9 Pitched Roof

A roof the pitch of which is greater than 10 degree to the horizontal.

12.0.10 Ridge

The horizontal inter-section at the apex of the two rising roof surfaces inclined in opposite directions.

12.0.11 Valley

The re-entrant angle formed by the inter-section of two inclined roof surfaces.

12.0.12 Verge

Free edge of a roof surface ending at a gable.

12.1 CORRUGATED GALVANISED STEEL SHEET ROOFING

12.1.1 C.G.S. Sheets

These shall be of the thickness specified in the description of the item and shall conform to IS 277. The sheets shall be of 275 grade of coating (See Appendix-A) unless otherwise specified in the description of item.

The sheets shall be free from cracks, split edges, twists, surface flaws etc. They shall be clean, bright and smooth. The galvanising shall be non-injured and in perfect condition. The sheets shall not show signs of rust or white powdry deposits on the surface. The corrugations shall be uniform in depth and pitch and parallel with the side.

12.1.2 Purlins

Purlins of the specified material or M.S. rolled sections of requisite size shall be fixed over the principal rafters. These shall not be spaced at more than the following distances. (Table 12.1)

TABLE 12.1

Thickness of C.G.S. sheet	*Maximum spacing of purlins*
1.00 mm	2.00 metre
0.80 mm	1.80 metre
0.63 mm	1.60 metre

The top surfaces of the purlins shall be uniform and plane. They shall be painted before fixing on top. Embedded portions of wooden purlins shall be coal tarred with two coats.

12.1.3 Slope

Roof shall not be pitched at a flatter slope than 1 vertical to 5 horizontal. The normal pitch adopted shall usually be 1 vertical to 3 horizontal.

12.1.4 Laying and Fixing

12. 1.4.1 The sheets shall be laid and fixed in the manner described below, unless otherwise shown in the working drawings or directed by the Engineer-in-Charge.

12.1.4.2 The sheets shall be laid on the purlins to a true plane, with the lines of corrugations parallel or normal to the sides of the area to be covered unless otherwise required as in special shaped roofs.

12.1.4.3 The sheets shall be laid with a minimum lap of 15 cm at the ends and 2 ridges of corrugations at each side. The above minimum end lap of 15 cm shall apply to slopes of 1 vertical to 2 horizontal and steeper slopes. For flatter slopes the minimum permissible end lap shall be 20 cm. The minimum lap of sheets with ridge, hip and valley shall be 20 cm measured at right angles to the line of the ridge, hip and valley respectively. These sheets shall be cut to suit the dimensions or shapes of the roof, either along their length or their width or in a slant across their lines of corrugations at hips and valleys. They shall be cut carefully with a straight edge chisel to give a smooth and straight finish.

12.1.4.4 Lapping in C.G.S. sheets shall be painted with a coat of approved steel primer and two coats of painting with approved paint suitable for G.S. sheet, before the sheets are fixed in place.

12.1.4.5 Sheets shall not generally be fixed into gables and parapets. They shall be bent up along their side edges close to the wall and the junction shall be protected by suitable flashing or by a projecting drip course, the later to cover the junction by at least 7.5 cm.

12.1.4.6 The laying operation shall include all scaffolding work involved.

12.1.4.7 Sheets shall be fixed to the purlins or other roof members such as hip or valley rafters etc. with galvanised J or L hook bolts and nuts, 8 mm diameter, with bitumen and G.I. limpet washers or with a limpet washer filled with white lead as directed by the Engineer-in-Charge. While J hooks are used for fixing sheets on angle iron purlins, and L hooks are used for fixing the sheet to R.S. joists, timber or precast concrete purlins. The length of the hook bolt shall be varied to suit the particular requirements.

The bolts shall be sufficiently long so that after fixing they project above the top of the nuts by not less than 10 mm. The grip of J or L hook bolt on the side of the purlin shall not be less than 25 mm. There shall be a minimum of three hook bolts placed at the ridges of corrugations in each sheet on every purlin and their spacing shall not exceed 30 cm. Coach screws shall not be used for fixing sheets to purlins.

12.1.4.8 The galvanised coating on J or L hooks, and bolts shall be continuous and free from defects such as blisters, flux stains, drops, excessive projections or other imperfections which would impair serviceability.

The galvanised coating should conform to IS 1367 (Pt. XIII) The mass of coating per square meter of the surface shall be as under:

Mass and Equivalent Thickness of Coating

Minimum Mass (g/m^2)	*Average Thickness (µm)*	*Minimum Mass (g/m^2)*	*Individual Thickness (µm)*
375	54	300	43

12.1.4.9 Where slopes of roofs are less than 21.5 degrees (1 vertical to 2.5 horizontal) sheets shall be joined together at the side laps by galvanised iron bolts and nuts 25 × 6 mm size, each bolt provided with a bitumen and a G.I. limpet washer or a G.I. limpet washer filled with white lead. As the overlap at the sides extends to two corrugations, these bolts shall be placed zig-zag over the two overlapping corrugations, so that the ends of the overlapping sheets shall be drawn tightly to each other. The spacing of these seam bolts shall not exceed 60 cm along each of the staggered rows. Holes for all bolts shall be drilled and not punched in the ridges of the corrugations from the underside, while the sheets are on the ground.

12.1.5 Wind Tie

Wind ties shall be of 40 x 6 mm flat iron section or of other size as specified. These shall be fixed at the eaves of the sheets. The fixing shall be done with the same hook bolts which secure the sheets to the purlins. The ties shall be paid for separately unless described in the item of roofing.

12.1.6 Finish

The roof when completed shall be true to lines, and slopes and shall be leak proof.

12.1.7 Measurements

12.1.7.1 The length and breadth shall be measured correct to a cm. Area shall be worked out in sqm correct to two places of decimal.

12.1.7.2 The superficial area of roof covering shall be measured on the flat without allowance for laps and corrugations. Portion of roof covering overlapping the ridge or hip etc. shall be included in the measurements of the roof.

12.1.7.3 Roof with curved sheets shall be measured and paid for separately. Measurements shall be taken on the flat and not girthed.

12.1.7.4 No deduction in measurement shall be made for opening upto 0.4 sqm and nothing extra shall be allowed for forming such openings. For any opening exceeding 0.4 sqm in area, deduction in measurements for the full opening shall be made and in such cases the labour involved in making these openings shall be paid for separately. Cutting across corrugation shall be measured on the flat and not girthed. No additions shall be made for laps cut through.

12.1.8 Rate

The rate shall include the cost of all the materials and labour involved in all the operations described above including a coat of approved steel primer and two coats of approved steel paint on overlapping of C.G.S. sheets. This includes the cost of roof sheets, galvanised iron J or L hooks, bolts and nuts, galvanised iron seam bolts and nuts, bituminous and galvanised iron limpet washers etc.

12.2 RIDGES AND HIPS OF PLAIN GALVANISED STEEL SHEETS

12.2.1 Ridges and Hips

Ridges and hips of C.G.S. roof shall be covered with ridge and hip sections of plain G.S. sheet with a minimum lap of 20 cm on either side over the C.G.S. sheets. The end laps of the ridges and hips and between ridges and hips shall also be not less than 20 cm. The ridges and hips shall be of 60 cm overall width plain G.S. sheet, 0.6 mm or 0.8 mm thick as given in the description of the item and shall be properly bent in shape.

12.2.2 Fixing

12.2.2.1 Ridges shall be fixed to the purlins below with the same 8 mm dia G.I. hook bolts and nuts and bitumen and G.I. limpet washers which fix the sheets to the purlins.

12.2.2.2 Similarly, hips shall be fixed to the roof members below such as purlins, hip and valley rafters with the same 8 mm dia G.I. hook bolts and nuts and bitumen and G.I. limpet washers which fix the sheets to those roof members. At least one of the fixing bolts shall pass through the end laps of ridges and hips, on either side. If this is not possible extra hook bolts shall be provided.

12.2.2.3 The end laps of ridges and hips shall be joined together with C.G.S sheet by galvanised iron seam bolts 25 x 6 mm size each with a bitumen and G.I. washer or white lead as directed by the Engineer-in-Charge. There shall be at least two such bolts in each end lap.

12.2.2.4 Surface of C.G.I. sheets of ridge and hip sections and the roofing sheets which overlap each other shall be painted with a coat of approved primer and two coats of approved paint suitable for painting G.S. Sheets before they are fixed in place.

12.2.3 Finish

The edges of the ridges and hips shall be straight from end to end and their surfaces should be plane and parallel to the general plane of the roof. The ridges and hips shall fit in squarely on the sheets.

12.2.4 Measurement

The measurements shall be taken for the finished work in length along the centre line of ridge or hip, as the case may be, correct to a cm. The laps in ridges and hips and between ridges and hips shall not be measured.

12.2.5 Rate

The rate shall include the cost of all labour and materials specified above, including painting, cost of seam bolts and any extra G.I. hook bolts, nuts and washers, required.

12.3 VALLEY AND FLASHING OF PLAIN GALVANISED STEEL SHEETS

12.3.1 Valley and Flashing

Valley shall be 90 cm wide overall plain G.S. sheet 1.6 mm thick or other size as specified in the item bent to shape and fixed. They shall lap with the C.G.S. sheets not less than 25 cm width on other side. The end laps of valley shall also be not less than 25 cm.

Valley sheets shall be laid over 25 mm thick wooden boarding if so required.

Flashing shall be of plain G.S. sheet of 40 cm overall width 1.25 mm thick or 1.00 mm thick as specified in the item bend to shape and fixed. They shall lap not less than 15 cm over the roofing sheets. The end laps between flashing pieces shall not be less than 25 cm.

12.3.2 Laying and Fixing

Flashing and valley sheets shall be fixed to the roof members below, such as purlins and valley rafters with the same 8 mm dia G.I. hook bolts and nuts and bitumen and G.I. limpet washers which fix the sheets to those roof members.

At least one of the fixing bolts shall pass through the end laps of the valley pieces on other side. If this is not possible extra hook bolts shall be provided. The free end of flashing shall be fixed at least 5 cm inside masonary with the mortar of mix 1: 3 (1 cement: 3 coarse sand). Refer Fig. 12.3.

12.3.3 Surface of G.S. sheets under overlaps shall be painted with a coat of approved primer and two coats of approved paint suitable for painting G.S. sheets.

12.3.4 Finish

The edges of valley and flashing should be straight from end to end. The surfaces should be true and without bulges and depressions.

12.3.5 Measurements

The length of the valleys and flashing shall be measured for the finished work correct to a cm. The laps along the length of the valley or flashing pieces, including the portion embedded in masonary, shall not be measured.

12.3.6 Rates

The rate for valleys, shall be for all the labour and materials specified above, including painting, cost of seam bolts and the cost of requisite G.I. hook bolts, nuts and washers required over and above those needed for connecting the roof sheets to the roof members. The rate for valleys shall exclude the cost of boarding underneath which shall be paid for separately. The rate for flashing shall be for all the labour and materials specified above, and shall include the cost of painting and mortar for fixing in wall.

12.4 GUTTERS MADE OF PLAIN GALVANISED STEEL SHEETS (FIG. 12.2)

12.4.1 Gutters

Gutter shall be fabricated from plain G.S. Sheets of thickness as specified in the item.

Eaves gutters shall be of the shape and section specified in the description of the item. The overall width of the sheet referred to therein shall mean the peripheral width of the gutter including the rounded edges. The longitudinal edges shall be turned back to the extent of 12 mm and beaten to form a rounded edge. The ends of the sheets at junctions of pieces shall be hooked into each other and beaten flush to avoid leakage.

12.4.2 Slope

Gutter shall be laid with a minimum slope of 1 in 120.

12.4.3 Laying and Fixing

12.4.3.1 Gutter shall be supported on and fixed to M.S. flat iron brackets bent to shape and fixed to the requisite slope. The maximum spacing of brackets shall be 1.20 metres.

12.4.3.2 Where these brackets are to be fixed to the sides of rafters, they shall be of 40 × 3 mm section bend to shape and fixed rigidly to the sides of rafters with 3 Nos. 10 mm dia bolts, nuts and washers. The brackets shall overlap the rafter not less than 30 cm and the connecting bolts shall be at 12 cm centres.

12. 4.3.3 Where the brackets are to be fixed to the purlins, the brackets shall consist of 50 × 3 mm M.S. flat iron bent to shape with one end turned at right angle and fixed to the purlin face with 2 Nos. of 10 mm dia bolts nuts and washers. The bracket will be stiffened by provision of 50 × 3 mm. M.S. flat whose over hung portion bent to right angle shape with its longer leg connected to the bracket with 2 Nos. 6 mm dia M.S. bolts, nuts and washers and its shorter leg fixed to face of purlin with 1 No. 10 mm dia, bolt, nut and washer. The over hang of the vertical portion of the bracket from the face of the purlin shall not exceed 22.5 cm with this arrangement. The spacing of the brackets shall not exceed 1.20 metres.

12.4.3.4 The gutter shall be fixed to the brackets with 2 Nos. G.I. bolts and nuts 6 mm dia, each fitted with a pair of G.I. and bitumen washers. The connecting bolts shall be above the water line of the gutters.

12.4.3.5 For connection to down take pipes, a proper drop end or funnel shaped connecting piece shall be made out of G.S. sheet of the same thickness as the gutter and riverted to the gutter, the other end tailing into the socket of the rain-water pipe. Wherever necessary stop ends, angles etc., should be provided.

12.4.4 Finish

The gutters when fixed shall be true to line and slope and shall be leakproof.

12.4.5 Measurements

Measurements shall be taken for the finished work along the centre line of the top width of the gutter connection to a cm. The hooked lap portion in the junctions and gutter lengths shall not be measured. The number of brackets which are fixed to purlins with stiffener flats should be measured.

12.4.6 Rate

The rate shall include the cost of all labour and materials specified above, including all specials such as angles, junctions, drop ends or funnel shaped connecting pieces, stop ends etc., flat iron brackets and bolts and nuts required for fixing the latter to the roof members. Brackets of 50 × 3 mm flats fixed to purlins with stiffener flats will be paid extra.

12.5 NON-ASBESTOS REINFORCED BY ORGANIC FIBRES AND/OR INORGANIC SYNTHETIC FIBRES CEMENT CORRUGATED SHEET ROOFING (FIG. 12.4)

12.5.1 Non-Asbestos reinforced by organic fibres and/or inorganic synthetic fibres Cement Corrugated Sheets

The sheets shall be of the approved quality and shall conform to IS 14871. The sheets shall be free from cracks, chipped edges or corners and other damages.

12.5.1 (a) General Composition of Sheets

The product shall be composed essentially of an inorganic hydraulic binder (see Note) or a calcium silicate binder formed by the chemical reaction of a silicate binder formed by the chemical reaction of a siliceous (includes ground silica, pulverized fuel ash and amorphous silica) and calcareous material reinforced by organic fibres and/or inorganic synthetic fibres. Pozzolanic materials process aids, fillers and pigments which are compatible with the fibre reinforced cement may be added. The inorganic hydraulic binder shall be either 33 grade ordinary Portland cement conforming to IS 269 or 43 grade ordinary Portland cement conforming to IS 8112 or 53 grade ordinary Portland cement conforming to IS 12269 or Portland pozzolana (fly ash based) cement conforming to IS 1489. (Part 1) or Portland pozzolana cement

(calcined clay based) conforming to IS 1489 (Part 2) or rapid hardening cement conforming to IS 8041 or Portland slag cement conforming to IS 455. Fly ash used shall be conforming to IS 3812.

Note : In case of Portland pozzolana cement and Portland slag cement, addition of pozzolanic materials and slag shall not be permitted.

12.5.1 (b) Classification – Sheets may be classified according to thickness as under :

Type A - The thickness of the sheets shall be approximately constant throughout the width of profile.

Type B - The thickness of the sheets shall vary regularly between the valley and the crown for corrugated sheets or between the lower part and the upper part of ribs for asymmetrical section sheets, in the same cross-section.

The sheets shall be categorized based on height of corrugations, 'h' and minimum thickness 'e' as under:

Category and Class (Minimum Breaking Load N/m)

Category	*Minimum Thickness e (mm)*	*Class*									
		1	2	3	4	5	6	7	8	9	10
A (15 mm < h < 55 mm)	3	600	800	1000	1400	-	-	-	-	-	-
B (25 mm < h < 55 mm)	4	-	-	1000	1400	2000	2500	3300	-	-	-
C (40 mm < h < 80 mm)	4.5	-	-	-	1400	2000	2500	3300	4250	-	-
D (60mm < h < 150 mm)	5.5	-		-	-	-	-	3300	4250	5600	7400

12.5.2 Slope

The roof shall not be pitched at flatter slope than 1 vertical to 5 horizontal. The normal pitch adopted shall usually be 1 vertical to 3 horizontal.

12.5.3 Laying

12.5.3.1 The sheets shall be laid on the purlins and other roof members as indicated in the working drawings or as instructed by the Engineer-in-Charge.

12.5.3.2 The maximum spacing of purlins under the sheets shall be 1.40 metres in the case of 5.5 mm thick sheets and these shall in no case be exceeded. Ridge purlins shall be fixed at 75 mm to 115 mm from the apex of the roof.

12. 5.3.3 The top bearing surfaces of all purlins and of other roof members shall be in one plane so that the sheets when being fixed shall not require to be forced down to rest on the purlins. The finished roof shall present a uniform slope and the line of corrugations shall be straight and true. The sheets shall be laid with the smooth side upwards

12.5.3.4 The sheets shall be laid with a side lap of half a corrugation and an end lap of 15 cm minimum in the case of roofs with a pitch flatter than 1 vertical to 2.5 horizontal (approx. 22 degree) or in the case of very exposed situations, the minimum permissible end lap shall be 20 cms. Side laps should be laid on the side facing away from the prevailing monsoon winds.

12.5.3.5 The free overhang of the sheets at the eaves shall not exceed 30 cm. Corrugated sheets shall be laid from left to right starting at the eaves. The first sheet shall be laid uncut but the remaining sheets in the bottom row shall have the top left hand corners cut or mitred. The sheets in the second and other intermediate rows except the first and the last sheets, shall have both the top left hand corner and bottom right hand corner cut. The last or top row sheets shall all have the bottom right hand corner cut with the exception of the last sheet which shall be laid uncut. If for any reason such as on considerations of the direction of prevailing winds, laying is to be started from the bottom right hand corner, then the whole procedure should be reversed.

12.5.3.6 The 'Mitred' described above is necessary to provide a snug fit where four sheets meet at a lap. It is cut from a point 15 cm (or whatever the length of the end lap may be) up the vertical side of the sheet to a point 5 cm along the horizontal edge. This cutting may be done with an ordinary wood saw at site.

12.5.4 Fixing

12.5.4.1 Sheets shall be secured to the purlins and other roof members by means of 8 mm diameter polymer coated iron J or L hook bolts and nuts. While, J hooks are used for fixing to angle iron purlins, L hooks are used for fixing to R.S. joists, timber or precast concrete purlins.

The grip of the J or L hook bolt on the side of the purlin shall not be less than 25 mm. Each iron J or L hook bolt shall have a bitumen washer and a galvanised iron washer placed over the sheet before the nut is screwed down from above. On each purlin there shall be one hook bolt on the crown adjacent to the side lap on either side. Bitumen washer shall be of approved manufacture. Galvanising of washers shall be as provided in para 12.1.4.8. Polymer coating of hooks, bolts and nuts shall be as per IS code 14871.

12.5.4.2 The G.I. flat washer shall be 25 mm in diameter, 1.6 mm thick and the bitumen washer shall be 35 mm in diameter and 1.5 mm thick. The length of J bolt or crank bolt shall be as specified in Table 12.2 below.

TABLE 12.2

S.No.	*Situation*	*No. of Bolts & Washers*	*Length of Bolts*
1.	At horizontal (end) laps of Sheets. At eaves when filler pieces are used. At ridge when sheets and ridge pieces are secured by the same bolt.	Twice the No. of sheets in one horizontal course.	Depth of purlin plus 90 mm.
2.	At eaves when filler pieces are not used. At ridge when corrugated sheets and ridge pieces are not secured by the same bolt.	Twice the No. of sheets in the horizontal course.	Depth of purlin plus 75 mm.
3.	At intermediate purlins where horizontal laps do not occur.	Twice the No. of sheets in the horizontal course.	Depth of purlin plus 75 mm.

12.5.4.3 Each nut shall be screwed lightly at first. After a dozen or more sheets are laid, the nuts shall be tightened to ensure a leak proof joint.

12.5.4.4. Holes for hook bolts etc. shall be drilled and not punched, always through the crown of the corrugation and not in valleys, in locations to suit the purlins while the sheets are on the roof in their correct position. The diameter of holes shall be 2 mm more than the diameter of the fixing bolts. No hole shall be nearer than 40 mm to any edge of a sheet or any accessory.

12.5.4.5 Roof ladders or planks shall always be used when laying and fixing the sheets, to avoid damage to the sheets, and to provide security to the workmen.

12.5.5 Wind Ties

Wind ties may be provided where the situation justify their provision. These shall be of 40 × 6 mm flat iron section or of other size as specified. These shall be fixed at the eave ends of the sheets. The fixing shall be done with the same hook bolts which secure the sheets to the purlins. Wind ties shall be paid for separately unless described as included in the items of the roof work.

12.5.6 Finish

The completed roof shall present a neat and uniform appearance and be leakproof.

12.5.7 Measurements

12.5.7.1 Length and breadth shall be measured correct to a cm and its area shall be calculated in square metres correct to two places of decimal.

12.5.7.2 The superficial area of roof coverings shall be measured on the flat without allowance for laps and corrugations. Portions of roof covering overlapping the ridge or hips etc. shall be included in the measurements of the roof.

12.5.7.3 Roof with curved sheets shall be measured and paid for separately. Measurements shall be taken on the flat and not girthed. The breadth of the roof shall be measured along the rest of the curved sheets.

12.5.7.4 No deductions in measurements shall be made for opening upto 0.4 sqm and nothing extra shall be allowed for forming such opening. For any opening exceeding 0.4 sqm in area, deduction in measurements for the full opening shall be made and in such cases the labour involved in making these openings shall be paid for separately. Cutting across corrugation shall be measured on the flat and not girthed.

12.5.8 Rate

The rate shall include the cost of all the materials and labour involved in all the operations described above except otherwise stated. This includes the cost of roof sheets, polymer coated or L hook, bolts and nuts, bituminous and galvanised iron washers.

12.6 NON-ASBESTOS REINFORCED BY ORGANIC FIBRES AND/OR INORGANIC SYNTHETIC FIBRES CEMENT SEMI-CORRU-GATED SHEET ROOFING

12.6.1 Non Asbestos reinforced by organic fibres and/or inorganic synthetic Cement Semi Corrugated Sheets

These shall be of the specified thickness and of approved quality and shall conform to IS 14871 they shall be free from cracks, chipped edge corners or other damages.

12.6.2 Laying

The specifications for laying shall be the same as described in 12.5.3 except that (a) the sheets shall be laid with the end stamped 'Top' on the smooth side pointing towards the ridge, (b) the sheets shall invariably be laid from right to left starting at the eaves with the procedure for mitring etc. described under 12.5.3.5 and 12.5.3.6 reversed, (c) the side laps provided will be of one corrugation, the left hand small corrugation of each sheet being covered by the right hand large corrugation of the next sheet and
(d) asbestos cement expansion joints shall be inserted every 45 metres or so in the length of the roof. Specially manufactured expansion joint pieces shall be used for the purpose. The end lap of expansion joints shall not be less than 150 mm. If the expansion joints may be between the purlins, these should be stitched with seam bolts.

12.6.3 Fixing

The specifications shall be same as described in 12.5.4 except that along each line of purlin there shall be a hook bolt in every vertical side lap corrugation and at the two verges and there shall be an

additional hook -bolt through one of the two intermediate corrugations on each sheet. When sheets are supported over intermediate purlins as in the case of length over1.40 metres for 5.5 mm thick sheets, fixing accessories are required on the intermediate purlins, through each side lap and the verges only.

The number and length of bolts and number of bitumenous felt and galvanised iron washers are given in Table 12.3.

TABLE 12.3

S.No.	*Situation*	*No. of Bolts & Washers*	*Length of Bolts*
1.	At horizontal (end) laps of Sheets. At eaves when filler pieces are used. At ridge when sheets and ridge pieces are secured by the same bolt.	Short bolts: The number of sheets in one horizontal course plus two Long bolts: The number of sheets in one course less one.	Depth of purlin 75 mm Depth of purlin plus 90 mm.
2.	At eaves when filler pieces are not used. At ridge when sheets and ridge pieces are not secured by the same bolt.	Twice the No. of sheets in one horizontal course plus one.	Depth of purlin plus 75 mm.
3.	At intermediate purlin when horizontal laps do not occur.	The No. of sheets in one horizontal course plus one.	Depth of purlin plus 75 mm.

12.6.4 Wind Ties & Finish

The specifications shall be as described in 12.5.5 and 12.5.6.

12.6.5 Measurements

It shall be as described in 12.5.7 in addition, the end lap of the sheets under asbestos cement expansion joints where provided shall also be included in measurements. Gap between the sheets under expansion joint shall not be measured. The expansion joint sheets shall be measured for the finished work correct to one cm.

12.6.6 Rate

The rate shall include the cost of all the materials and labour involved in all the operations described above except otherwise stated. This includes the cost of roof sheets, polymer coated J or L hook bolts and nuts, bituminous and galvanised iron washers.

12.7 RIDGES AND HIPS OF NON-ASBESTOS REINFORCED BY ORGANIC FIBRES AND/OR INORGANIC SYNTHETIC FIBRES CEMENT (FIG. 12.4)

12.7.0 Ridges and hips shall be of the same manufacture as the corrugated or semi-corrugated sheets used for roof, unless specifically permitted in writing by the Engineer-in-Charge. The sections shall be free from cracks, chipped edges or corners or other damages.

Ridges shall be of the type specified in the item, such as:

1. One piece plain angular.
2. Serrated or plain wing adjustable.
3. Close fitting adjustable.
4. Northlight adjustable and appropriate for the corrugated or semi-corrugated roof which is to be covered 'Plain Wing Angular' type ridges can be used only if the slope of the roof is exactly 30 degree. Hips shall be of 'under-rated adjustable for hips' sections.
5. Un-serrated adjustable.

12.7.1 Laying

The ridge sections shall be laid as per manufacturers instructions with the rolls of the two wings in the case of adjustable ridges fitting closely and with the serrations of serrated ridges registering correctly with the sheets underneath. The stagger lapping or two wings of an adjustable ridge section and the laps between adjacent pieces on the same wing of the ridges shall be as per manufacturers instructions. The end portions of the wings of the adjustable ridges which project beyond the verges of the roof shall be cut and trimmed off neatly. Asbestos cement expansion joint ridge pieces shall be provided every 45 metres (approx.) of ridge where the latter is of the semi-corrugated serrated adjustable type.

In laying hip pieces, serrations to suit the corrugations in the sheets below should be cut in them so that they will be a snug fit over the sheets.

12.7.2 Fixing

12.7.2.1 The wings of ridges shall be fixed to the sheets below with the seam bolts and nuts 8 mm diameter polymer coated J or L hook bolts and nuts and bitumen and G.I. washers which fix the sheets to the purlins. In additions, in northlight adjustable ridges the curves of the two wings shall be joined together at their crown with 8 mm dia polymer coated seam bolts and nuts, at the rate of 2 numbers per pair of wings. Each seam bolt shall be provided with one bitumen and a pair of G.I. washers.

12.7.2.2 Where 'Plain wing angular' or 'Plain wing adjustable' ridges are used, the gaps formed by the roofing corrugations and the wings shall be filled with cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 12.5 mm nominal size) upto the full length of the overlap. The exposed face shall be finished perpendicular to the sheeting.

12.7.2.3 Wing of hips shall be fixed to the roof members below with the same 8 mm dia polymer coated or L hook bolts and nuts which fix the sheet to those members. In addition, they shall be secured to the sheets below with 8 mm dia polymer coated seam bolts, nuts and washers, so that taken together with hook bolts there shall be bolt on each wing atleast every fifth corrugation of the sheet below in the case of 'Corrugation' and at least every second corrugation of the sheet below in the case of 'semi-corrugated' sheets. The seam bolts shall each be provided with one bitumen and a pair of G.I. washers.

12.7.3 Measurements

The measurements for ridges and hips shall be taken for the finished work along the centre line of the ridge and hip lines in length, correct to a cm. The laps in adjacent ridges or hip pieces shall not be measured. The underlay of ridges under expansion joint pieces where the latter are provided shall however be measured.

12.7.4 Rate

The rate shall include the cost of all materials and labour specified above, but does not include (a) the cost of required polymer coated hook bolts and nuts and their washers, (b) the cost of supplying and fixing expansion joint pieces, (c) the cost of closing the gaps between plain ridge and the sheet corrugations with concrete. Item (a) above will be covered by the rate for the non-asbestos cement sheet roofing while items (b) and (c) will be paid for separately unless specifically included in the description of item of the ridge or hip item.

12.8 OTHER ROOFING ACCESSORIES OF NON-ASBESTOS REINFORCED BY ORGANIC FIBRES AND/OR INORGANIC SYNTHETIC FIBRES CEMENT (FIG. 12.5)

12.8.1 Accessories

The other accessories that may be required to be used on a roof are (a) finishing pieces, eaves filler pieces, northlight and ventilator curves, barge boards and expansion joint sheets (b) ridge finials, cowl type ventilators, curved boards for northlight, curves, roof light expansion joints for ridge and expansion

joints for northlight curves and (c) 'S' type louver. The accessories shall be of the type appropriate for use with corrugated or semi corrugated sheets which form the roofing.

The accessories shall be of the same manufacture as the corrugated or semi -corrugated sheets used for the roof. The pieces shall be free from cracks, chipped edges or corners and other damages.

12.8.2 Laying & Fixing

These shall be laid and secured with the same polymer coated hook bolts which secure sheets to the roof members below where possible or with separate polymer coated hook bolts to the roof members below and/or with 8 mm dia polymer coated seam bolts, nuts and washers to the sheeting, generally as per manufacturers printed instructions and as ordered by the Engineer-in-Charge. 'S' type louvers shall be fixed to ventilators to timber, M.S. angle or flat iron verticals spaced not more than 1.65 metre centres. The laps of adjacent pieces over the verticals shall not be less than 10 cm. The upper flat of the top most row of louvers shall be fixed to the vertical by 10 mm dia polymer coated bolts and nuts and bitumen and polymer coated washers.

The lower flats of the top and intermediate rows of louvers and the flat of the louvers pieces below shall be secured together to the verticals behind by 10 mm dia G.I. separating bolts threaded at both ends and of suitable length. Each of these bolts shall be equipped with 2 pair of nuts, G.I. and bitumen washers. The louver flats of the lowest line of louvers shall also be fixed to the verticals at the proper distance from the same by the use of similar separating bolts and nuts.

12.8.3 Measurements

The accessories listed under group (a) in 12.8.1 shall be measured for finished work in length correct to a cm. Laps between adjacent pieces shall not be measured.

The accessories listed under group (b) in 12.8.1 shall be measured and paid for in number. This applies in the case of finial too where the unit shall consist of a pair of inter locking pieces.

The 'S' type louvers listed under group (c) in 12.8.1 shall be measured for the finished work in length of each row of louvers correct to a cm. The laps, between adjacent pieces of louvers will not be taken into account in the measurements.

12.8.4 Rate

12.8.4.1 The rates for supplying and fixing, non-asbestos cement accessories listed in groups (a) & (b) of 12.8.1 shall include the cost of all materials and labour involved in all the operations described above bolts, nuts, washers and other fixing accessories but does not include the members.

12.8.4.2 The rate for supplying and fixing roof lights shall not unless otherwise described in the item, include the glazing which shall be paid for separately.

12.8.4.3 The rate for supplying and fixing 'S' type louvers shall include all fixing accessories such as ordinary and separating polymer coated bolts, nuts, and bitumen washers including drilling the holes for the same in the vertical supporting member behind but shall not unless otherwise described in the item the cost of supplying and fixing the supporting members which shall be paid for separately.

12.9 EAVES AND VALLEY GUTTERS OF NON-ASBESTOS REINFORCED BY ORGANIC FIBRES AND/OR INORGANIC SYNTHETIC FIBRES CEMENT (FIG. 12.6)

12.9.1 Gutters and Accessories

Eaves gutters shall be of the type specified in the item such as (1) plain ended eaves, (2) boundary wall, (3) socketed eaves ogee and (4) socketed half round. These shall be of standard size as stipulated in the item. Valley gutters shall be of the 'Plain' ended valley types and of size as stipulated in the item.

These shall be of approved manufacture, approved by the Engineer-in-Charge. The gutter sections and their accessories such as drop ends, stop ends, nozzles, angles and union clips shall be free from cracks, chipped edges or corners and other damages.

12.9.2 Laying and Fixing

12.9.2.1 Gutters shall be laid with a minimum slope of 1 in 120, which should be increased where possible. Gutters shall be true to line and slope and shall be laid with the requisite accessories such as drop ends, stop ends, nozzles, angles and union clips as shown in the working drawing or as ordered by the Engineer-in-Charge.

12.9.2.2 The size of outlet of drop ends and nozzles shall be of the same size as the size of the rain water pipes into which they shall be discharging the water.

12.9.2.3 Gutters and their accessories shall be supported by M.S. flat iron bracket. Where these brackets are to be fixed to the sides of rafters, they shall be of 40 x 3 mm section bent to shape and fixed rigidly to the sides of the rafter with 3 Nos. 10 mm diameter bolts, nuts and washers. The brackets shall overlap the rafter not less than 30 cm and the connecting bolts shall be 11.5 cm centres.

12.9.2.4 Where the brackets are to be fixed to the purlins they shall consist of 50 × 3 mm M.S. flat iron bent to shape with one end turned at a right angle, and fixed to the purlin face with a 10 mm dia bolt, nut and washer. The perpendicular over hang portion of 50 × 3 mm bracket shall be stiffened by another 50 × 3 mm flat, bent to right angle shape with its lower leg connected to the bracket with 2 Nos. 6 mm dia M.S. bolts, nuts and washers and its shorter leg fixed to face of purlin with one number 10 mm dia bolt, nuts and washers. The overhang of the vertical portion of the flat iron bracket from the face of the purlin shall not exceed by 22.5 cm with this arrangement.

12.9.2.5 The requisite slope in the gutters shall be given in the line of the bracket. The brackets shall be placed at not more than 90 cm centres.

12.9.2.6 The gutters shall be fixed to the brackets with 2 Nos. 8 mm dia polymer coated seam bolts and nuts, each bolt and nut being equipped with a pair of bitumen and polymer coated washers. These connecting bolts shall be above the water line of the gutters.

12.9.2.7 Spigot and socket ends of gutters of 'socketed eaves ornamental' or 'socketed half round' type and their accessories shall be connected together at their laps with one row of 8 mm dia polymer coated bolts and nuts, each bolt and nut being provided with a pair of bitumen and a pair of polymer coated washers. The gap between the socket and spigot shall be packed with approved plastic roofing compound, flanked on both sides with 6 mm dia non-asbestos rope. The connecting polymer coated bolts are then tightened so that the lapped joints become leak proof. The outer faces of the packed non-asbestos rope shall not be farther than 6 mm from the edges of the spigot and socketed ends.

12.9.2.8 Where both ends of gutters and or their accessories to be connected together are of spigot ends they shall be laid as butt joints with 1.5 mm gap in between over union clips (loose socket pieces). The union clip shall be connected to the two butt ends of the gutter or other section on both ends with two rows (one row per ends) of 8 mm dia polymer coated bolts and nuts, each bolt and nut being provided with a pair of bitumen and a pair of G.I. washers. The gap between the union clips and the butt ends of the gutter sections or accessories shall be packed with approved plastic roofing compound flanked at both edges by 6 mm dia non-asbestos rope as before. The whole joint shall be made leak proof by tightening the bolts.

12.9.2.9 The ends of 'Plain' ended eaves or boundary wall type and 'Plain' ended valley type gutters and their accessories shall be laid with butt joints over union clips and connected together in the same manner as for connecting spigot and socket ends described in the preceding sub-para.

12.9.2.10 The number of connecting bolts, nuts and washers and the quantities of 6 mm diameter non-asbestos rope and plastic roofing compound required per spigot socket of 'ornamental' and 'half round' gutters of different sizes and butt joint of plain ended 'Boundary wall or eave' and 'valley' type gutters of different sizes shall be shown in Table 12.4.

TABLE 12.4
Jointing Materials per Joint of Gutter

Type of Gutter	*Nominal Sizes*	*6 mm dia Asbestos Rope*	*Required per joint*			
			Plastic Roofing Compound	*8 mm dia nuts and bolt*	*G.I. Washer 25mm dia*	*Bitumen Washer 25mm dia*
Socketed ornamental	125 mm	0.57 m	170 g	1 No. 45 mm long	2 Nos	2 Nos
Socketed ornamental	200 mm	0.98 m	255 g	3 Nos. 45 mm long	6 Nos	6 Nos
Socketed half round	150 mm	0.57 m	170 g	1 No. 45 mm long	2 Nos	2 Nos
Socketed half round	250 mm	0.92 m	567 g	3 Nos. 45 mm long	6 Nos	6 Nos
Socketed half round	300 mm	1.07 m	709 g	3 Nos. 45 mm long	6 Nos	6 Nos
Plain ended boundary wall or eaves	275 × 125 × 175 mm	0.97 m	737 g	8 Nos. 40 mm long	16 Nos	16 Nos
Plain ended boundary wall or eaves	300 × 150× 225 mm	1.15 m	850 g	8 Nos. 50 mm long	16 Nos	16 Nos
Plain ended boundary wall or eaves	450 × 150 × 300 mm	1.38 m	1020 g	8 Nos. 50 mm long	16 Nos	16 Nos
Plain ended boundary wall or eaves	500 × 150× 250 mm	1.43 m	1049 g	10 Nos. 50 mm long	20 Nos	20 Nos
Plain ended valley	400 × 125× 250 mm	1.12 m	850 g	8 Nos. 50 mm long	16 Nos	16 Nos
Plain ended valley	50 × 125	1.12 m	850 g	8 Nos. 50 mm long	16 Nos	16 Nos
Plain ended valley	600 × 150× 225 mm	1.48 m	1105 g	8 Nos. 50 mm long	16 Nos	16 Nos
Plain ended valley	900 × 200× 225 mm	2.08 m	1531 g	12 Nos. 50 mm long	24 Nos	24 Nos

12.9.3 Finish

The gutters and accessories when fixed shall be true to line and slope and shall be ridged. All the joints shall be leak proof.

12.9.4 Measurements

The measurement of gutters shall be taken for the finished work in length correct to a cm along the centre line of the gutters. The measured length of the finished gutters will include the length over accessories such as drop ends, stop ends, nozzles and angles, though the rate for the same shall not include the cost of the accessories unless specially described in the item. Laps between the adjacent pieces of gutter and gutter section or between gutter section and accessories shall not be measured.

Accessories such as drop ends, stop ends, nozzles and angles shall be measured and paid for separately.

Union clips (loose sockets) shall not be measured separately as they are included in the rate for gutters.

12.9.5 Rate

The rate for the gutters shall not, unless otherwise specified in the description of item, include the cost of providing and fixing accessories such as drop ends, stop ends, nozzles and angles. The rate shall include the cost of providing and fixing all union clips (loose sockets), all connecting G.I. bolts, nuts and bitumen and G.I. washers, M.S. flat iron brackets and their fixture to the gutter sections and to the roof members, non-asbestos rope and plastic roofing compound.

Extra over the rate for the gutter shall be paid for providing and fixing accessories, stop ends, drop ends, angles and nozzles. Where brackets of 50 × 3 mm size are provided in place of brackets of 40 × 3 mm size as indicated in para 12.9.2.4 extra rate will be paid for separately.

12.10 PAINTING OF ROOF SLAB WITH HOT BITUMEN

12.10.1 Preparing the Surface

The surface shall be painted only when it is thoroughly dry. The surface to be painted shall be cleaned with wire brushes and cotton or gunny cloth. All loose materials and scales shall be removed and the surface shall be further cleaned with a piece of cloth lightly soaked in kerosene oil.

12.10.2 Painting with Bitumen

12. 10.2.1 The contractor shall bring the bitumen to site in its original packing and shall open and use it in the presence of the Engineer-in-Charge or his authorised representative. The containers shall not be removed from the site until the painting job is completed and the Engineer-in-Charge has satisfied himself regarding the quantity of bitumen actually used and has given his permission to remove the empty containers.

12.10.2.2 The surface prepared and treated shall be painted uniformly with bitumen of approved quality such as residual type petroleum bitumen of penetration 80/100, hot cut back bitumen or equivalent as per specifications of the manufacturer. The coat of bitumen shall be continued 15 cm along the vertical surfaces joining the roof. In case of parapet walls it shall be continued upto the drip courses.

12.10.2.3 Residual type petroleum bitumen of penetration 80/100 shall be heated to a temperature of not less than 180 degree C and not more than 190 degree C and shall be applied on the roof surface at not less than 180 degree C. Similarly, hot cut back bitumen shall be heated to a temperature of not less than 165 degree C and not more than 170 degree C and shall be applied on the surface at not less than 165 degree C.

12.10.2.4 Care shall be taken to see that no blank patches are left. The quantity of bitumen to be applied per 10 square metres of roof surface shall be 17 kg, unless otherwise stipulated in the description of the item. It shall be carefully regulated so that the application is uniform at the stipulated rate of 17 Kg. per 10 square metres.

12.10.3 Spreading Sand

Immediately after painting, dry, clean sharp coarse sand at the rate of 60 cubic decimeter per 10 sqm. shall be evenly spread and levelled over the surface when the bitumen is still hot.

12.10.4 Measurements

The superficial area of the surface painted shall be measured in square metres. No deduction in measurements shall be made for unpainted areas of roof slab occupied by chimney stacks, roof lights etc. of areas, each upto 40 sq. decimetre. The measurements of length and breadth shall be taken correct to a cm.

12.10.5 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above.

12.11 MUD PHUSKA TERRACING WITH BRICK TILE PAVING

12.11.1 Mud Phuska

For mud phuska, selected soil which should be a good quality earth suitable for making bricks not containing excessive clay or sand, free from stones, kankar, vegetable matter and other foreign matter, shall be collected and stacked at site. The soil shall not be collected from a locality infested with white ants. Before laying on the roof, the soil shall be made damp by adding water about 12 hours earlier. It shall be turned over with phawaras so as to break clods and to pulverise the same. Quantity of water to be added to the soil shall be carefully regulated so that the soil shall have optimum moisture content at the time of laying and compaction on the roof. The soil shall be laid on the roof to requisite thickness and slope, well compacted with wooden rammers and thappies, to obtain an even surface to correct slope. Average thickness of soil after compaction shall be as specified for the item.

Note: A practical way of determining the moisture content of soil suitable for giving good compaction is that the soil should contain that much quantity of moisture, which when a handful of soil is moulded with hand to the shape of a ball, it shall just retain its form. If the soil on moulding cannot retain its shape of a ball, moisture content is inadequate. On the other hand, if the ball can be plastically deformed on pressing with hand, the moisture content is on the high side.

12.11.2 Mud Plaster

After laying the mud phuska, the surface shall be given a coat of mud plaster 25 mm thick and the plaster shall be allowed to dry and crack.

The mud plaster shall be prepared from the same soil as for mud phuska. The dry soil shall be reduced to fine powder and mixed with water in a pit, adding fibrous reinforcing materials such as chopped straw (Bhusa) in proportion of 35 kg per cum of soil. The mixture shall be allowed to mature for a period of not less than 7 days. During this period it shall be worked over with feet and spades (Phawaras) at intervals so as to get pugged into a homogeneous mass free from lumps and clods. The mud mortar shall be puddled again very thoroughly just before use.

The consistency of mud mortar shall be checked by taking it on a trowel and observing how it slides off the face of trowel. The mortar shall readily slide off the trowel and should not be so wet as to part on to large drops before falling. Alternatively slump test may be performed in accordance with IS 1199. The slump should be about 70 mm.

12.11.3 Gobri Leaping

After the mud plaster has dried, the surface should be given a coat of gobri leaping so as to completely fill any crack that may have formed in the mud plaster. Mortar for gobri leaping shall be prepared by mixing equal quantities of fresh gobar and finely sieved clay and adding sufficient water to form a thin paste. The quantity of gobar used in gobri leaping shall not be less than 0.03 cum per 100 sqm of plaster area. Five percent of cut back bitumen by mass of dry clay may be added to improve upon the water proofing qualities.

12.11.4 Laying of Bricks Tile

After the gobri leaping has dried, brick tiles shall be laid using the minimum amount of plain mud mortar (without bhusa) as bedding so as to obtain correct slope and even surface of tile floors. Care shall be exercised to see that mud mortar does not rise into the vertical joints of the tiles more than 12 mm. The brick tiles shall be either flat tile bricks of class designation 100 or machine moulded tile bricks of class designation 125 conforming to IS 2690 (Prt I) as per the nomenclature of the item. The tiles shall be laid such that the thickness of joints shall not be less than 6 mm and more than 12 mm in width. After the tiles are well set and bedding mortar has dried, joints of the tiles shall be grouted with cement mortar of mix 1:3 (1 cement : 3 fine sand) such that all the joints of tiles are completely filled with mortar and the

joints should be finished neat. Cement used for the mortar shall be mixed with 2% of integral water proofing compound which should conform to IS 2645.

12.11.5 Curing

As soon as cement grouting obtains initial set, the surface of the brick tile floor shall be covered with wet gunny bags, hessian cloth or wet sand to prevent quick drying. After 8- 12 hours, the brick tile floor shall be cured by frequent sprinkling of water on the surface for a period of 7 days. After curing has been done, the surface shall be swept clean.

The tile surface as completed shall be even and true to slopes of 1 in 48 or as specified and should be leak proof.

Note: When surplus earth of a suitable quality exists at the site of work, the contractor shall be allowed to use the same free of cost for laying the mud terracing, mud plaster and gobri leaping on the top. The Engineer-in-Charge shall be the final authority to decide whether the earth obtained from excavation is surplus to the requirements at site and is suitable for mud phuska work.

12.11.6 Measurements

Length and breadth shall be measured correct to a cm. The measurements shall be taken for the finished work, (mud phuska terracing of stipulated thickness with mud plaster, gobri leaping and tile paving and grouting) over the tiled surface, in superficial area.

No deductions in measurements shall be made for either openings or recesses for chimney stacks, roof lights or khurras, of area upto 0.40 sqm. No extra shall be paid either for any extra materials or labour involved in forming such openings, recesses etc. For areas exceeding 0.40 sqm deductions will be made in the measurements for the full opening but extra shall be paid for any extra labour, materials etc. in forming such openings.

For plus or minus deviation from the average thickness stipulated for the mud phuska in the item, payments will be adjusted in the rate admissible to the contractor for the relevant schedule item provided that such deviations were authorised by the Engineer-in-Charge in writing.

12.11.7 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above.

12.12 PAVING OVER MUMTY ROOFS WITH BRICKS TILE

12.12.0 The roofs shall be paved with bricks tile laid flat and grouted with cement mortar.

12.12.1 Bricks Tile

These shall conform to the specifications detailed in subhead 6.0 of masonry work

12.12.2 Cement Mortar

The cement mortar shall be of 1:3 mix (1 cement : 3 fine sand) unless otherwise specified in the description of the item and shall conform to the specifications described in subhead 3.0 of Mortars.

12.12.3 Preparing the Surfaces

The surface shall be hacked, roughened and cleaned of all dust and other foreign matter. It shall then be wetted before applying the mortar.

12.12.4 Paving and Grouting

Cement mortar shall be spread in 12 mm layer over the surface evenly to required slope. Brick tiles which had been soaked as in brick work in water for at least an hour before hand shall then be laid open

jointed and flat on the mortar and lightly pressed, and set to plane surface true to slopes etc. using a trowel and wooden straight edge. The brick tiles shall be laid with their joints not more than 10 mm wide. They shall be laid with their longitudinal lines of joints truly parallel and horizontal and at right angles to the sloping edges of the roof.

Transverse joints in alternate rows should come directly in line with one another. Transverse joints in adjacent courses shall not have distance by less than 5 cm. As soon as the paving is done, the open joints shall be grouted with cement mortar 1:3 (1cement : 3 fine sand) . Cement used for grouting mortar shall be mixed with 2% (by unit of cement) water proofing compound conforming to IS 2645. Care shall be taken to see that no joints are left unfilled or inadequately filled. The joints shall be finished flush with the brick surface.

12.12.5 Curing

The tile paving shall be cured for at least 7 days during which period it shall be suitably protected from damage.

12.12.6 Measurements

Length and breadth shall be measured correct to a cm. Measurements shall be taken for the finished work in superficial area covered.

No deduction in measurement shall be made for either openings or recesses for chimney stacks, roof lights, or for khurras, for areas upto 0.40 sqm nor extra shall be paid for forming such openings.

For similar areas exceeding 0.40 sqm deduction shall be made in measurements for all openings but nothing extra shall be paid for forming such openings.

12.12.7 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above.

12.13 CEMENT CONCRETE GOLA (FIG. 12.7)

12.13.1 Cement Concrete

The specifications for concrete shall be the same as described in subhead 4.0 of concrete work.

12.13.2 Gola

A chase of 75 mm wide and 75 mm deep shall be cut in the parapet wall just above the junction of mud phuska or lime concrete with parapet wall and it shall be filled with cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 stone aggregate 10 mm and down gauge) the external face finish with a slope of 1 : 0.75 and the exposed surface of the gola shall be plastered with cement mortar 1 : 3 (1 cement : 3 fine sand).

Expansion joint at every 3.5 to 4.5 metres shall be provided and filled with bitumen filler. The bitumen filler shall be prepared by mixing bitumen, cement and coarse sand in the ratio of 80 : 1 : 0.25 (80 kg of hot bitumen : 1 kg of cement and 0.25 cum of coarse sand).

12.13.3 Curing

The finished surface shall be cured for at least 7 days.

12.13.4 Measurements

The length of the finished gola shall be measured at its junction with the wall face correct to a cm. No deduction shall be made in measurements for gaps for water outlets.

12.13.5 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above including the cost of bitumen filler in expansion joint. The rate includes for all turnings and roundings at all the corners and risers.

12.14 KHURRAS (FIG. 12.7)

12.14.0 The khurras shall be constructed before the brick masonry work in parapet wall is taken up and it shall be of size 45 cm x 45 cm unless otherwise specified in the description of the item and shall be made of cement concrete 1:2:4 mix (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size) or other mix as stipulated in the description of the item.

12.14.1 Laying

12.14.1.1 A PVC sheet of size 1 m x 1 m x 400 micron (alternatively, aluminium foil of 32 SWG) shall be laid under the khurra and then cement concrete shall be laid over it to average thickness of 50 mm with its top surface lower than the level of adjoining roof surface by not less than 50 mm.

12.14.1.2 The concrete shall be laid to a size greater than the stipulated size of the khurra in such a way that the adjoining terracing shall overlap the concrete on its three edges by not less than 7.5 cm. The concrete will slope uniformly from the edges to the outlet, the slope being as much as possible and in no case less than 20 mm cement concrete at the outlet. The concrete shall be continued at the same slope through the width of the wall into the outlet opening to ensure a water tight joint.

12.14.1.3 The khurras and the sides of the outlet shall then be rendered with 12 mm coat of cement plaster 1:3 mix (1 cement : 3 coarse sand) or other mix as stipulated in the description of the item. This shall be done when the concrete is still green and shall be finished. The sides of the khurras and sides of the outlet opening shall be well rounded. The size of the finished outlet opening shall be 10 cm wide and by 20 cm high or as directed by the Engineer-in-Charge.

12.14.1.4 In cases where rain water is to be disposed off through rain water pipes, iron grating shall be provided at the outlet as a safeguard against choking, if so directed by the Engineer- in- Charge. Iron gratings, shall be of overall size 20 × 25 cm. with an outer frame of 15 × 3 mm M.S. flat to which 4 Nos M.S. bars of 10 mm dia shall be welded in a vertical direction keeping equal clear spacing of 2.5 cm. or as directed by the Engineer in Charge.

12.14.2 Measurements

Khurras shall be counted in numbers.

12.14.3 Rate

The rate is for each completed khurra of the specified size and is inclusive of the cost of all materials and labour in forming the khurras and outlet opening as described above, except for iron gratings which shall be paid for separately.

12.15 RED OR WHITE SAND STONE ROOFING

12.15.1 Sand Stone Slabs

The stone slabs shall be hard, even, sound and durable and shall conform to standards as detailed in subhead 7.0 of stone work. Slabs shall have been sawn or chiselled in a plane parallel to the natural bed of the stone. The slabs shall be rough chisel dressed on the top so that the dressed surface shall not be more than 6 mm from a straight edge placed on it. The edges of the depressions or projections shall be chisel dressed in a slant, so that surface does not have sharp unevenness. The sides shall also be chisel dressed to a minimum depth of 20 mm so that the dressed edges shall at no place be more than 3 mm from a straight edge butted against it. The thickness of the slab shall be uniform and as

specified in the item with a permissible tolerance of 2 mm. The slabs shall be uniform in length, the length being 5 to 8 mm less than the centre to centre spacing of the supporting wooden Joists (Karries) or RCC battens. Unless the design require some other shape the slabs shall be rectangular.

The width of the slabs may vary unless otherwise stipulated. It shall not be less than 40 cm.

12.15.2 Rafter Spacing

The maximum spacing of rafters (karries) or RCC battens supporting the slabs shall not exceed figures given in Table 12.5.

TABLE 12.5

Thickness of Slab	*Maximum Spacing of Rafters*
40 mm	52.5 cm.
45 mm	60 cm.
50 mm	68 cm.

The bearing of slabs over the supporting rafts karries shall not be less than 30 mm. Where a raft karry supports a slab from one side only, the bearing of such slab shall be for full width of the rafts. For bearing over the wall, the stone slabs shall be bedded over a layer of cement mortar 1 : 4 (1 cement : 4 fine sand) of thickness not less than 12 mm.

12.15.3 Laying

The slabs shall be washed clean and wetted before being laid. The stone slabs shall be jointed in cement mortar 1:4 (1 cement : 4 coarse sand). The width of joints shall not be more than 8 mm not less than 5 mm. The top joints shall be finished flush and ceiling joints pointed with the cement mortar 1:3 (1 cement : 3 fine sand).

12.15.4 Finish

The finished surface shall be truly levelled or slopped as shown in the plan or as directed by the Engineer-in-Charge. It shall be cleaned off all mortar droppings and cement markings both on top and on the under side.

12.15.5 Curing

The slabs and their joints shall be kept wet during progress of work and for 7 days after completion.

12.15.6 Measurements

Length and width of finished stone slab work including bearing shall be measured correct to a cm. The area shall be calculated in sqm correct up to two places of decimal.

No deduction in area shall be made for openings in roof slab for chimney, stacks, roof lights etc. of area upto 40 square decimetre nor any extra shall be paid for extra labour, materials etc. involved in cutting and wastage, in forming such openings. For openings exceeding 40 sq. decimeter in area, deduction shall be made in measurements for the full opening but extra shall be paid for extra labour, material etc. required in forming such openings.

12.15.7 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above.

12.16 WOODEN CEILING

12.16.1 Boards

12.16.1.1 Boards shall be of the class of timber and of finished thickness as specified in the description of the item and shall be in accordance with the general specifications for wood work. Only selected boards of

uniform width shall be used. Unless otherwise specified in the description of the item or shown in the drawings, the width of boards selected for use shall not be less than 100 mm nor more than 150 mm.

12.16.1.2 The specific width of boards once selected within these two limits shall be maintained through-out and shall not be varied except in the first and last lines of boards adjustment to the two walls, where remaining odd width shall be adjacent equally on both sides. The maximum length of the board in the finished work shall be 180 cm. The minimum length of board in the finished work shall be such that it will span at least two spacings of the supporting frame work except where shorter lengths are unavoidable, depending on the arrangements of the lines of heading joints which shall be carried out to the pattern ordered by the Engineer-in-Charge.

The boards shall be plained true on the exposed side.

12.16.1.3 Unless stipulated otherwise in the description of the item, the longitudinal joints of the boards shall be tongued and grooved, while the heading joints shall be of the square butt type and shall occur under the centre line of the supporting joint. Heading joints in adjacent boards shall not be placed over the same joists, those in alternate boards being arranged in the same line, except where the joints are to be concealed by headings.

12.16.2 Frame

Timber frame of the class of timber and section specified in the description of the item or as ordered by the Engineer-in-Charge shall be provided. The width of the frame scantling shall not be less than 50 mm. The arrangements and spacing of the frame scantling shall be as per design furnished. The frame shall be given two coats of approved preservative paint before the boarding is screwed. The frame and paints thereof shall be paid for separately unless specifically included in the description of the item. M.S. angles or other sections shall be used for suspending the frame and paid for separately.

The bottom surface of the frame shall be checked and corrected to true plans and slopes.

12.16.3 Mild Steel Screws

Screws shall be got approved from the Engineer-in-Charge before fixing. They shall be of the slotted counter sunk head type of length not less than the thickness of the board plus 20 mm. The designation number shall not be less than 9 for screws of length 40 to 50 mm and shall not be less than 6 for screws of length 25 to 35 mm.

12.16.4 Fixing

The outer lines of boards shall be accurately fixed, parallel and close to the wall. Each subsequent plank shall be carefully jointed up. The boards shall be fixed to the frame scantling above with two screws at each of frame and one at every intermediate joist. The screws shall be counter sunk and the screw holes filled with putty or sloping out wax.

The unexposed faces of planks shall be painted with wood preservative before fixing.

12.16.5 Finishing

The exposed side of the boards shall be truely level and plane. The joints shall be truely parallel and/or perpendicular to the walls.

Beadings shall then be fixed to the ceiling, to the size and pattern required. These shall be measured and paid for separately unless specifically included in the description of the ceiling item.

12.16.6 Measurements

Length and breadth shall be measured correct to a cm. Areas shall be worked out to nearest 0.01 sqm. The superficial area of the finished work ceiling shall be measured in square metres.

No deduction in measurements shall be made for openings of areas upto 40 square decimetre. Nothing extra shall be payable either for any extra material or labour involved in forming such openings. For openings exceeding 0.40 sqm in area, deductions in measurements for the full opening will be made and in such case any labour involved in making these openings shall be paid for separately in running metres.

Wooden ceiling of boardings fixed to curve surfaces in narrow widths shall be measured and paid for separately and shall include making the joints to proper splay.

Circular cutting and waste shall be measured and paid for separately in running metres.

12.16.7 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above.

12.17 CEILING WITH FIBRE INSULATING BUILDING BOARDS

12.17.1 Insulating Building Boards

The insulating building boards shall be of approved quality as per IS code 3348 and, unless otherwise specified, shall have square edges. The dimension shall be subjected to the tolerances given in the Table 12.6 below:

TABLE 12.6
Dimensions and Tolerances

S.No.	*Type of Board*	*Nominal Thickness mm*	*Tolerance on Thickness mm*	*Length cm*	*Width cm*	*Tolerance on length and width*
(i)	Fibre insulation board, ordinary or flame retardant type	9 12 18 25	± 0.75 ± 0.75 ± 1.00 ± 1.25	365, 300 270, 240 210,180 150,120 100, 90 60, 45 and 30	180,150 120,100 90, 60 45 and 30	120 cm and below ± 3 mm Above120 cm ± 6 mm

12.17.2 Frame

Frame of the class of timber and section specified in the description of the relevant item or as ordered by the Engineer-in-Charge shall be provided. The width of the scantlings provided shall be sufficient to provide a minimum nailing surface of 50 mm. The longitudinal and header scantlings shall be so arranged that (a) the boards can be fixed to form the panel arrangements required as per drawings or as ordered by the Engineer -in-Charge (b) the longitudinal scantling to which the boards are mainly fixed are spaced at 30 to 45 cm centres, the actual spacing selected depending on the width of the cut board in the panel arrangement, (c) all edges of the cut board units are supported either on the longitudinal scantlings or on the header scantlings or on both.

The frame shall be given two coats of approved preservative paint (to be paid for separately) before the board is nailed on. M.S. angles or other sections shall be used for suspending the frame and will be paid for separately.

Where the joints in the board are to be covered with beadings the frames should allow 3 to 6 mm for space between boards.

The frame and painting thereof shall be paid for separately unless specifically included in the description of the ceiling item.

The bottom surface of the frame shall be checked and corrected to true planes and slopes.

12.17.3 Nails

The sheets shall be fixed to the frame scantling with G.I. headless nails 2.24 mm dia when the joints are to be left exposed. Where the joints will be covered with beadings, the sheets are to be fixed to the frames scantlings with G.I. felt headed (clout) nails 2.5 mm dia. The length of the nails shall generally be equal to thickness of sheet plus 25 mm so that their grip on the framing members will not be less than 25 mm.

12.17.4 Fixing

The boards shall be laid with lengths parallel to all joints centered over the framing members. Where joints are to be covered, the boards may be spaced 3 to 6 mm apart as described in the respective manufacturers' specifications. Where joints are to be left exposed the sheets shall be butt laid with their edges abutting in moderate contact, but without having to force them into place. The boards shall be supported and held tight to the frame with timber pieces the later being moved outwards as the nailing proceeds. The boards are first nailed to the intermediate framing member proceeding from the centre of the board outwards, the edges being nailed last.

Where the joints are to be left exposed, the outer rows of nails are placed at 10 cm centres and about 12 mm from the edge of the sheet. In the rows in the middle of the sheets, the nails are placed 20 cm apart. The nails should be counter sunk in the under side of board with a suitable punch. Care shall be taken in driving the nails so that the sheets are not marked by hammer blows.

Where the joints are to be covered with beadings, felt headed (clout) nails shall be used instead of nails without head. The spacing of the nails in the interior rows in boards shall be the same as in the preceding para. In the outer rows at edges to be covered by beadings, the nails will be spaced at 20 cm centres in each row with the nails staggered. The beadings will then be fixed over the sheets with screws at 20 cm centres in each row with the screws in the two rows staggered and passing through beading, sheet and framing so that ultimately the spacing of the fixing (nails and screws taken together) in each row will be at 10 cm centres so far as the sheets and frames are concerned.

12.17.5 Finishing

The exposed side of the board shall be truely level and plane without any local bulges or sags. The joints shall be truely parallel and/or perpendicular to the walls. The width of joints shall be uniform. Care shall be taken to see that the uniformity of colour of the sheets is not spoilt during the fixing operations.

Where the joints are required to be covered, beadings of size, pattern and material as approved by Engineer-in-charge be fixed with screws. These shall, however, be measured and paid for separately, unless specifically included in the description of the ceiling item.

The ceiling shall be treated with distemper or painting if so required but such surface treatment will be paid for separately, unless specifically included in the description of the ceiling item.

12.17.6 Measurements and Rate

These shall be the same as described in 12.16.6 and 12.16.7.

12.18 PARTICLE BOARD /MULTIPURPOSE CEMENT BOARD CEILING

12.18.1 Boards

12.18.1.1 ***Particle Board :*** Particle board flat pressed 3 layers medium density shall be graded particle board grade-1 conforming to IS 3087 of specified thickness. The specifications for particle board shall be same as in sub head 9.0 of wood work and PVC work.

12.18.1.2 ***Multipurpose Cement Board :*** (High Pressure Steam cured). This shall be conforming to IS 14862 and of thickness specified in the item.

12.18.2 Frame

The specifications as described in 12.17.2 shall apply except that the maximum spacing of the longitudinal scantlings shall be 40 cm centres. The specifications for cutting and chamfering etc. will be same as in 12.17.2.

12.18.3 Nails

The specifications shall be the same as in 12.17.3.

12.18.4 Fixing

The specifications as in 12.17.4 shall apply.

12.18.5 Finishing

The specifications as in 12.17.5 shall apply except that normally no surface treatment like painting, varnishing, etc. is necessary.

12.18.6 Measurements and Rate

These shall be the same as under 12.17.6.

12.19 PLAIN/SEMI PERFORATED PARTICLE BOARD TILES CEILING

12.19.1 Frame

The frame work shall consist of anodized aluminium T sections for main runners /cross runners of size specified in the item with anodic coating of 15 micron and perimeter wall angle of anodized aluminium section of size specified by the Engineer-in- charge with anodic coating of 15 micron fixed to the wall with M.S. screws 50 mm long and PVC raw plugs. The frame work shall be executed in a manner so as to form a grid of 600 mm x 600 mm as specified in the item. The frame work shall be suspended from ceiling by level adjusting hangers made of 6 mm dia. M.S. rods fixed to slab by means of MS ceiling cleats. The ceiling cleats shall be fixed to the slab by means of mechanical dash fasteners 6 mm dia and 50 mm long. MS hangers and ceiling cleats shall be painted with a coat of yellow zinc chromate primer and two coats of synthetic enamel paint.

12.19.2 Ceiling Tiles

Ceiling tiles shall be of 12 mm plain/semi perforated or with design BWP type phenol formaldehyde synthetic resin bonded particle board conforming to IS 3087 of required size. Tiles shall be finished with a coat of aluminium primer on both side and edges and two coats of synthetic enamel paint of approved quality and shade on exposed faces of the tiles.

12.19.3 Fixing of Ceiling Tiles

The ceiling tiles shall be placed over the aluminium frame and fixed to the frame with help of 25 mm long CP brass screws with minimum 2 screws on each side of the grid. The CP brass screws shall be counter sunk star head screws.

12.19.4 Measurements

Length & breadth of the finished ceiling shall be measured correct to a centimetre. The area shall be calculated in square metre correct to two decimal places. No deduction shall be made for making openings for electrical, air conditioning, fire fighting fixtures nor shall extra payment be made either for extra materials or labour involved in making such openings.

12.19.5 Rate

The rate shall include the cost of all the materials and labour involved in all the operation described above including scaffolding etc. Aluminium frame work mentioned in para 12.19.1 will be paid for separately unless otherwise stipulated in the description of the items.

12.19A G.I. METAL TILES CEILING

12.19A.1 Frame

The frame work shall consists of G.I spring tee of specified size fixed to main C carrier with the help of suspension Brackets. The frame work shall be executed in a manner so as to form a grid of 600 mm x 600 mm as specified in the item. The pre-painted steel 'C' wall angle of size 20x30x20 mm and 0.5mm thick shall be fixed along the periphery of the room with nylon sleeves and wooden screws at 300 mm center to center. The main 'C' carrier of size 10x38x10 mm made of G.I steel 0.7 mm thick shall be fixed with cleats of size 37x27x25x1.6 mm and rawl plugs of size 38x12 mm.

12.19A.2 Ceiling tiles

Ceiling tiles shall be of G.I metal plain beveled of specified white color of size 600x600 mm and 0.5 mm thick with 25 mm height made of G.I. sheet having galvanizing of 100 gms/sqm and electro statically polyester powder coated of minimum 60 microns thickness including factory painted after bending with or without perforation.

12.19A.3 Fixing of ceiling tiles

The ceiling tiles shall be placed over the G.I frame and clip-in with frame.

12.19A.4 Measurements

These shall be the same as under 12.19.4.

12.19A.5 Rate

The rate shall include the cost of all the materials and labour involved in all the operations described above including scaffolding etc.

12.20 TRANSLUSCENT WHITE ACRYLIC PLASTIC (PMMA) SHEET CEILING

12.20.1 Frame

It shall be as para 12.19.1

12.20.2 Ceiling Tiles

These shall be made of tanslucent white acrylic plastic sheet conforming to IS 14753 of thickness specified in the item.

12.20.3, 12.20.4, 12.20.5 Fixing, Measurements & Rate

Same as per paras 12.19.3, 12.19.4, 12.19.5 respectively.

12.21 PLASTER OF PARIS (GYPSUM ANHYDROUS) CEILING OVER WOODEN STRIPS

12.21.1 Frame

The frame work shall be of the specified wood. In case of sloping roofs, wooden battens of suitable section (depending upon the span and load to be carried) shall be firmly fixed as main supports, to the under side of the tie beams of the trusses at required spacing by means of bolts and nuts of proper size. In case of flat roofs, the battens shall be securely fixed to the walls and pillars by holding down bolts and shall be fastened to the slabs above with iron straps of suitable sections and encroached therein. Cross battens of 50 x 40 mm sections at 40 cm centres or so, shall then be fixed at right angles to the main battens. The frame work shall be treated with approved wooden preservative before fixing. The underside of the frame work shall be true to planes and slopes.

The frame work for ceiling shall be paid for separately unless specifically included in the description of the ceiling item.

12.21.2 Wooden Strips

Wooden strips of size 25 x 6 mm of first class kailwood, (unless otherwise stipulates specifically in the description of the item) shall be fixed to the cross battens, in the parallel rows with gaps of 10 mm in between adjacent rows, by means of felt headed (clout) nails. The strips shall be fixed butt jointed and not overlapped. The joints shall be staggered. The minimum length of strips to be used shall be 1.5 m depending upon the length of strips required.

12.21.3 Rabbit Wire Mesh

Rabbit Wire mesh shall then be fixed to the underside of wooden strips and their junctions with the battens with nails at pitch of 15 to 20 cm as ordered by the Engineer-in-Charge. The rabbit wire mesh shall be straight, tight and perfectly true to planes and slopes and without any sagging and shall be slightly below the underside of the laths to allow the plaster to encase the metal round.

12.21.4 Plaster of Paris

The plaster of Paris shall be of the calcium-sulphate semi-hydrate variety.

Its fineness shall be such that when sieved through a sieve of IS sieve designation 3.35 mm for 5 minutes the residue left on it after drying shall be not more than 1% by weight. It shall not be too quick setting. Initial setting time shall not be less than 13 minutes. The average compressive strength of material determined by testing 5 cm cubes after removal from moulds, after 24 hours and drying in an oven at 40 degree C till weight of the cubes is constant, shall not be less than 84 kg per square metre.

12.21.5 Applications

The material will be mixed with water to a workable consistency. Plaster of Paris shall be applied to the underside of the laths over the rabbit wire mesh in suitable sized panels and finished to a smooth surface by steel trowels. The plaster shall be applied in such a manner that it fully fills the gaps between the laths and the thickness over the laths is as specified in the description of the item. The joints shall be finished flush to make the ceiling in one piece. The finished surface shall be smooth and true to plane, slopes or curves as required.

12.21.6 Measurements

12.21.6.1 Length and breadth of superficial area of the finished work shall be measured correct to a cm. Area shall be calculated in square metre correct to two places of decimal. No deduction will be made to openings of areas upto 40 square decimetre nor shall extra payment be made either for any extra material or labour involved in forming such openings.

12.21.6.2 For openings exceeding 40 square decimetre in area, deduction in measurements shall be made but extra payment will be made for any extra material or labour involved in making such openings.

12.21.6.3 Curved surfaces shall be measured and paid for separately from flat surfaces. The work shall be deemed to comprise of flat surfaces only unless specifically stated otherwise in the description of the item.

12.21.6.4 Any sunk or raised mouldings in the plaster shall be measured and paid for separately, deductions being made from plastering on ceiling only if the width exceeds 15 cm. Ceiling at a height greater than 5 metres shall be so described and measured separately stating the height.

12.21.7 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above including all scaffolding, staging etc. The frame work mentioned in para 12.21.1 supporting the ceiling will be paid for separately unless otherwise stipulated in the description of the item.

The rate does not include for any raised or sunk mouldings or for any patterned finishing of the surface which will be measured and paid for extra over the plaster work.

12.22 RAIN WATER SPOUTS

12.22.0 The sectional area of rain water spouts provided shall be generally at the rate of 1 square cm per 70 to 80 square decimetre of roof area drained. However in locations subject to excessive and high intensities of rainfalls, the area of spouts provided may be suitably increased to suit local conditions. No spout shall be less than 80 mm in diameter. The spacing of spouts shall be arranged to suit the position of openings in the wall.

12.22.1 Stone Ware Spouts

The spouts shall be 100 mm in diameters and 60 cm long.

12.22.1.1 The stone ware pipe shall be perfectly sound, free from fine cracks, imperfections of glazing etc. They must be straight cylindrical and of standard nominal diameter and length and depth of socket as given in IS 651. Full length of pipes shall be used on the work. They must be thoroughly salt glazed inside and outside shall generally conform to IS 651.

12.22.1.2 ***Fixing :*** These shall be provided at the mouths of khurras and shall be fixed in cement mortar 1:3 (1 cement : 3 coarse sand) with the socket embedded in the masonry and the spigot end projecting outside. The masonry alround the pipe and socket shall be thoroughly wetted and the holes shall be given a coat of cement mortar alround. The S.W. pipe shall then be inserted and fixed with a surround of mortar. In case the hole has become much larger than the size of the pipe, cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 12.5 mm nominal size) shall be used to fill in the annular space. The spouts shall slope downward at the rate of 1 in 6. The projection outside the wall shall be uniform and not less than 40 cm. The entrance into the pipe shall be smoothly rounded to meet the internal bore of the pipe to facilitate easy flow. Care shall be taken to ensure that the vertical plane through the centre line of the spouts is at right angles to the plane of the wall. Spouts in a row shall be true to line.

12.22.1.3 ***Measurements :*** Spouts shall be measured in numbers.

12.22.1.4 ***Rate :*** The rate shall include the cost of all materials and labour involved in all the operations described above including scaffolding.

12.23 CAST IRON RAIN WATER PIPES (FIG. 12.8)

12.23.1 Cast Iron Pipes

Pipes shall conform to IS 1230 and shall be perfectly, smooth and cylindrical, their inner and outer surfaces being as nearly as practicable concentric. These shall be sound and of uniform castings, free from laps, pin holes or other imperfections and shall be neatly finished and carefully fitted both inside and outside. The ends of pipes shall be reasonably square to their axes.

12.23.2 Dimensions

C.I. rain water pipes shall be of the dia specified in the description of the item and shall be in full length of 1.8 metre including socket ends of the pipes, unless shorter lengths are required at junctions with fittings. The pipe lengths shall be in each case be with socket. The pipes shall be supplied without ears unless otherwise specifically mentioned.

The pipes supplied shall be factory painted (with a tar base composition) both inside and outside which shall be smooth and tenacious.

Every pipe shall ring clearly when struck all over with a light hand hammer. When shorter pipes are cut from full lengths they shall be cut with a hacksaw. The sizes, weights, sockets and tolerances of pipes shall be as shown in Table 12.7.

TABLE 12.7
Dimensions and Weight of C.I. Rain Water Pipes

Nominal size of pipes (Internal diameter in mm)	*50*	*75*	*100*	*125*	*150*
1. PIPE					
(a) External diameter in mm	53	79	104	130	156
Tolerance in mm	± 3	± 3	± 3.50	± 3.50	± 4.00
(b) Thickness in mm	3.00	3.00	3.00	3.00	4.00
Tolerance in mm	± 1	± 1	± 1	± 1	± 1
(c) Nominal weight of 1800 mm long pipe without ears in kg	7.50	11.00	14.00	20.00	26.00
Tolerance in weight	(–) 10%	(–) 10%	(–) 10%	(–) 10%	(–) 10%
Tolerance in length in mm	± 13.00	± 13.00	± 13.00	± 13.00	± 13.00

Nominal size of pipes (Internal diameter in mm)	*50*	*75*	*100*	*125*	*150*
2. SOCKET					
(a) Internal diameter in mm	63	89	114	139	167
Tolerance in mm	± 3.00	± 3.00	± 3.00	± 3.00	± 3.00
(b) Thickness in mm	4.00	4.00	4.00	4.00	4.00
Tolerance in mm	± 1.00	± 1.00	± 1.00	± 1.00	± 1.00
(c) Internal depth in mm	60	65	65	75	75
Tolerance in mm	± 10	± 10	± 10	± 10	± 10

Note: 1. All dimensions are in mm.

2. Pipes weighing more than the nominal weight may be accepted provided they comply in every other respect with the requirements of this standard.
3. The above table applies only to rain water pipes fixed on wall face.
4. For pipes and fittings which are to be embedded in masonry, specifications shall correspond with those of pipes for soil, waste, and vent pipes. For their weights, specifications under chapter 19.0 shall be referred to.

12.23.3 Fixing and Jointing

12.23.3.1 Pipes shall be either fixed on face of wall or embedded in masonry, as required in the description of the item.

12.23.3.2 Plain pipes (without ears) shall be secured to the walls at all joints with M.S. holder bat clamps. The clamps shall be made from 1.6 mm thick galvanised M.S. sheet of 30 mm width, bent to the required shape and size so as to fit tightly on the socket of the pipe, when tightened with screw bolts. It shall be formed out of two semi -circular pieces, hinged with 6 mm dia M.S. bolt on one side and provided with flanged ends on the other side with hole to fit by the screw bolt and nut, 40 mm long. The clamp shall be provided with a hook made out of 27.5 cm long 10 mm diameter M.S. bar, rivetted to the ring at the centre of one semi circular piece. The details of the clamps are shown in Fig 12.8. The clamps shall be fixed to the wall by embedding their hooks in cement concrete block 10 x 10 x 10 cm in 1:2:4 mix (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size) for which necessary holes shall be made in the wall at proper places. The clamps shall be kept about 25 mm clear off finished face of wall, so as to facilitate cleaning and painting of pipes.

Note : Where G.I. sheet clamps are not provided, M.S. sheet clamps of 3 mm thick and 20 mm wide shall be used for making the clamps.

12.23.3.3 The pipes shall be fixed perfectly vertical or to the lines as directed. The spigot of the upper pipe shall be properly fitted in the socket of the lower pipe such that there is a uniform annular space for filling with the jointing material. The annular space between the socket and the spigot shall be filled with a few turns of spun yarn soaked in neat cement slurry. These shall be pressed home by means of caulking tool. More skins of yarn shall be wrapped if necessary and shall be rammed home. The joint shall then be filled with stiff cement mortar 1:2 (1 cement : 2 fine sand) well pressed with caulking tool and finished smooth at top at an angle of 45 degree sloping up. The joints shall be kept wet for not less than 7 days by tying a piece of gunny bag, four fold, to the pipe and keeping it moist constantly.

12.23.3.4 Where pipes are to be embedded in masonry, these shall be fixed in masonry work as it proceeds. In such cases care shall be taken to keep the pipes absolutely vertical or to the line as directed by the Engineer-in-Charge. The pipe shall have a surrounding of 12 mm minimum thickness of mortar at every portion of the external surface. The mortar shall be of the same mix as is used in the masonry. The joint shall be caulked with lead as soon as the next length of pipe is placed in position.

The open end (socket end) of the pipe shall be kept closed till the next length is fitted and jointed, to prevent any brick bats or concrete or pieces of wood falling in and choking the pipe.

The depth of lead from the lip of socket shall be 25 mm minimum. In case of 100 mm dia. 75 mm and 50 mm pipes, the quantity of lead required per joint shall be 1.00 kg, 0.66 kg and 0.50 kg respectively for purpose of reckoning theoretical Consumption.

In order to ensure that required quantity of lead is poured into the joint and to control wastage of lead, at the beginning, three or four samples shall be made and the quantum of lead per joint approved by the Engineer-in-Charge.

The actual consumption of lead should be within ± 5% of the approved sample job subject to the provision that a variation of ± 20% shall be allowed over the theoretical quantity of lead due to dimensional tolerances allowed as per Indian Standards. This variation includes allowances of wastage also.

12.23.3.5 The spigot end shall butt the shoulder of the socket and leave no gap in between. The annular space between the socket and the spigot will be first well packed in with spun yarn leaving 25 mm from the lip of the socket for the lead. The joint shall then be lead caulked as described in detail under jointing of S.C.I soil, waste and vent pipes.

12.24 CAST IRON ACCESSORIES FOR RAIN WATER PIPES (FIG. 12.8)

12.24.1 C.I. Fittings

C.I. accessories such as bends of various degrees, heads, offsets of different projections, branches and shoes shall conform to IS 1230.

Bends shall be of the nearest standard degree as actually required at site. Heads shall be of the flat or corner type as required. Offsets shall be of the projection as stipulated in the description of the item. Branches shall be single or double as described in the item and shall be of the nearest standard degree as actually required. Standard shoes shall be of overall vertical length, 180 mm for 75 mm dia., 205 mm for 100 mm dia and 275 mm for 150 dia sized pipe from top of socket to lowest tip of shoe. Shoes of longer lengths if used shall be in lengths 300 mm, 375 mm, 450 mm, or 600 mm from top of socket to lowest tip of shoe of as actually required at site.

12.24.2 Dimensions

The fittings shall be of the diameter specified in the description of the item.

The thickness of the fittings and details of spigots and sockets shall be same as those of the corresponding size of straight pipes. The fittings shall be supplied without ears unless otherwise specifically mentioned in the item. The fittings shall be factory painted with a tar basis composition both inside and outside which shall be smooth and tenacious. Every fittings shall ring clearly when struck all over with a light hard hammer. The fittings shall be of standard size and their individual weights shall conform to the weights given in the Table 12.8.

TABLE 12.8
Weight of C.I. Rain Water Pipe Fittings

S.No	*Description*	*75 mm dia (weight in kg)*	*100 mm dia (weight in kg)*	*150 mm dia (weight in kg)*	*Unit*
1	*2*	*3*	*4*		*6*
1.	Bends (Plain)	3.20	4.50	9.10	Each
2.	Offsets (Plain)				
	(a) 55 mm projection	2.70	5.00	8.20	Each
	(b) 75 mm projection	3.20	5.50	9.10	Each

1	2	3	4	5	6
	(c) 115 mm projection	4.10	5.90	9.50	Each
	(d) 150 mm projection	4.50	6.40	10.40	Each
	(e) 225 mm projection	5.00	7.30	11.80	Each
	(f) 300 mm projection	6.00	8.60	12.70	Each
3.	Branches (Plain)				
	Single	5.00	7.30	14.50	Each
	Double	6.80	10.00	19.10	Each
4.	Standard shoes (Plain)	3.20	4.10	8.60	Each
5.	Longer shoes (Plain)				
	(a) 300 mm	3.20	5.00	-	Each
	(b) 375 mm	4.10	5.50	-	Each
	(c) 450 mm	5.50	6.40	-	Each
	(d) 600 mm	7.30	8.60	-	Each
6.	Heads	6.40	6.80	11.30	Each
7.	Extras:				
	(a) For ears cast on any fitting and short pipes	0.90	0.90	1.35	Each
	(b) For inspection doors fitted on any fitting	1.80	1.80	2.25	Each

Note: 1. The above table applies only to rain water fittings which are part of pipe lines fixed on wall face. Permissible tolerance in weight of fittings shall be 5%.

2. For fittings to be used with pipe lines to be embedded in masonry, specifications shall correspond with those of pipe fittings for soil, waste and vent pipes. For their weights, specifications under S.C.I. soil, waste and vent pipes may be referred to.

12.24.3 Fixing and jointing shall be as specified in 12.23.3.

12.24.4 Measurements

The fittings shall be measured by numbers. Where longer shoes are used in lieu of standard shoes specified in the description of the item, they shall be measured as standard shoes of 180 mm, 205 mm and 275 mm for 75 mm dia, 100 mm dia and 150 mm dia respectively in number and the extra lengths of the shoes shall be measured and paid for under the corresponding size of pipes.

12.24.5 Rate

The rate shall include in the case of fittings fixed on the face of wall, the cost of all materials and labour involved in all the operations described above including jointing but excluding the supply and fixing the M.S. holder bat clamps in walls and the anchoring concrete. Unless otherwise specified in the description of the item, the rate shall apply for fittings without access doors. In the case of fittings forming part of a rain water pipe line embedded in masonry, the rate shall be for supplying and embedding the fittings in masonry but shall not include for the jointing and lead caulking which shall be paid for separately.

12.25 THERMAL INSULATION FOR ROOFING

12.25.1 With Cellular Concrete

12.25.1.1 ***Types and Grades:*** Cellular concrete is a light weight concrete formed by producing gas or air bubbles in cement slurry or a cement sand slurry. Cellular concrete shall conform to IS 6598 and shall be of following two types depending on the manner of manufacture.

(i) Type I: High pressure steam cured (auto-claved) materials in the form of precast blocks.
(ii) Type II: Materials cured under natural conditions (that is under ambient pressure and temperature) by water. The material may be either cast in situ or may be in the form of precast blocks.

Grades - Each of these two types of the material shall have three grades, namely:
Grade A - Light weight cellular concrete;
Grade B - Medium weight cellular concrete and;
Grade C - Heavy weight cellular concrete.

12.25.1.2 ***Materials***

(a) Aggregate: A variety of sillicious fines, such as ground quarts sand shale, flyash and granulated slag may be used in the manufacture of cellular concrete.
(b) Water and binder shall conform to para 3.1.1 and 3.1.2 of CPWD Specifications 2019.
(c) Gassing Agents: Organic foaming agents based on resin soap, glue, surface active agents, or fine aluminium powder, zinc, dust, calcium carbide, calcium by pocheride etc. may be used for gassing the concrete.

12.25.1.3 ***Dimensions :*** The dimensions of the type I and type II precast cellular concrete block shall be either 50 or 60 cm in length, 20, 25 or 30 cm in width and 7.5, 10, 15, 25 or 40 cm in thickness.

12.25.1.3.1 *Tolerance :* A tolerance of ±3 percent shall be allowed on width and height and ±1 percent on thickness.

12.25.1.4 ***Requirement for Cellular Concrete***

TABLE 12.9

S. No.	*Characteristics*	*Grade A*	*Grade B*	*Grade C*	*Test reference*
1.	Density in kg/cum	Upto 320	321 to 400	400 to 500	IS 5688
2.	Crushing Strength in kg/sq. cm. (type I) (type II)	 7.0 2.5	 12.0 4.5	 20.0 8.0	 -do-
3.	Thermal conductivity in kw/cm deg c at 50 deg. c mean temperature	0.7	0.85	1.0	IS 3346
4.	Capillary absorption not to exceed 20% in case of type I cellular concrete when tested as per Appendix A of IS 6598.				

12.25.1.5 ***Sampling:*** In a consignment, cellular concrete of the same type and grade and manufactured approximately in the same period shall be grouped to form a lot. If it is in the form of blocks, a lot shall be made up of not more than 1000 blocks. If the material is in situ, not more than 10 tons of materials shall constitute a lot.

If the material is transported in lorries and received as such, the material in lorry (or vehicle load) & may conveniently be termed as lot.

Each lot shall be tested for all the requirements separately.

If the lot is made up of precast blocks, the number of sample blocks to be tested shall be selected at random as per the following Table 12.10.

TABLE 12.10

Lot Size	*Sample size (block to be sampled) (n)*	*Permissible No. of defectives (visual and dimensional requirements) (a)*
Up to 100	5	0
101 to 300	8	0
301 to 500	13	0
501 to 1000	20	1

12.25.1.6 ***General :*** Cellular concrete if done with precast blocks shall be laid on terrace slab after thoroughly cleaning the surface. The blocks shall be laid over a layer of 12 mm average thick cement mortar 1:4 (1 cement : 4 coarse sand) and the joints shall also be filled properly with neat cement slurry. The joints shall be staggered. Thickness of joints shall be as minimum as possible and not more than 5 mm.

12. 25.1.7 ***Measurements :*** Length and breadth of the roofing insulation shall be measured correct to a cm and the surface area worked out in square metre of the finished work.

No deduction shall be made for openings of areas upto 40 square decimetre. No extra payment will be made for any extra material or labour involved in forming such openings. For openings exceeding 40 square decimetre in area, deduction for the full opening will be made, but nothing extra will be paid for any extra material or labour involved in forming such openings.

12.25.1.8 ***Rate :*** The rate shall include the cost of all materials and labour required in providing cellular concrete.

12.25.2 With Resin Bonded Fibre Glass Wool (Bonded Mineral Wool)

12.25.2.1 ***Material:*** The material shall be mineral wool made from rock slag or glass processed from a molten state into fibrous form and shall be bonded with a suitable binder. Bonded mineral wool shall conform to specifications of group I of IS 8183.

12.25.2.2 ***Dimensions:*** The bonded mineral wool shall be supplied in width of 50, 60, 75 and 100 cms, and length of 100, 120 and 140 cms and the thickness of the bonded mineral wool shall be 25, 40, 50, 65 or 75 mm.

12.25.2.3 ***Tolerances:*** For width and length, the dimensional tolerances of the bonded mineral wool slabs shall be -½%. For nominal thickness in the range 25 to 75 mm the tolerance shall be -2 mm. An excess, in all dimensions is permitted.

12.25.2.4 ***Requirements for Fibre Glass Wool***

TABLE 12.11

S. No.	*Characteristics*	*Group I*	*Test Reference*
1.	Bulk density	12 to 15 kg/cum	IS 3144
2.	Recovery after compression	not less than 90% of original thickness	Annex. A of IS 8183

S. No.	*Characteristics*	*Group I*	*Test Reference*
3.	Shot content max	500 micron - 5% 250 micron - 15%	IS 3144
4.	Moisture content and absorption	not more than 2%	IS 3144
5.	Incombustibility	Incombustible	IS 3144
6.	Thermal conductivity deg. C at mean temperature 50 deg.C	0.49 mw/ $cm^{o}C$	IS 3346
7.	Sulphur content	Not more than 0.6%	IS 3144

12.25.2.5 ***General :*** Bonded mineral wool insulation can be either laid over false ceiling or alternatively it can be fixed to the ceiling when the space above false ceiling is being used for carrying return air. In the first case the bonded mineral wool can either be fixed with suitable adhesive to the false ceiling board or else it can simply be rolled over the suspended false ceiling.

In the second case when space above false ceiling is to be used for carrying return air 1.5" x 1.5" slotted angle (3" length) shall be fixed to the ceiling by means of rawl plugs at 2'0" spacing. Draw 14 gauge tie wires from the slots. Make a mat of mineral wool insulation backed with scrim cloth with a light coating of Plaster of Paris or polythene faced hessian and 24g x 1" wire mesh netting. The joints of wire netting should be butted and tightly laced down with G.I. wire. Stretch the mat tightly across the angles holding it in place by means of tie wires.

12. 25.2.6 ***Measurements :*** Length and breadth of the roofing insulation shall be measured correct to a cm and the surface area worked out in square metre of the finished work.

No deduction shall be made for openings of areas upto 40 square decimetre. No extra payment will be made for any extra material or labour involved in forming such openings. For openings exceeding 40 square decimetre in area, deduction for the full opening will be made, but no extra will be paid for any extra material or labour involved in forming such openings.

Boarding fixed to curved surfaces in narrow widths shall be measured and paid for separately. Circular cutting and waste shall be measured and paid for separately in running metres.

12.25.2.7 ***Rate :*** The rate shall include the cost of all materials and labour required in providing bonded mineral wool.

12.25.3 With Expanded Polystyrene

12.25.3.1 ***Material :*** Expanded polystyrene shall conform to IS 4671. It is of two types as given below:

(a) Type N - Normal
(b) Type SE - It shall be of self extinguishing type when tested in accordance with Appendix E of IS 4671.

12.25.3.2 ***Dimensions*** **:** The size of the finished boards shall be 1.0 × 0.5 m or as specified and having a thickness of 15, 20, 25, 40, 50, 60, 75 or 100 mm.

12.25.3.2.1 *Tolerances* **:** The tolerances on length, width and thickness of the finished board shall be ±2 mm.

12.25.3.3 ***Requirements for Expanded Polystyrene for General Use:***

TABLE 12.12

S. No.	*Characteristics*	*Requirements at various nominal apparent densities in kg/cum*					*Test Reference*
		15	20	25	30	35	
1.	Thermal conductivity (K. value) (a) at 0ºC (b) at 10ºC	 0.34 0.37	 0.32 0.35	 0.30 0.33	 0.29 0.32	 0.28 0.30	IS 3346
2.	Compressive strength at 10% deformation in Kg/sq.cm Min.	0.7	0.9	1.1	1.4	1.7	IS 4671 Appendix A
3.	Cross breaking strength in kg/sq. cm Min.	1.4	1.6	1.8	2.2		IS 4671 Appendix B
4.	Water vapour permeance in g/sqm 24 hrs. Max.	50	40	30	20		IS 4671 Appendix C
5.	Thermal stability Percent Max.	1	1	1	1		IS 4671 Appendix D
6.	Water absorption	less than 0.5% by volume (after 24 hrs. immersion)					IS 4671 Appendix E

12.25.3.4 ***Sampling :*** In a single consignment all the items of the same type, shape and dimensions belonging to the same batch of manufacture shall be grouped together to constitute a lot. For the purpose of judging conformity to the requirements each lot shall be considered separately. The number of sample items for this purpose shall depend on the size of the lot and shall be in accordance with col. 1 & 2 of Table No. 12.13 given below. The sample shall be taken at random from the lot.

TABLE 12.13

No. of items in the lot	*No. of sample items*	*Permissible number of defective sample items*
1	*2*	*3*
Upto 25	3	0
26 to 100	5	0
101 to 300	8	0
301 to 1000	13	0
1001 to 3000	20	1
3001 and above	32	2

All the sample items selected from the lot shall be tested for all requirements of the specifications. Any item failing in one or more of the requirements shall be regarded as defective.

12.25.3.5 ***General*** **:** Expanded polystyrene can either be fixed with suitable adhesive to the false ceiling board or else it can simply be rolled over the suspended false ceiling.

12. 25.3.6 ***Measurements*** **:** Length and breadth of the roofing insulation shall be measured correct to a cm and the surface area worked out in square metre of the finished work.

No deduction shall be made for openings of areas upto 40 square decimetre. No extra payment will be made for any extra material or labour involved in forming such openings. For openings exceeding 40 square decimetre in area deduction for the full opening will be made, but nothing extra will be paid for any extra material/labour involved in forming such openings.

12.25.3.7 ***Rate :*** The rate shall include the cost of material and labour in providing and fixing the polystyrene boards.

12.25.4 With Exfoliated Vermiculite

12.25.4.1 ***Material :*** Exfoliated vermiculite consists of vermiculite mineral which has been expanded many times of its original volume after being subjected to high temperature (700 degree C to 1000 degree C).

It is utilised as a thermal insulation material after mixing it with a cementitious material.

12.25.4.2 ***Requirements of Exfoliated Vermiculite for General Use***

12.25.4.2.1 Exfoliated vermiculite in loose fill condition should conform to following :

TABLE 12.14

S.No	*Characteristics*		*Type-I*	*Type-II*	*Type-III*	*Type-IV*
1.	Density in kg/m	Min.	56	64	80	96
			12	128	144	160
		Max				
2.	Thermal conductivity at mean temp. 25 deg. C in mw/cm deg.C		0.72	0.72	0.72	0.72
3.	Guarding: As per following table. Accumulated % age retained on sieves having square holes, by wt					

TABLE 12.15

Size	*9.51 mm*		*4.76 mm*		*2.38 mm*		*1.19 mm*		*595 mcn*		*297 mcn*		*149 mcn*	
designation	*Min*	*Max*	*Min*	*Max*	*Min*	*Max*	*Min*	*Max*	*Min*	*Max*	*Min*	*Max*	*Min*	*Max*
Type-I	0	40	30	90	65	98	85	100	-		-		-	
Type-II	-		0	95	20	80	75	100	90	100	97	100	-	
Type-III	-		-		0	10	20	70	65	95	75	98	90	100
Type-IV	-		-		-		0	5	15	65	60	98	90	100

12.25.4.2.2 Exfoliated vermiculite after being mixed with a cementitious material should conform to following:

TABLE 12.16

S.No.	*Characteristics*	*Requirements*
1.	Consistency	35 to 45% or 178 to 229 mm
2.	Dry covering capacity in sqm of 100 kg of material 1 cm thick	34 sqm
3.	Compressive strength at 5% deformation min.	103.5 KN/sqm
4.	Liner shrinkage after 24 hrs. at 1800 Deg. F max.	3%
5.	Thermal conductivity max. at mean temperature 95 deg.C.	1.37 mw/cm deg.C.

12.25.4.3 ***Sampling & Testing :*** If any of the test date obtained on the samples tested fail to conform to the requirements given above, the material shall be rejected.

12.25.4.4 ***General :*** Exfoliated vermiculite along with cementitious material is mixed with water in the required proportion (as specified by manufacturers). This mix is to be immediately spread over the terrace slab in prescribed thickness. No curing need be done. After laying the insulation, the entire surface shall be cement plastered with cement mortar 1:4 of 20 mm thickness.

12. 25.4.5 ***Measurements :*** Length and breadth of the roofing insulation shall be measured correct to a cm and the surface area worked out in square metre of the finished work.

No deduction shall be made for openings of areas upto 40 square decimetre. No extra payment will be made for any extra material or labour involved in forming such openings. For openings exceeding 40 square decimetre in area, deduction for the full opening will be made, but nothing extra will be paid for any extra material or labour involved in forming such openings.

Boarding fixed to curved surfaces in narrow widths shall be measured and paid for separately. Circular cutting and waste shall be measured and paid for separately in running metres.

12.25.4.6 ***Rate :*** The rate shall include the cost of all materials and labour in providing exfoliated vermiculite.

12.25A HEAT RESISTANCE TERRACE TILES

12.25A.1 Terrace tiles

Heat resistance terrace tiles are basically ceramic floor tiles which reflects solar radiation. These tiles are used on the floor of the terrace to prevent building from getting heated. These are used on the roof of any building or balcony. These can be used on wall of a building which are directly exposed to sunlight.

12.25A1.1 Solar Refractive Index (SRI)

It is a measure of the constructed surface's ability to stay cool in the sun by reflecting solar radiation and emitting thermal radiation. SRI is calculated according to ASTM E1980.

12.25A.1.2 Benefits of Heat Resistance Tiles:-

1. Reduce inside building temperature.
2. Save electricity.
3. Lower power demand.
4. Save burning fossil fuel by power plants.
5. Lower emission of green house.
6. Reduction of global warming.
7. Reduce conduction of heat into building.

12.25A.1.3 Requirement for Heat Resistance Terrace Tiles

Table 12.17

S. No.	Characteristics	Requirement
1	Size	300mm x 300mm x 20mm
2	Solar refractive index	Not less than 78
3	Solar reflection	Not less than 0.70
4	Initial emittance	Not less than 0.75

12.25A.1.3.1 Tolerance

Tolerances on length and breadth shall be plus or minus one millimeter, and tolerance on thickness shall be plus 5 mm. The variation of dimensions in any one delivery of tiles shall not exceed 1 mm on length and breadth and in thickness not less than plus 3 mm.

12.25A.2 Laying

12.25A.2.1 Base concrete or RCC slab on which the tiles are to be laid shall be cleaned, wetted and mopped. Cement mortar 1:4 (1 Cement : 4 coarse sand) bedding shall be used. Average thickness of the bedding mortar shall be 20 mm and the thickness at any place shall not be less than 10 mm.

12.25A.2.2 Cement mortar bedding shall be spread, tamped and corrected to proper levels. If cement mortar is laid in bedding the tiles, then tiles shall be set immediately after laying the mortar. Over this bedding neat grey cement slurry of honey like consistency shall be spread at the rate of 4.4 kg of cement per square metre over such an area as would accommodate about twenty tiles. Tiles shall be washed clean and shall be fixed

in this grout one after another, each tile being gently tapped with a wooden mallet till it is properly bedded, and in level with the adjoining tiles. The joints shall be kept as thin as possible not exceeding 1 mm and in straight lines or to suit the required pattern. The joints shall be properly cleaned before filling with grout of mix of white cement and marble powder in the ratio of 1:1.

12.25A.2.3 The surface of the flooring during laying shall be frequently checked with a straight edge of length at least 2 metre, so as to obtain a true surface with the required slope.

12.25A.2.4 Where full tiles or half tiles can not be fixed, tiles shall be cut (sawn) from full tiles to the required size and their edges rubbed smooth to ensure a straight and true joint.

12.25A.2.5 Tiles which are fixed in the floor adjoining the wall shall enter not less than 12 mm under the skirting which shall be fixed upto 150mm height along the parapet walls in the same manner.

12.25A.2.6 After the tiles have been laid, surplus cement grout that may have come out of the joints shall be cleared off.

12.25A.3 Curing, Polishing and Finishing

12.25A.3.1 The day after the tiles are laid all joints shall be cleaned of the grey cement with a wire brush or trowel to a depth of 5 mm and all dust and loose mortar removed and cleaned. Joints shall then be grouted with white cement mixed marble powder in the ratio of 1:1. The same cement slurry shall be applied to the entire surface of the tiles in a thin coat with a view to protect the surface from abrasive damage and fill the pin holes that may exist on the surface.

12.25A.3.2 The floor shall then be kept wet for a minimum period of 7 days. The surface shall thereafter be grounded evenly with machine fitted with coarse grade grit block (No. 60). Water shall be used profusely during grinding. After grinding, the surface shall be thoroughly washed to remove all grinding mud, cleaned and mopped. It shall then be covered with a thin coat of grey or white cement, mixed with or without pigment to match the colour of the topping of the wearing surface in order to fill any pin hole that appear. The surface shall be again cured. The second grinding shall then be carried out with machine fitted with fine grade grit block (No. 120).

12.25A.3.3 The final grinding with machine fitted with the finest grade grit blocks (No. 320) shall be carried out the day after the second grinding described in the preceding para or before handing over the floor, as ordered by the Engineer-in-Charge.

12.25A.3.4 For small areas or where circumstances so require, hand grinding/polishing with hand grinder may be permitted in lieu of machine polishing after laying. For hand polishing the following carborundum stones, shall be used:

1st grinding — coarse grade stone (No. 60)

Second grinding — medium grade (No. 80)

Final grinding — fine grade (No. 120)

In all other respects, the process shall be similar as for machine polishing.

12.25A.3.5 After the final polish, oxalic acid shall be dusted over the surface at the rate of 33 gm per square metre sprinkled with water and rubbed hard with a 'namdah' block (pad of woollen rags). The following day the floor shall be wiped with a moist rag and dried with a soft cloth and finished clean.

12.25A.3.6 If any tile is disturbed or damaged, it shall be refitted or replaced, properly jointed and polished.

The finished floor shall not sound hollow when tapped with a wooden mallet.

12.25A.4 Measurements

12.25A.4.1 Heat resistance terrace tiles shall be measured as laid in square metre correct to two places of decimal. For length and breadth dimensions correct to a cm including skirting shall be taken. No deduction shall be made nor extra paid for voids not exceeding 0.20 sqm. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square metre. Nothing extra shall be paid for use of cut tiles nor for laying the floor at different levels in the same terrace.

12.25A.5 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above.

12.26 UNPLASTICISED POLYVINYL CHLORIDE PIPES AND FITTINGS

12.26.1 UPVC Pipes

Pipes shall conform to Type A pipes of IS 13592. The internal and external surfaces of the pipes shall be smooth and clean and free from groovings and other defects. The end shall be clearly cut and shall be square with the axis of the pipe. The end may be chamfered on the plain sides. Slight shallow longitudinal grooves or irregularities in the wall thickness shall be permissible provided the wall thickness remains within the permissible limit.

12.26.2 Colour of Pipe

Surface colour of the pipes shall be dark shade of grey or as specified .

12.26.3 Marking

Each pipe shall be clearly and indelibly marked with the following informations at intervals not more than 3 meter.

(a) Manufacturer's name or trade mark.

(b) Nominal outside dia of pipe.

(c) Type 'A'

(d) Batch number.

12.26.4 Dimensions

12.26.4.1 ***Diameter and Wall Thickness:*** Mean outside diameter, outside diameter at any point and wall thickness for type –A manufactured plain or with socket shall be as given in Table- 1 of IS 13592.

UPVC rain water pipes shall be of the dia, specified in the description of the item and shall be in nominal lengths of 2,3,4 or 6 metres either plain or with sliding/grooved socket unless shorter lengths are required at junctions with fittings. Tolerances on specified length shall be + 10 mm and – 0 mm.

12.26.5 Fixing and Jointing

Pipes shall be either fixed on face of wall or embedded in masonry as required in the description of the item.

Plain pipes shall be secured to the walls at all joints with PVC Pipes clips by means of 50 x 50 x 50 mm hard wood plugs, screwed with M.S. screws of required length i/c cutting brick work and fixing in cement mortar 1:4 (1 cement : 4 coarse sand). The clips shall be kept about 25 mm clear off finished face of wall, so as to facilitate cleaning of pipes. Pipes shall be fixed perfectly vertical or to the lines as directed. The pipes shall be fitted to fittings with seal ring conforming to IS 5382 allowing 10 mm gap for thermal expansion.

12.26.6 Installation in Wall/Concrete

The walls/concrete slots should allow for a stress free installation. Pipes and fittings to be inserted into the slots without a cement base have to be applied first with a thin coat of PVC solvent cement

followed by sprinkling of dry sand (medium size). Allow it to dry. The process gives a sound base for cement fixation. This process is repeated while joining PVC material to CI/AC materials.

12.26.7 Fittings

Fittings used shall be of the same make as that of the PVC pipes Injeciton moulded or fabricated by the manufacturer and shall have a minimum wall thickness of 3.2 mm. The fittings shall be supplied with grooved socketted ends with square grooves and provided with Rubber Gasket conforming to IS 5382. The plain ends of the fittings should be chamfered. The fittings shall be joined with the help of Rubber lubricant. The details of fittings refer IS 13592.

12.26.8 Measurements

The fittings shall be measured by numbers. The pipes shall be measured net when fixed correct to a cm. excluding all fittings along its length.

12.26.9 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above including jointing but excluding the supply and fixing of wall plugs and PVC clips which shall be paid for separately.

Note : These pipes shall be used only in shaft or unexposed location to avoid damage to these pipes due to willful act.

12.27 THERMAL INSULATION OVER EXISTING WALL WITH FIBER GLASS WOOL

12.27.1 Material & Fixing:

Resin Bonded fiber glass wool conforming to IS: 8183 having density 24 kg/ m3, 50 mm thick, wrapped in 200 G Virgin Polythene bags shall be used. Resin Bonded fiber glass wool is to be fixed over existing wall with screw, rawl plug and washers and held in position by criss crossing G.I. wire .

12.27.2 Precaution:

All wet trades such as plastering, conducting and painting etc. be completed prior to start of insulation over existing wall. Electrical chasing or drawing lines & cables, etc are to be in place before start of insulation work. The area shall be made dry prior to ceiling installation work.

Care should be taken while placing resin bounded glass wool over existing wall so that there will be no displacement to grid.

12.27.3 Measurements:

Length and breadth shall be measured correct to a cm. Areas shall be calculated nearest to 0.01sqm. No deduction in measurements shall be made for openings of areas upto0.36 Sqm. Nothing extra shall be payable either for any extra material or labour involved in forming such openings. For openings exceeding 0.36 sqm in area, deductions in measurements for the full opening will be made.

12.27.4 Rate:

The rate shall include the cost of all materials and labour involved in all the operations described above.

12.28 CALCIUM SILICATE TILES FALSE CEILING

12.28.1 Materials & Fixing:

8 mm thick fully perforated calcium silicate board made with Calcareous & Siliceous materials reinforced with cellulose fiber manufactured through autoclaving process to give stable crystalline structure with minimum compressive strength 225 kg/ sq. cm, bending strength 100 kg/sq. cm , of size 595x595 mm, having perforation of dia. 10 mm with minimum perforated area 18 % with non woven tissue on the back side, having an NRC (Noise Reduction Coefficient) of 0.85, with 50 mm thick rock wool of 48 kg /cum backing shall be used.

Frame is made up of interlocking metal grid of hot dipped galvanized steel sections (galvanized @ 120 grams/ sqm, both side inclusive) consisting of main “T” runner with suitably spaced joints to get required length and of size 24x38 mm made from 0.30 mm thick (minimum) sheet, spaced at 1200 mm center to

center and cross “T” of size 24x25 mm made of 0.30 mm thick (minimum) sheet, 1200 mm long spaced between main “T” at 600 mm center to center to form a grid of 1200x600 mm and secondary cross “T” of length 600 mm and size 24x25 mm made of 0.30 mm thick (minimum) sheet to be interlocked at middle of the 1200x600 mm panel to form grids of 600x600 mm and wall angle of size 24x24x0.3 mm etc. complete.

Main “T” runners to be suspended from ceiling using GI slotted cleats of size 27 x 37 x 25 x1.6 mm fixed to ceiling with 12.5 mm dia and 50 mm long dash fasteners, 4 mm GI adjustable rods with galvanized butterfly level clips of size 85 x 30 x 0.8 mm spaced at 1200 mm center to center along main T, bottom exposed width of 24 mm of all T sections shall be pre-painted with polyester paint, all complete for all heights as per specifications, drawings and as directed by Engineer-in-charge. false ceiling tiles of approved texture shall be laid in the grid including, required cutting/making, opening for services like diffusers, grills, light fittings, fixtures, smoke detectors etc.

Manufacturers test certificate/ report of invoice shall be submitted for every delivery challan by suppliers.

12.28.2 Precaution:

All wet trades such as plastering, conduting and painting etc, be completed prior to start of false ceiling works. Air conditioning duct work is to be completed preferably even before the suspension of the grid section. Electrical chasing or drawing lines & cables, etc are to be in place before start of false ceiling work. No unauthorized weight is put on false ceiling. Lighting fixtures, diffusers are to be suspended independently with proper chain/wire & dash fasteners as directed by Engineer In Charge/manufacturer guide line. The area shall be made dry prior to ceiling installation work

Care should be taken while placing Light Weight calcium silicate tiles into the grid so that there will be no displacement to grid and stains/ dirty marks put by the workers. (Worker should preferably wear clean soft cotton gloves while placing tile).

12.28.3 Measurements:

Length and breadth shall be measured correct to a cm. Areas shall be calculated nearest to 0.01sqm. No deduction in measurements shall be made for openings of areas upto0.36 Sqm. Nothing extra shall be payable either for any extra material or labour involved in forming such openings. For openings exceeding 0.36 sqm in area, deductions in measurements for the full opening in multiple of area of each tile (0.36 Sqm) will be made.

12.28.4 Rate:

The rate shall include the cost of all materials and labour involved in all the operations described above.

12.29 CALCIUM SILICATE BOARD FALSE CEILING

12.29.1 Material &Fixing :

8 mm thick Calcium Silicate Board made with Calcareous & Siliceous materials reinforced with cellulose fiber manufactured through autoclaving process shall be used.

Frame work is made of special section, power pressed from M.S. sheets and galvanized with zinc coating of 120 gms/ sqm (both side inclusive) as per IS : 277 and consisting of angle cleat of size 25mm wide x 1.6mm thick with flanges of 27mm and 37mm, at 1200mm c/c, one flange fixed to the ceiling with dash fastener 12.5mm dia x 50mm long with 6mm dia bolts, other flange of cleat fixed to the angle hangers of 25 x10 x0.50mm of required length with nuts & bolts of required size and other end of angle hanger fixed with intermediate G.I chanels 45 x15 x 0.90mm running at the spacing of 1200 mm c/c, to which the ceiling section 0.5mm thick bottom wedge of 80mm with tapered flanges of 26 mm each having lips of 10.5mm, at 450mm c/c, shall be fixed in a direction perpendicular to G.I intermediate channel with connecting clip made out of 2.64mm dia x 230mm long G.I wire at every junction, including fixing perimeter channels 0.50mm thick 27mm high having flanges of 20mm and 30mm long.

The perimeter of ceiling fixed to wall/ partitions with the help of rawl plugs at 450mm centre, with 25mm long dry wall screws @ 230mm interval, including fixing of Calcium Silicate Board to ceiling section and perimeter channels with the help of dry wall screws of size 3.5 x25mm at 230mm c/c, including jointing & finishing to a flush finish of tapered and square edges of the board with recommended jointing compounds, jointing tapes, finishing with jointing compounds in three layers covering up to 150mm on both sides of joints

and two coats of primer suitable for boards, all as per manufacture's specification and also including the cost of making opening for light fittings, grills, diffusers, cut outs made with frame of perimeter channels suitably fixed, all complete as per drawings, specification and direction of the Engineer in charge but excluding the cost of painting.

Manufacturers test certificate/ report of invoice shall be submitted for every delivery challan by suppliers.

12.29.2 Precaution:

All wet trades such as plastering, conduting and painting etc, be completed prior to start of false ceiling works. Air conditioning duct work is to be completed preferably even before the suspension of the grid section. Electrical chasing or drawing lines & cables, etc are to be in place before start of false ceiling work. No unauthorized weight is put on false ceiling. Lighting fixtures, diffusers are to be suspended independently with proper chain/wire & dash fasteners as directed by Engineer In Charge/manufacturer guide line. The area shall be made dry prior to ceiling installation work.

Care should be taken while placing Light Weight calcium silicate tiles into the grid so that there will be no displacement to grid and stains/ dirty marks put by the workers. (worker should preferably wear clean soft cotton gloves while placing tile).

12.29.3 Measurements:

Length and breadth shall be measured correct to a cm. Areas shall be calculated nearest to 0.01sqm. No deduction in measurements shall be made for openings of areas upto0.36 Sqm. Nothing extra shall be payable either for any extra material or labour involved in forming such openings. For openings exceeding 0.36 sqm in area, deductions in measurements for the full opening in multiple of area of each tile (0.36 Sqm) will be made.

12.29.4 Rate:

The rate shall include the cost of all materials and labour involved in all the operations described above.

12.30 THERMAL INSULATION OF CEILING

12.30.1 Material &Fixing:

Resin Bonded Rockwool conforming to IS: 8183,density 48 kg/ m3, 50 mm thick, wrapped in 200 G Virgin Polythene bags shall be used. The Wire mesh of 12.5 mm x24 gauge shall be used. Fixing shall be done to ceiling with metallic cleats (50x50x3 mm) @ 60 cm and wire mesh of 12.5mm x 24 gauge wire mesh, for top most ceiling of building.

12.30.2 Precaution:

All wet trades such as plastering, conducting and painting etc, be completed prior to start of insulation ceiling works. Air conditioning duct work is to be completed preferably even before the suspension of the grid section. Electrical chasing or drawing lines & cables, etc are to be in place before start of false ceiling work. No unauthorized weight is put on false ceiling. Lighting fixtures, diffusers are to be suspended independently with proper chain/wire & dash fasteners as directed by Engineer In Charge/manufacturer guide line. The area shall be made dry prior to ceiling installation work. Care should be taken while placing resin bounded Rockwool into the wire mesh so that there will be no displacement to grid.

12.30.3 Measurements:

Length and breadth shall be measured correct to a cm. Areas shall be calculated nearest to 0.01sqm. No deduction in measurements shall be made for openings of areas upto0.36 Sqm. Nothing extra shall be payable either for any extra material or labour involved in forming such openings. For openings exceeding 0.36 sqm in area, deductions in measurements for the full opening will be made.

12.30.4 Rate:

The rate shall include the cost of all materials and labour involved in all the operations described above.

12.31 THERMAL INSULATION OVER EXISTING FALSE CEILING

12.31.1 Material & Fixing:

Resin Bonded Rockwool conforming to IS: 8183,density 48 kg/ m3, 50 mm thick, wrapped in 200 G Virgin Polythene bags shall be used. Resin Bonded Rockwool is to be placed over existing false ceiling and to be held in position by criss crossing G.I. wire .

12.31.2 Precaution:

All wet trades such as plastering, conducting and painting etc, be completed prior to start of insulation ceiling works. Air conditioning duct work is to be completed preferably even before the suspension of the grid section. Electrical chasing or drawing lines & cables, etc are to be in place before start of false ceiling work. No unauthorized weight is put on false ceiling. Lighting fixtures, diffusers are to be suspended independently with proper chain/wire & dash fasteners as directed by Engineer In Charge/manufacturer guide line. The area shall be made dry prior to ceiling installation work. Care should be taken while placing resin bounded Rockwool over existing false ceiling so that there will be no displacement to grid.

12.31.3 Measurements:

Length and breadth shall be measured correct to a cm. Areas shall be calculated nearest to 0.01sqm. No deduction in measurements shall be made for openings of areas upto0.36 Sqm. Nothing extra shall be payable either for any extra material or labour involved in forming such openings. For openings exceeding 0.36 sqm in area, deductions in measurements for the full opening will be made.

12.31.4 Rate:

The rate shall include the cost of all materials and labour involved in all the operations described above.

12.32 THERMAL INSULATION OVER EXISTING WALL

12.32.1 Material & Fixing :

Resin Bonded Rockwool conforming to IS: 8183,density 48 kg/ m3, 50 mm thick, wrapped in 200 G Virgin Polythene bags shall be used. Resin Bonded Rockwool is to be fixed over existing wall with screw, rawl plug and washers and held in position by criss crossing G.I. wire .

12.32.2 Precaution:

All wet trades such as plastering, conducting and painting etc, be completed prior to start of insulation over existing wall. Electrical chasing or drawing lines & cables, etc are to be in place before start of insulating work. The area shall be dry prior to ceiling installation work. Care should be taken while placing resin bounded Rockwool over existing wall so that there will be no displacement to grid.

12.32.3 Measurements:

Length and breadth shall be measured correct to a cm. Areas shall be calculated nearest to 0.01sqm. No deduction in measurements shall be made for openings of areas upto0.36 Sqm. Nothing extra shall be payable either for any extra material or labour involved in forming such openings. For openings exceeding 0.36 sqm in area, deductions in measurements for the full opening will be made.

12.32.4 Rate:

The rate shall include the cost of all materials and labour involved in all the operations described above.

APPENDIX A

GALVANISED STEEL SHEETS

(Clause 12.1.1)

A-1 Dimensions

A-1.0 Sizes of plain Sheet: The plain sheets shall be supplied in any combination of the following lengths, widths and thickness.

(a) Length : 2500 and 3000 mm
(b) Width : 900 and 1000 mm
(c) Thickness : 0.50, 0.63, 0.80, 1.00 mm

A-1.1 In case of sheets supplied in coil, the internal diameter of coil shall be 450, 510 and 610 mm and the mass of each coil shall not exceed 12 tonne.

A-1.1.1 Coils weighing more than 12 tonnes may be supplied subject to mutual agreement between the contracting parites.

A-1.2 Corrugated sheets.

A1.2.1 Length- The length of the corrugated sheets shall be as follows: 2500, 3000 mm

A-2 Zinc Coating

The weight of coating referred to in this specification shall represent the total weight of zinc both side inclusive.

On any sample selected at random from the delivery, one set of three samples each 50 x 50 mm or 50 mm diameter shall be selected at random from one sheet for every 500 G.S. sheets, the coating for the different classes shall be within the limit specified in table below:

TABLE I
Mass of Coating (Total Both Sides)

Grade of coating	*Minimum average coating Triple spot test g/sqm*	*Minimum coating single spot test g/sqm**
600	600	510
450	450	380
350	350	300
275	275	235

* minimum individual value obtained in triple spot test.

A-3 Mass

The mass of sheets and coils shall be calculated as given in Table II on the basis of nominal dimensions and mass of zinc coating.

TABLE II
Calculation of Mass of Sheets or Coils

Type of materials	*Order of calculation*	*Method of calculation*	*Number of Numerals in resultant value*
Sheet	Mass of single sheet	Nominal mass of single sheet plus mass of zinc coating	Rounded off to 4 effective figures
	Total mass	Mass of single sheet (kg) x number of sheets	Rounded off to integral value of kg
Coil	Unit mass of coil	Unit mass of sheet (kg/m^2)x width (mm) x10 -3	Rounded off to 3 effective figures
	Mass of single coil	Unit mass of coil (kg/m)x length (m)	
	Total mass (kg)	Total mass of each coil	Integral number of kg

Note:

(i) Nominal mass of single sheet shall be calculated by calculating the volume of the sheet and multiplying the same with density of sheet (density 7.85 g/ cubic cm) and rounding the same to 4 effectve figures.

(ii) Mass of the coating shall be calculated by multiplying the surface area of single sheet with indicated inominal coating mass (g/square metre) as shown for triple spot test (Table I).

(iii) For calculation of corrugated sheet mass, the width before corrugation shall be considered while calculating the area.

A-4 Corrugations

The depth and pitch of corrugation shall be as follows:

Grade	*Depth of Corrugation (mm)*	*Pitch of Corrugation (mm)*
A	17.5	75
B	12.5	75

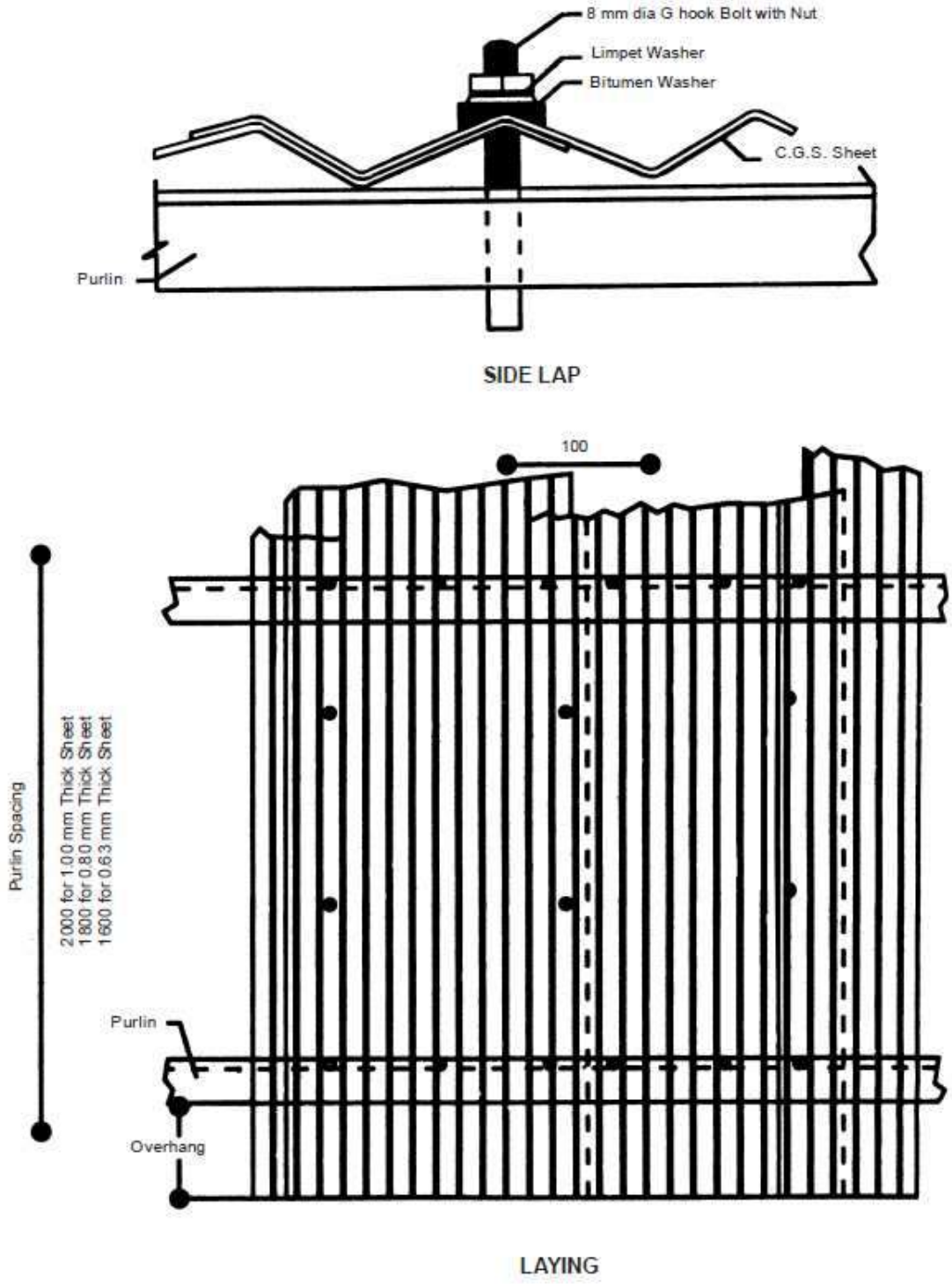
The number of corrugations shall be 8,10, 11 or 13 per sheet. The overall width of the sheets before and after corrugation shall be as given in Table below.

TABLE III
Details of Corrugations

Number of corrugations	*Grade*	*Nominal overall width of sheet measured between crowns of outside corrugations*	
		Before corrugation mm	*After corrugation mm*
(1)	*(2)*	*(3)*	*(4)*
8	A	750	660
10	A	900	810
11	A	1000	910
13	A	1200	1110
8	B	750	680
10	B	900	830
11	B	1000	930
13	B	1200	1130

C.G.S. SHEETS

Sub Head : Roofing
Clause : 12.1

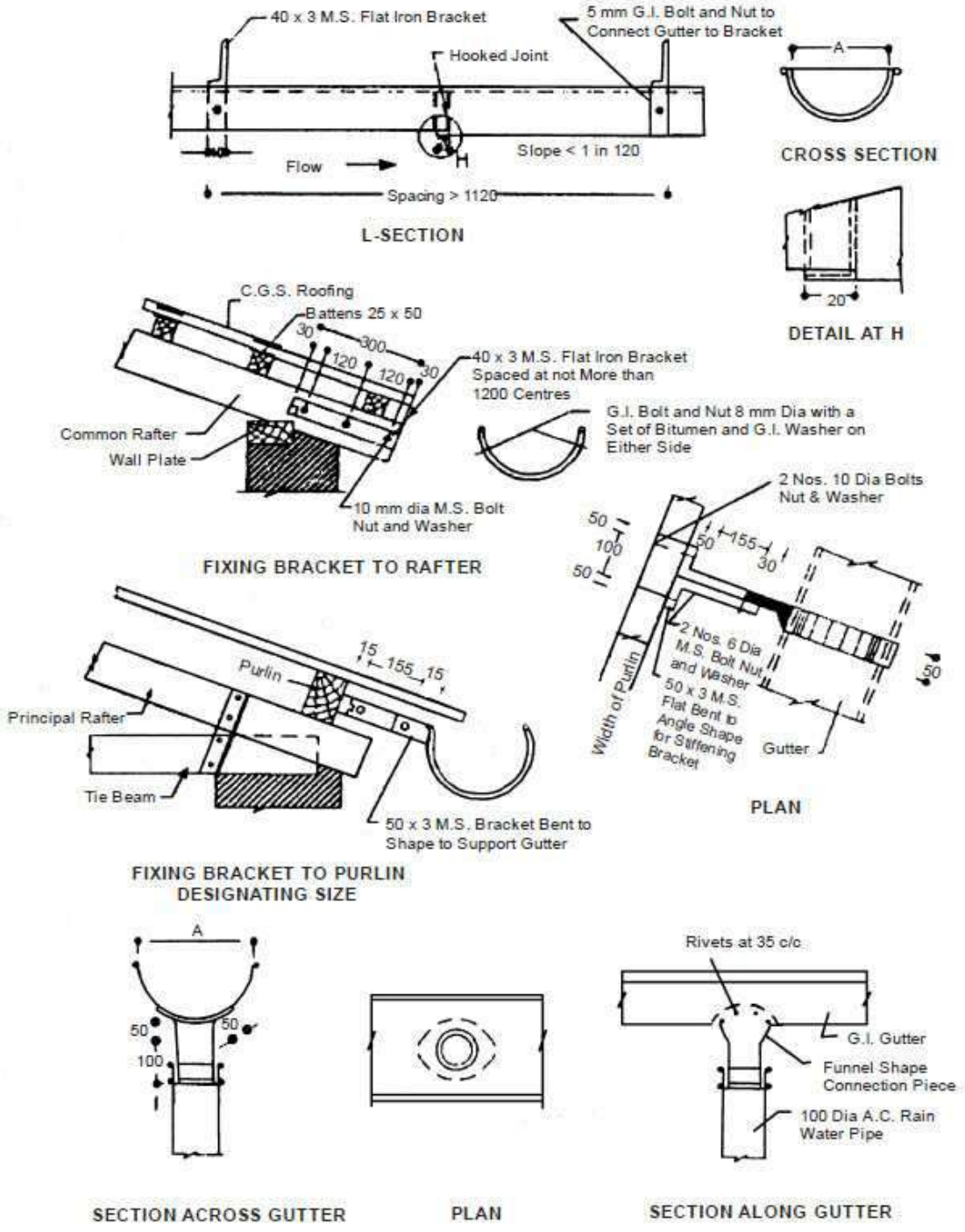


Drawing Not to Scale
All Dimensions are in mm

Fig. 12.1 : C.G.S. Sheets

GALVANISED STEEL SHEET GUTTER

Sub Head : Roofing
Clause : 12.1

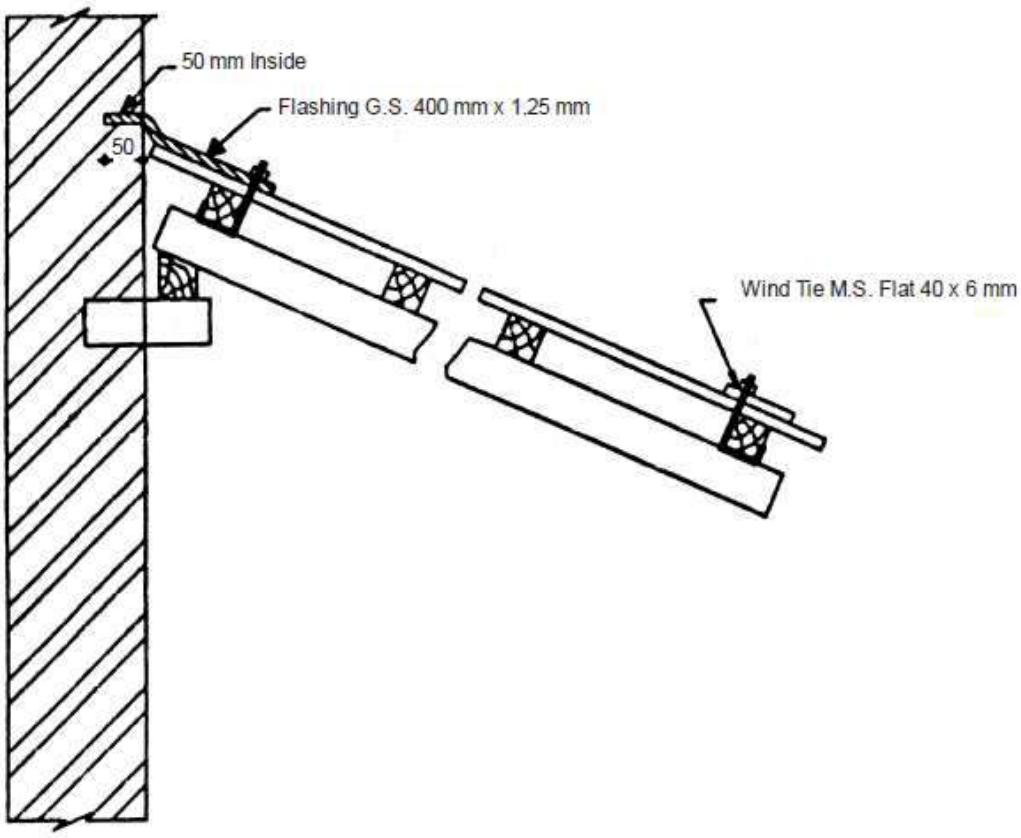


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All Dimensions are in mm

Fig. 12.2 : Galvanised Steel Sheet Gutter

WIND TIE AND FLASHING

Sub Head : Roofing
Clause : 12.1.5 & 12.3

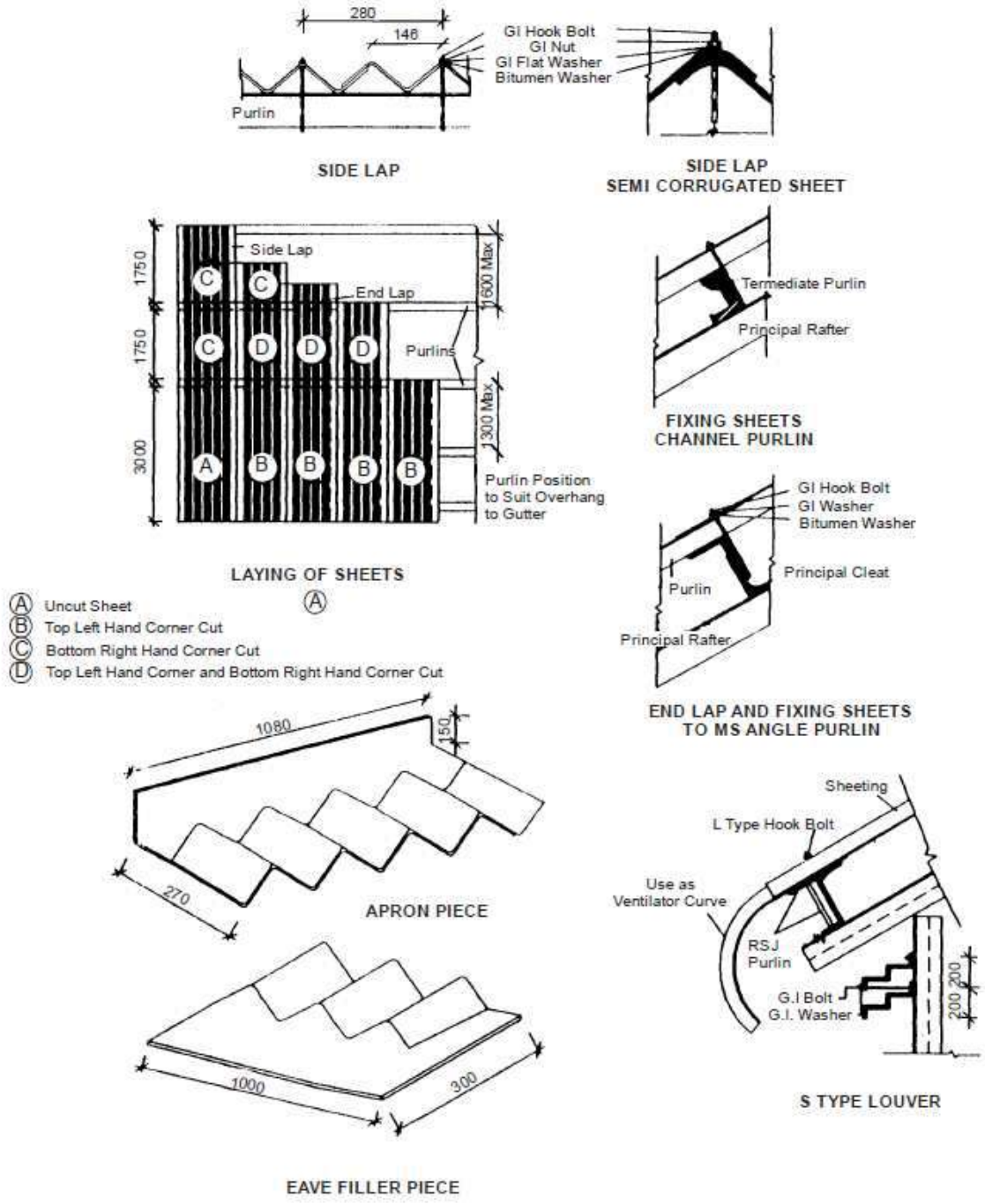


Drawing Not to Scale
All Dimensions are in mm

Fig. 12.3 : Wind Tie and Flashing

NON-ASBESTOS CORRUGATED SHEET

Sub Head : Roofing
Clause : 12.5, 12.8

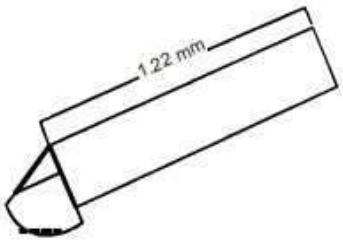


Drawing Not to Scale
All Dimensions are in mm

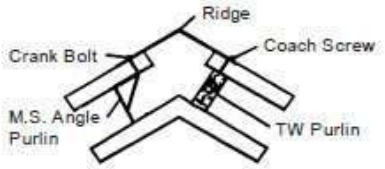
Fig. 12.4 : Non-Asbestos reinforced by organic fibres and/or inorganic synthetic fibres cement Corrugated Sheet roofing

NON-ASBESTOS CEMENT ACCESSORIES

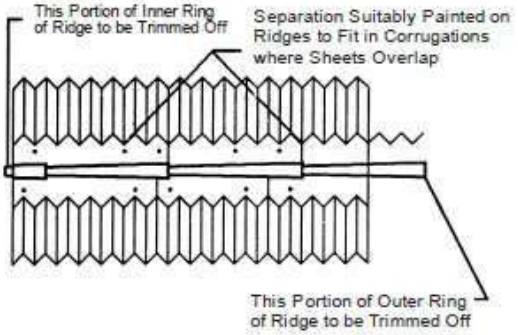
Sub Head : Roofing
Clause : 12.8

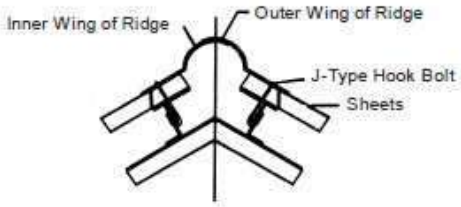


ONE PIECE PLAIN ANGULAR RIDGE

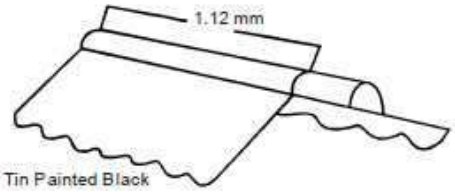


SECTION SHOWING ALTERNATIVE FIXING ACCESSORIES

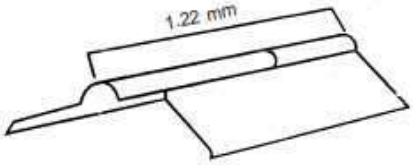




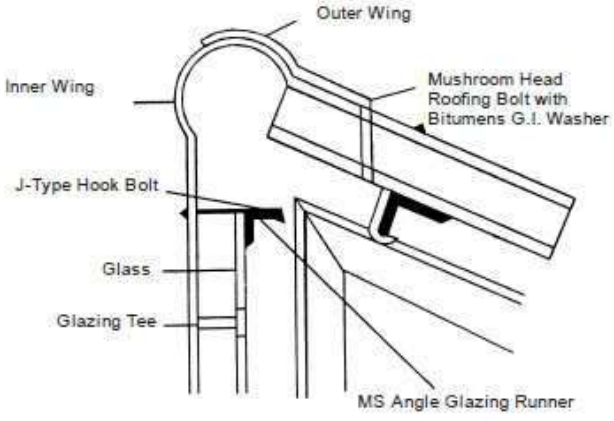
FIXING OF SERRATED ADJUSTABLE RIDGE



SERRATED ADJUSTABLE RIDGE



UNSRPRATED ADJUSTABLE RIDGE

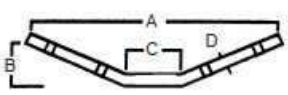


Drawing Not to Scale
All Dimensions are in mm

Fig. 12.5 : Non-Asbestos reinforced by organic fibres and/or inorganic synthetic fibres Cement Accessories

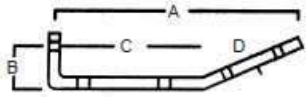
NON-ASBESTOS CEMENT GUTTERS

Sub Head : Roofing
Clause : 12.9



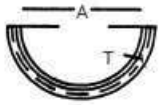
VELLEY GUTTER

Nominal Size	A	B	C	D
900X200X225	900	200	225	12.5
600X150X225	600	150	225	12.5
450X125X150	450	125	150	12.5
400X125X150	400	125	150	12.5



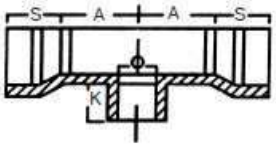
BOUNDARY WALL GUTTER OR EAVES GUTTER

Nominal Size	A	B	C	D
500X150X250	500	150	250	12.5
450X150X300	450	150	300	12.5
300X150X225	300	150	225	12.5
275X125X175	275	125	175	10.0

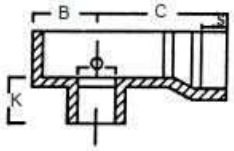


HALF ROUND GUTTER

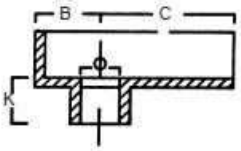
Nominal Size	A	T
150	150	9.5
250	250	9.5
300	300	9.5



NOZZLE



DROP END WITH SOCKET

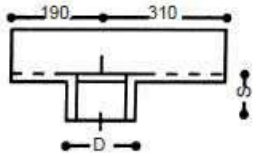


DROP END WITH SPIGOT

FOR HALF ROUND GUTTER

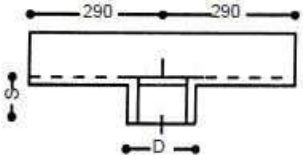
Type of Gutter	Nominal Size	A	B	C	S	K	D
	150	150	90	240	70	105	90
						110	100
	250	200	200	300	100	105	90
						110	100
						115	150
	300	200	200	300	100	105	90
						110	100
						115	150
	125	150	90	240	70	105	90
						110	100
Ogee Gutter	200	150	90	240	70	105	90
						110	100
						115	150

For Boundary Wall & Valley Gutter

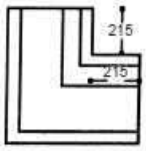


DROP END

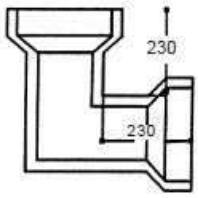
S	D
105	90
110	100
115	150



NOZZLE



ANGLE FOR BOUNDARY WALL GUTTER



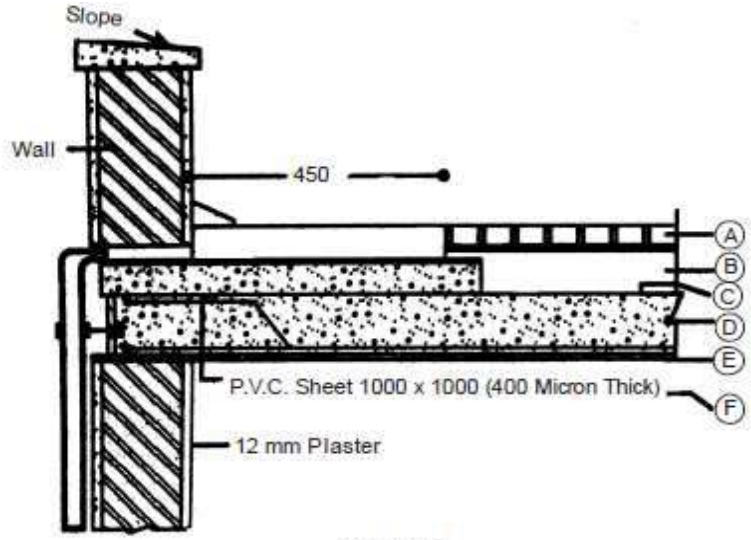
ANGLE FOR HALF ROUND GUTTER

Drawing Not to Scale
All Dimensions are in mm

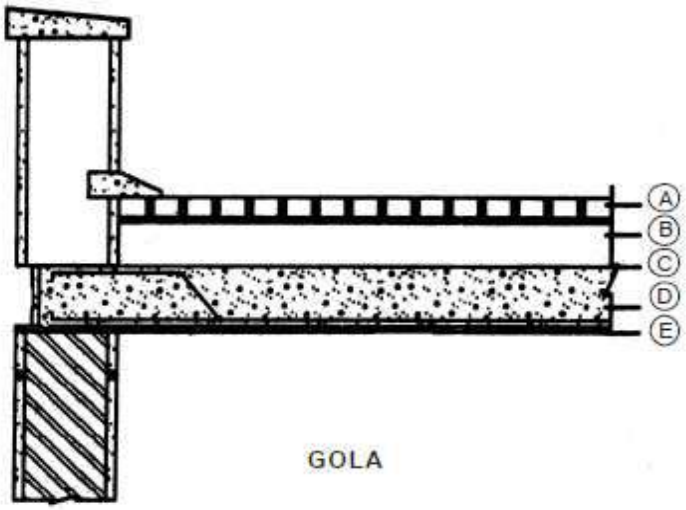
Fig. 12.6 : Non-Asbestos reinforced by organic fibres and/or inorganic synthetic fibres Cement Gutters

CEMENT CONCRETE KHURRA - GOLA

Sub Head : Roofing
Clause : 12.13 and 12.14



KHURRA



GOLA

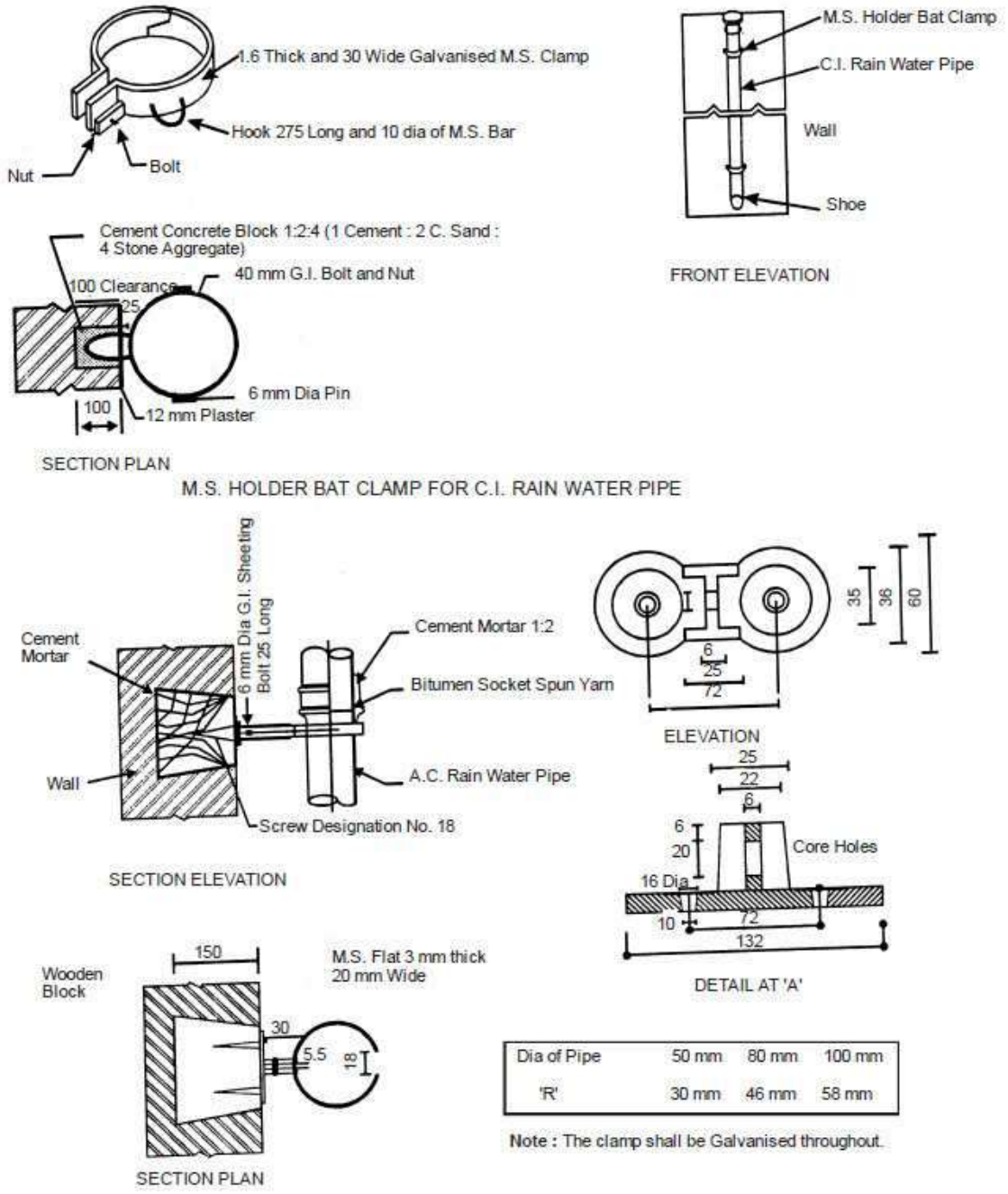
(A) Brick Tiles
(B) Mud Phuska/Lime Concrete
(C) Painting with Hot Bitumen 80/100 at 1.7 kg/sq.cm.
(D) R.C.C. Slab
(E) 6 mm Thick Ceiling Plaster Finished neat and Thick Coat of White Washing or Kraft Paper
(F) P.V.C. Sheet 1000 x 1000 (400 Micron Thick)

Drawing Not to Scale
All Dimensions are in mm

Fig. 12.7 : Cement Concrete Khurra – Gola

HOLDER BAT CLAMP

Sub Head : Roofing
Clause : 12.23, 12.24



Dia of Pipe	50 mm	80 mm	100 mm
'R'	30 mm	46 mm	58 mm

Note : The clamp shall be Galvanised throughout.

Drawing Not to Scale
All Dimensions are in mm

Fig. 12.8 : Holder Bat Clamp

सत्यमेव जयते

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Ministry of Housing and Urban Affairs

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SUB HEAD : 13.0

FINISHING

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1.	IS 16 (Pt-I)	Shellac : Part : I - Hand Made Shellac
	IS 16 (Pt-II)	Shellac : Part : II - Machine Made Shellac
2.	IS 75	Linseed Oil Raw and Refined
3.	IS 77	Linseed Oil Boiled For Paints
4.	IS 102	Ready Mixed Paint, Brushing, Red Lead, Nonsetting, Priming
5.	IS 104	Specification for Ready Mixed Paint, Brushing, Zinc Chrome, Priming
6.	IS 109	Ready Mixed Paint, brushing, priming Plaster to Indian Standard Colour No.361, 631 White and off White
7.	IS 117	Ready Mixed Paint, Brushing, Finishing Exterior, Semigloss for General Purposes to Indian Standards Colours.
8.	IS 133	Enamel, Interior (a) Under Coating (b) Finishing
9.	IS 137	Ready Mixed Paint, Brushing, Matt Or Egg Shell Flat, Finishing Interior to Indian Standard Colour as required
10.	IS 158	Ready Mixed Paint, Brushing, Bituminous Black, Lead Free, Acid, Alkali and Heat Resisting
11.	IS 217	Specification for Cut Back Bitumen
12.	IS 218	Specification for Creosote and Anthracene Oil For Use As Wood Preservatives
13.	IS 290	Coal Tar Black Paint
14.	IS 337	Varnish, Finishing Interior
15.	IS 341	Black Japan, Types 'A', 'B' & 'C'
16.	IS 347	Varnish, Shellac for General Purposes
17.	IS 348	French Polish
18.	IS 419	Putty for Use On Window Frames
19.	IS 427	Distemper, Dry Colour as Required
20.	IS 428	Distemper, Oil Emulsion, Colour as Required
21.	IS 524	Varnish, Finishing, Exterior, Synthetic Air Drying
22.	IS 533	Gum Spirit of Turpentine (Oil of Turpentine)
23.	IS 712	Specification For Building Limes
24.	IS 1200 (Pt-XII)	Method of Measurements of Building and Civil Engineering Works : Part : XII - Plastering and Pointing
25.	IS 1200 (Pt-XIII)	Method of Measurements of Building and Civil Engineering Works : Part : XIII - White Washing, Colour Washing Distempering and Painting of Building Surfaces.

26.	IS 1200 (Pt-XV)	Methods of Measurements of Building and Civil Engineering Works : Part : XV - Painting, Polishing, Varnishing etc.
27.	IS 2339	Aluminium Paint For General Purposes, in Dual Container
28.	IS 2547 (Pt-II)	Gypsum Building Plasters Pt.II Premixed Light Weight Plasters
29.	IS 2932	Enamel, Synthetic, Exterior (a) Undercoating, (b) Finishing
30.	IS 2933	Enamel, Exterior (a) Undercoating (b) Finishing
31.	IS 5410	Cement Paint
32.	IS 5411 (Pt-1)	Plastic Emulsion : Paint Part I For Interior Use
33.	IS 6278	Code of Practice For White Washing and Colour Washing
34.	IS 12777	Method for classification of flame spread of products

13.0 FINISHING

13.1 CEMENT PLASTER

The cement plaster shall be 12 mm, 15 mm or 20 mm thick as specified in the item.

13.1.1 Scaffolding

For all exposed brick work or tile work double scaffolding independent of the work having two sets of vertical supports shall be provided. The supports shall be sound and strong, tied together with horizontal pieces over which scaffolding planks shall be fixed.

For all other work in buildings, single scaffolding shall be permitted. In such cases the inner end of the horizontal scaffolding pole shall rest in a hole provided only in the header course for the purpose. Only one header for each pole shall be left out. Such holes for scaffolding shall, however, not be allowed in pillars/columns less than one metre in width or immediately near the skew backs of arches. The holes left in masonry works for scaffolding purposes shall be filled and made good before plastering.

Note : In case of special type of brick work, scaffolding shall be got approved from Engineer-in-charge in advance.

13.1.2 Preparation of Surface

The joints shall be raked out properly. Dust and loose mortar shall be brushed out. Efflorescence if any shall be removed by brushing and scrapping. The surface shall then be thoroughly washed with water, cleaned and kept wet before plastering is commenced.

In case of concrete surface if a chemical retarder has been applied to the form work, the surface shall be roughened by wire brushing and all the resulting dust and loose particles cleaned off and care shall be taken that none of the retarders is left on the surface.

13.1.3 Mortar

The mortar of the specified mix using the type of sand described in the item shall be used. It shall be as specified in Subhead 3.0. For external work and under coat work, the fine aggregate shall conform to grading IV. For finishing coat work the fine aggregate conforming to grading zone V shall be used.

13.1.4 Application of Plaster

13.1.4.1 Ceiling plaster shall be completed before commencement of wall plaster.

13.1.4.2 Plastering shall be started from the top and worked down towards the floor. All putlog holes shall be properly filled in advance of the plastering as the scaffolding is being taken down. To ensure even thickness and a true surface, plaster about 15 × 15 cm shall be first applied, horizontally and vertically, at not more than 2 metres intervals over the entire surface to serve as gauges. The surfaces of these gauged areas shall be truly in the plane of the finished plaster surface. The mortar shall then be laid on the wall, between the gauges with trowel. The mortar shall be applied in a uniform surface slightly more than the specified thickness. This shall be brought to a true surface, by working a wooden straight edge reaching across the gauges, with small upward and side ways movements at a time. Finally the surface shall be finished off true with trowel or wooden float according as a smooth or a sandy granular texture is required. Excessive troweling or over working the float shall be avoided.

13.1.4.3 All corners, arrises, angles and junctions shall be truly vertical or horizontal as the case may be and shall be carefully finished. Rounding or chamfering corners, arrises, provision of grooves at junctions etc. where required shall be done without any extra payment. Such rounding, chamfering or grooving shall be carried out with proper templates or battens to the sizes required.

13.1.4.4 When suspending work at the end of the day, the plaster shall be left, cut clean to line both horizontally and vertically. When recommencing the plastering, the edge of the old work shall be scrapped cleaned and wetted with cement slurry before plaster is applied to the adjacent areas, to enable the two to properly join together. Plastering work shall be closed at the end of the day on the body of wall and not nearer than 15 cm to any corners or arrises. It shall not be closed on the body of the features such as plasters, bands and cornices, nor at the corners of arrises. Horizontal joints in plaster work shall not also occur on parapet tops and copings as these invariably lead to leakages. The plastering and finishing shall be completed within half an hour of adding water to the dry mortar.

No portion of the surface shall be left out initially to be patched up later on. The plastering and finishing shall be completed within half an hour of adding water to the dry mortar.

13.1.5 Thickness

Where the thickness required as per description of the item is 20 mm the average thickness of the plaster shall not be less than 20 mm whether the wall treated is of brick or stone. In the case of brick work, the minimum thickness over any portion of the surface shall be not less than 15 mm while in case of stone work the minimum thickness over the bushings shall be not less than 12 mm.

13.1.6 Curing

Curing shall be started as soon as the plaster has hardened sufficiently not to be damaged when watered.

The plaster shall be kept wet for a period of at least 7 days. During this period, it shall be suitably protected from all damages at the contractor's expense by such means as the Engineer-in-Charge may approve. The dates on which the plastering is done shall be legibly marked on the various sections plastered so that curing for the specified period thereafter can be watched.

13.1.7 Finish

The plaster shall be finished to a true and plumb surface and to the proper degree of smoothness as required. The work shall be tested frequently as the work proceeds with a true straight edge not less than 2.5 m long and with plumb bobs. All horizontal lines and surfaces shall be tested with a level and all jambs and corners with a plumb bob as the work proceeds.

13.1.8 Precaution

Any cracks which appear in the surface and all portions which sound hollow when tapped, or are found to be soft or otherwise defective, shall be cut out in rectangular shape and redone as directed by the Engineer-in-Charge.

(i) When ceiling plaster is done, it shall be finished to chamfered edge at an angle at its junction with a suitable tool when plaster is being done. Similarly when the wall plaster is being done, it shall be kept separate from the ceiling plaster by a thin straight groove not deeper than 6 mm drawn with any suitable method with the wall while the plaster is green.

(ii) To prevent surface cracks appearing between junctions of column/beam and walls, 150 mm wide chicken wire mesh should be fixed with U nails 150 mm centre to centre before plastering the junction. The plastering of walls and beam/column in one vertical plane should be carried out in one go. For providing and fixing chicken wire mesh with U nails payment shall be made separately.

13.1.9 Measurements

13.1.9.1 Length and breadth shall be measured correct to a cm and its area shall be calculated in square metres correct to two places of decimal.

13.1.9.2 Thickness of the plaster shall be exclusive of the thickness of the key i.e. grooves, or open joints in brick work.

13.1.9.3 The measurement of wall plaster shall be taken between the walls or partitions (the dimensions before the plaster shall be taken) for the length and from the top of the floor or skirting to the ceiling for the height. Depth of coves or cornices if any shall be deducted.

13.1.9.4 The following shall be measured separately from wall plaster.

(a) Plaster bands 30 cm wide and under

(b) Cornice beadings and architraves or architraves moulded wholly in plaster.

(c) Circular work not exceeding 6 m in radius.

13.1.9.5 Plaster over masonry pilasters will be measured and paid for as plaster only.

13.1.9.6 A coefficient of 1.63 shall be adopted for the measurement of one side plastering on honey comb work having 6 x 10 cm. opening.

13.1.9.7 Moulded cornices and coves.

(a) Length shall be measured at the centre of the girth.

(b) Moulded cornices and coves shall be given in square metres the area being arrived at by multiplying length by the girth.

(c) Flat or weathered top to cornices when exceeding 15 cm in width shall not be included in the girth but measured with the general plaster work.

(d) Cornices which are curved in their length shall be measured separately.

13.1.9.8 Exterior plastering at a height greater than 10 m from average ground level shall be measured separately in each storey height. Patch plastering (in repairs) shall be measured as plastering new work, where the patch exceed 2.5 sqm. extra payment being made for preparing old wall, such as dismantling old plaster, raking out the joints and cleaning the surface. Where the patch does not exceed 2.5 sqm in area it shall be measured under the appropriate item under sub head 'Repairs to Buildings.'

13.1.9.9 Deductions in measurements, for opening etc. will be regulated as follows:

(a) No deduction will be made for openings or ends of joists, beams, posts, girders, steps etc. upto 0.5 sqm in area and no additions shall be made either, for the jambs, soffits and sills of such openings. The above procedure will apply to both faces of wall.

(b) Deduction for opening exceeding 0.5 sqm but not exceeding 3 sqm each shall be made for reveals, jambs, soffits sills, sills, etc. of these openings.

(i) When both faces of walls are plastered with same plaster, deductions shall be made for one face only.

(ii) When two faces of walls are plastered with different types of plaster or if one face is plastered and other is pointed or one face is plastered and other is unplastered, deduction shall be made from the plaster or pointing on the side of the frame for the doors, windows etc. on which width of reveals is less than that on the other side but no deduction shall be made on the other side.

Where width of reveals on both faces of wall are equal, deduction of 50% of area of opening on each face shall be made from area of plaster and/or pointing as the case may be.

(iii) For opening having door frame equal to or projecting beyond thickness of wall, full deduction for opening shall be made from each plastered face of wall.

(c) For opening exceeding 3 sqm in area, deduction will be made in the measurements for the full opening of the wall treatment on both faces, while at the same time, jambs, sills and soffits will be measured for payment.

In measuring jambs, sills and soffits, deduction shall not be made for the area in contact with the frame of doors, windows etc.

13.1.10 Rate

The rate shall include the cost of all labour and materials involved in all the operations described above.

13.2 CEMENT PLASTER WITH A FLOATING COAT OF NEAT CEMENT

13.2.0 The cement plaster shall be 12, 15 or 20 mm thick, finished with a floating coat of neat cement, as described in the item.

13.2.1 Specifications for this item of work shall be same as described in 13.1 except for the additional floating coat which shall be carried out as below.

When the plaster has been brought to a true surface with the wooden straight edge (clause 13.1.4.2) it shall be uniformly treated over its entire area with a paste of neat cement and rubbed smooth, so that the whole surface is covered with neat cement coating. The quantity of cement applied for floating coat shall be 1 kg per sqm. Smooth finishing shall be completed with trowel immediately and in no case later than half an hour of adding water to the plaster mix. The rest of the specifications described in 13.1.4 shall apply.

13.3 18 MM CEMENT PLASTER (TWO COAT WORK)

13.3.1 The specification for scaffolding and preparation of surface shall be as described in 13.1

13.3.2 Mortar

The mix and type of fine aggregate specified in the description of the item shall be used for the respective coats. Generally the mix of the finishing coat shall not be richer than the under coat unless otherwise described in item.

Generally coarse sand shall be used for the under coat and fine sand for the finishing coat, unless otherwise specified for external work and under coat work, the fine aggregate shall conform to grading zone IV. For finishing coat work the fine aggregate conforming to grading zone V shall be used.

13.3.3 Application

13.3.3.1 The plaster shall be applied in two coats i.e. 12 mm under coat and then 6 mm finishing coat and shall have an average total thickness of not less than 18 mm.

13.3.3.2 ***12 mm Under Coat*** **:** This shall be applied as specified in 13.1.4 except that when the plaster has been brought to a true surface a wooden straight edge and the surface shall be left rough and furrowed 2 mm deep with a scratching tool diagonally both ways, to form key for the finishing coat. The surface shall be kept wet till the finishing coat is applied.

13.3.3.3 ***6 mm Finishing Coat :*** The finishing coat shall be applied after the under coat has sufficiently set but not dried and in any case within 48 hours and finished in the manner specified in 13.1.4.

13.3.4 Specifications for Curing, Finishing, Precautions, Measurements and Rate shall be as described under 13.1.

13.4 6 MM CEMENT PLASTER ON CEMENT CONCRETE AND REINFORCED CEMENT CONCRETE WORK

13.4.1 Scaffolding

Stage scaffolding shall be provided for the work. This shall be independent of the walls.

13.4.2 Preparation of Surface

Projecting burrs of mortar formed due to the gaps at joints in shuttering shall be removed. The surface shall be scrubbed clean with wire brushes. In addition concrete surfaces to be plastered shall be pock marked with a pointed tool, at spacings of not more than 5 cm. Centres, the pock being made not less than 3 mm deep. This is to ensure a proper key for the plaster. The mortar shall be washed off and surface, cleaned off all oil, grease etc. and well wetted before the plaster is applied.

13.4.3 Mortars

Mortar of the specified mix using the types of sand described in the item shall be used. It shall be as specified in 3.2.

13.4.4 Application

To ensure even thickness and a true surface, gauges of plaster 15 x 15 cm. shall be first applied at not more than 1.5 m intervals in both directions to serve as guides for the plastering. Surface of these gauged areas shall be truly in the plane of the finished plaster surface. The plaster shall be then applied in a uniform surface to a thickness slightly more than the specified thickness and shall then be brought to true and even surface by working a wooden straight edge reaching across the gauges. Finally the surface shall be finished true with a trowel or with wooden float to give a smooth or sandy granular texture as required. Excess troweling or over working of the floats shall be avoided. The plastering and finishing shall be completed within half an hour of adding water to the dry mortar.

Plastering of ceiling shall not be commenced until the slab above has been finished and centring has been removed. In the case of ceiling of roof slabs, plaster shall not be commenced until the terrace work has been completed. These precautions are necessary in order that the ceiling plaster is not disturbed by the vibrations set up in the above operations.

13.4.5 Finish

The plaster shall be finished to a true and plumb surface and to the proper degree of smoothness as required. The work shall be tested frequently as the work proceeds with a true straight edge not less than 2.5 m long and with plumb bobs. All horizontal lines and surfaces shall be tested with a level and all jambs and corners with a plumb bob as the work proceeds.

13.4.6 Thickness

The average thickness of plaster shall not be less than 6 mm. The minimum thickness over any portion of the surface shall not be less than 5 mm.

13.4.7 Curing

The specifications shall be as detailed in 13.1.6.

13.4.8 Precautions

The specifications shall be as detailed in 13.1.8.

13.4.9 Measurements

13.4.9.1 Length and breadth shall be measured correct a cm. and its area shall be calculated in sqm. correct to two places of decimal. Dimensions before plastering shall be taken.

13.4.9.2 Thickness of plaster shall be exclusive of the thickness of the key i.e. depth or rock marks and hacking.

13.4.9.3 Plastering on ceiling at height greater than 5 m above the corresponding floor level shall be so described and shall be measured separately stating the height in stages of 1 m or part thereof.

13.4.9.4 Plastering on the sides and soffits of the projected beams of ceiling at a height greater than 5 m above the corresponding floor level shall be measured and added to the quantity measured under 13.4.9.3.

13.4.9.5 Plastering on spherical and groined ceiling and circular work not exceeding 6 m in radius, shall be measured and paid for separately.

13.4.9.6 Flowing soffits (*viz.* portion under spiral stair case etc.) shall be measured and paid for separately.

13.4.9.7 Ribs and mouldings on ceiling shall be measured as for cornices, deductions being made from the plastering on ceiling in case the width of the moulding exceed 15 cm.

13.4.9.8 The mode of measurement of exterior plastering and patch plastering (in repairs) shall be as laid down in 13.1.9.8

13.4.9.9 Deduction shall not be made for openings or for ends of columns, or columns caps of 0.5 sqm each in area and under. No additions will be made either for the plastering of the sides of such openings. For openings etc. of areas exceeding 0.5 sqm deduction will be made for the full opening but the sides of such openings shall be measured for payment.

13.4.10 Rate

The rate shall include the cost of all labour and materials involved in all the operations described above.

13.5 6 MM CEMENT PLASTER FOR SLAB BEARING

13.5.0 Cement plaster shall be 6 mm thick finished with a floating coat of neat cement and thick coat of lime wash on top of walls for bearing of slabs.

13.5.1 Application

The plaster shall be applied over the cleaned and wetted surface of the wall. When the plaster has been brought to a true surface with the wooden straight edge (Clause 13.1.4) it shall be uniformly treated over its entire area with a paste of neat cement and rubbed smooth, so that the whole surface is covered with neat cement coating. The quantity of cement applied for floating coat shall be 1 kg per sqm. Smooth finishing shall be completed with trowel immediately and in no case later than half an hour of adding water to the plaster mix. The rest of the specifications described in 13.1.4 shall apply.

13.5.2 Lime wash

This shall be applied in a thick coat after curing the plaster for three days.

13.5.3 Measurements

Length and breadth shall be measured correct to a cm and area worked out in sqm correct to two places of decimal.

13.5.4 Rate

The rate shall include the cost of all labour and materials involved in all the operations described above.

13.6 NEAT CEMENT PUNNING

13.6.1 The specifications given for floating coat described in 13.2.1 shall apply.

13.6.2 Specification for scaffolding and curing shall be as described in 13.1.1 and 13.1.6. respectively. Specifications for Finish and Precautions shall be as described in 13.1.7. and 13.1.8.

13.6.3 Measurements

13.6.3.1 The measurements for cement punning shall be taken over the finished work. The length and breadth shall be measured correct to a cm. The area shall be calculated in sqm correct to two places of decimal.

13.6.3.2 Punning over Plaster on bands, skirting, coping, cornices, drip courses, string courses etc. shall not be measured separately but only as wall surfaces. In these cases the measurements shall be taken girthed over the above features.

13.6.3.3 Punning over plaster on circular work also, of any radius shall be measured only as wall surfaces, and not separately.

13.6.3.4 Cement punning in patch repairs irrespective of the size of the patch shall be measured as new work, and in this case the rate shall include for cutting the patch to rectangular shape before lime punning.

13.6.3.5 Deductions in measurements for openings shall be regulated generally as described in 13.1.9.9.

13.6.4 Rate

The rate shall include the cost of all labour and materials involved in all the operations described above.

13.7 ROUGH CAST PLASTER

13.7.0 Rough cast finish comprises of a mixture of sand and gravel in specified proportions dashed over a freshly plastered surface.

13.7.1 Scaffolding

Scaffolding shall be done as specified in 13.1.1.

13.7.2 Preparation of Surface

The joints shall be raked out, dust and loose mortar, shall be brushed out. The surface shall be thoroughly washed with water, cleaned and kept wet before plastering is commenced.

13.7.3 Mortar

Mortar of specified mix using the type of sand described in the item shall be used, where coarse sand is to be used, the fineness modulus of the sand shall not be less than 2.5 mm.

13.7.4 Application

13.7.4.1 The plaster base over which rough cast finish is to be applied shall consist of two coats, under layer 12 mm thick and top layer 10 mm.

13.7.4.2 ***12 mm Under Layer :*** This shall be applied in the same manner as specified in para 13.1.3 under 18 mm cement plaster except that the finishing, after the mortar has been brought to a level with the wooden straight edge, shall be done with wooden float only.

13.7.4.3 ***Top Layer :*** The top layer shall be applied a day or two after the under layer has taken initial set. The latter shall not be allowed to dry out, before the top layer is laid on. The mortar used for applying top layer shall be sufficiently plastic and of rich mix 1 : 3 (1 cement : 3 fine sand) or as otherwise specified so that the mix of sand and gravel gets well pitched with the plaster surface. In order to make the base plastic, about 10% of finely grouted hydrated lime by volume of cement, shall be added when preparing mortar for the top layer.

13.7.5 Finish

It shall be ensured that the base surface which is to receive rough cast mixture is in plastic state. The rough cast mixture shall consist of sand or gravel or crushed stone of uniform colour from 2.36 mm to 12.5 mm or as specified and in the proportions as specified accurately to the effect required. The mixture shall be wetted and shall be dashed on the plaster base in plastic state by hand scoop so that the mix get well pitched into the plaster base. The mix shall again be dashed over the vacant spaces if any so that the surface represents a homogeneous surfaces of sand mixed with gravel. A sample of rough cast plaster shall be got approved by the Engineer-in-Charge.

13.7.6 Specification for other details like precautions, measurement and rate shall be as described under 13.1.

13.8 PEBBLE DASH FINISH (IN SITU WORK)

13.8.1 The specification shall be the same as for rough cast plaster, except that the washed pebble or crushed stone graded from 12.5 mm to 6.3 mm or as specified shall be dashed over the plaster base and the vacant spaces if any shall be filled in by pressing pebbles or crushed stone as specified by hand, so that the finished surface represents a homogeneous surface.

13.8.2 Specification for scaffolding, preparation of surface, Mortar, Measurements and Rate shall be as described under 13.7.

13.9 PLAIN BANDS OF CEMENT MORTAR

13.9.0 'Plain band' is a plaster strip of uniform width not exceeding 30 cm and of uniform thickness, provided for decorative or other purpose flush with, sunk below or projecting beyond, the wall plaster. A flush band is one where due to the difference in mix or shade of the mortar, the band is executed as a separate and distinct operation from the wall plaster.

13.9.1 Thickness

The thickness of a raised band is the thickness of the projection beyond the plane of the wall plaster.

In the case of a flush or a sunk band, the thickness will be the thickness of the plaster measured from the untreated wall surface.

13.9.2 Preparation of Surfaces and Application

13.9.2.1 In the case of flush or sunk bands the joints shall be raked out properly. Dust and loose mortar shall be brushed out. Efflorescence if any shall be removed by brushing the scraping. The surface shall then be thoroughly washed with water, cleaned and kept wet before plastering is commenced.

In case of concrete surface if a chemical retarder has been applied to the form work, the surface shall be roughened by wire brushing and all the resulting dust and loose particles cleaned off and care shall be taken that none of the retarders is left on the surface.

13.9.2.2 In case of raised band, the surface shall be prepared as specified in 13.1.4. The surface of the wall plaster behind the band shall be left rough and furrowed 2 mm deep with a scratching tool, diagonally both ways to form key for the band. No reduction in the rate for the above backing wall plaster shall, however, be made for not finishing the same smooth.

13.9.3 Mortar

Mortar of the mix and type of sand specified in the description of the item shall be used.

13.9.4 Finish

The bands shall be finished exactly to the size as shown in the drawings. The horizontal or vertical lines of bands shall be truly parallel and straight and the surfaces shall be finished truly plane and smooth. The lines and surfaces shall be checked with fine threads for straightness, level and accuracy.

13.9.5 Scaffolding, Curing and Precaution shall be as described under 13.1.

13.9.6 Measurements

Length will be measured in running metres correct to a cm. The length shall be taken along the finished face. The width shall not be measured by girth. For width of band 30 cm or below, the width shall be measured in cm correct to 5 mm. The quantity shall be calculated in metre-cm units.

13.9.7 Rate

The rate shall include the cost of all labour and materials involved in all the operations described above. Nothing extra shall be paid for mitres, stops nor for bands on curved surfaces of whatever radius, they may be. The rate is also inclusive of all rounding or chamfering at corners, arrisers, providing grooves at junctions etc.

13.10 MOULDED BANDS OF CEMENT MORTAR (SINGLE COAT WORK)

13.10.0 Moulded band is a plaster strip of uniform width but with varying thickness across its section formed over wall plaster for decorative purposes. The sectional periphery of the band is formed by a combination of straight lines or of curves or of straight lines and curves.

13.10.1 Thickness

The higher thickness stipulated in the description of the item shall refer to the upper limiting thickness of the moulding at its most projected portion, measured from the wall plaster.

13.10.2 Preparation of Surface, Mortar, Scaffolding, Curing and Precautions shall be as specified under 13.9.

13.10.3 Application and Finish

Proper templates conforming accurately to the sectional periphery of the moulded band shall be got approved, before use. The finished band shall be true to the template at all sections. The lines of the band shall be truly parallel and straight and surfaces smoothly finished.

13.10.4 Measurements

The width of the band 30 cm or below shall be measured in cm correct to 5 mm and shall be measured along the sectional periphery of the moulded band, from wall plaster face to wall plaster face. The length shall be measured, in running metres correct to a cm. It shall be taken along the finished face of the band at the centre of its girth. The quantity should be calculated in metre-cm units.

13.10.5 Rate

The rate shall include the cost of all labour and materials involved in all the operations described above. Nothing extra shall be paid for mitres, stops nor for bands on curved surfaces of whatever radius, they may be. The rate is also inclusive of all rounding or chamfering at corners, arrisers etc.

13.11 MOULDED BANDS OF CEMENT MORTAR (TWO COAT WORK)

13.11.0 Moulded band is a plaster strip of uniform width but with varying thickness across its section formed over wall plaster for decorative purposes. The sectional periphery of the band is formed by a combination of straight lines or of curves or of straight lines and curves.

13.11.1 Thickness

The higher thickness stipulated for the under coat in the description of the item shall refer to the upper limiting thickness of the under coat of the moulding at its most projected portion from the wall plaster.

The thickness stipulated for the finishing coat is the uniform thickness of the finished peripheral surface of the moulded band from the under coat.

13.11.2 Mortar

The under coat shall consist of cement mortar 1 : 5 (1 cement : 5 coarse sand) and the top coat shall be of cement mortar 1 : 4 (1 cement : 4 fine sand) unless otherwise specified in the description of item.

13.11.3 Application and Finish

Proper templates conforming to the sectional periphery of the moulded band as at the stages of the under coat and the finished final coat shall be made and got approved and used at the proper stages in executing the bands to true and accurate profile. The lines of the bands as finally completed shall be truly parallel and straight and the surfaces smoothly finished.

13.11.4 All other details shall be as specified under 13.10.

13.12 CEMENT WATER PROOFING COMPOUND

13.12.0 It shall be used for cement mortar for plastering or concrete work.

13.12.1 Water Proofing Compound

Integral cement water proofing compound conforming to IS 2645 and of approved brand and manufacture, enlisted by the Engineer-in-Charge from time to time shall be used.

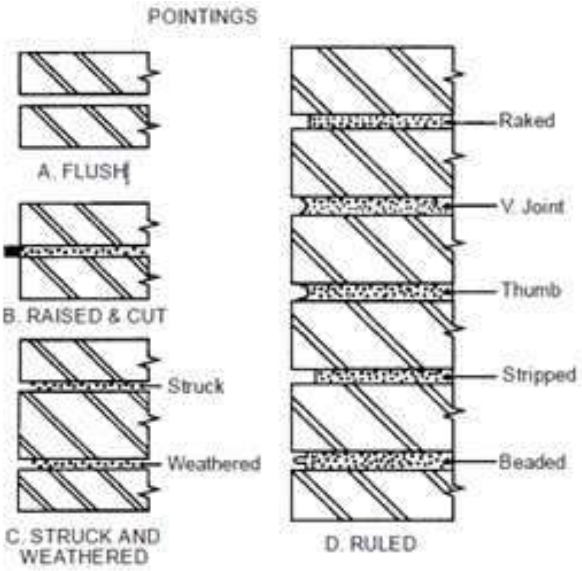
13.12.2 The contractor shall bring the materials to the site in their original packing. The containers will be opened and the material mixed with dry cement in the proportion by weight, recommended by the manufacturers or as specifically described in the description of the item. Care shall be taken in mixing, to see that the water proofing material gets well and integrally mixed with the cement and does not run out separately when water is added.

13.12.3 It shall be measured by weight.

13.12.4 The rate shall include the cost of all labour and materials involved in all the operations described above.

13.13 POINTING ON BRICK WORK, TILE WORK AND STONE WORK

13.13.0 Pointing shall be of the type shown in figure below:



Drawings not to Scale

13.13.1 Scaffolding

For all exposed brick work, tile work or stone work independent double scaffolding having two sets of vertical supports shall be provided. The supports shall be sound and strong tied together with horizontal pieces over which scaffolding planks shall be fixed.

For all other work in building, single scaffolding shall be permitted. In such cases, the inner end of the horizontal scaffolding pole shall rest in a hole provided only in the header course for the purpose. Only one header for each pole shall be left out. Such holes for scaffolding shall, however, not be allowed in pillars/columns less than one metre in width, or immediately near the skew backs of arches. The holes left in masonry works for scaffolding purposes shall be filled and made good before plastering.

Note : In case of special type of work, scaffolding shall be got approved from Engineer-in-Charge in advance.

13.13.2 Preparation of surface

The joints shall be raked out properly. Dust and loose mortar shall be brushed out. Efflorescence if any shall be removed by brushing and scraping. The surface shall then be thoroughly washed with water, cleaned and kept wet before pointing is commenced.

In case of concrete surface if a chemical retarder has been applied to the form work, the surface shall be roughened by wire brushing and all the resulting dust and loose particles cleaned off and care shall be taken that none of the retarders is left on the surface.

The joints shall be raked to such a depth that the minimum depth of the new mortar measured from either the sunk surface of the finished pointing or from the edge of the brick shall not be less than 12 mm.

13.13.3 Mortar

Mortar of specified mix shall be used. It shall be as specified under Chapter 3.0.

13.13.4 Application and Finishing

13.13.4.1 The mortar shall be pressed into the raked out joints, with a pointing trowel, either flush, sunk or raised, according to the type of pointing required. The mortar shall not spread over the corner, edges or surface of the masonry. The pointing shall then be finished with the proper tool, in the manner described below:

13.13.4.2 ***Flush Pointing :*** The mortar shall be pressed into the joints and shall be finished off flush and level with the edges of the bricks, tiles or stones so as to give a smooth appearance. The edges shall be neatly trimmed with a trowel and straight edge.

13.13.4.3 ***Ruled Pointing :*** The joints shall be initially formed as for flush pointing and then while the mortar is still green, a groove of shape and size as shown in drawings or as instructed, shall be formed by running a forming tool, straight along the centre line of the joints. This operation shall be continued till a smooth and hard surface is obtained. The vertical joints shall also be finished in a similar way. The vertical lines shall make true right angles at their junctions with the horizontal lines and shall not project beyond the same.

13. 13.4.4 ***Cut or Weather Struck Pointing:*** The mortar shall first be pressed into the joints. The top of the horizontal joints shall then be neatly pressed back about 3 mm or as directed, with the pointing tool so that the joints are sloping from top to bottom.

The vertical joints shall be ruled pointed. The junctions of vertical joints with the horizontal joints shall be at true right angles.

13.13.4.5 ***Raised and Cut Pointing :*** Raised and cut pointing shall project from the wall facing with its edges cut parallel so as to have a uniformly raised band about 6 mm raised and width 10 mm more as directed.

13.13.4.6 The superfluous mortar shall then be cut off from the edges of the lines and the surface of the masonry shall also be cleaned off all mortar. The finish shall be such that the pointing is to the exact size and shape required and the edges are straight, neat and clean.

13.13.5 Curing

The pointing shall be kept wet for seven days. During this period it shall be suitably protected from all damages.

The pointing lines shall be truly horizontal and vertical except where the joints are slanting as in rubble random masonry. Lines of joints from different directions should meet neatly at the junctions instead of crossing beyond.

13.13.6 Measurements

13.13.6.1 Length and breadth shall be measured correct to a cm and its area shall be calculated in square metres upto two places of decimal.

13.13.6.2 The various types of pointing for example, struck, keyed, flush, tuck, etc. shall each be measured separately.

13.13.6.3 Pointing on different types of walls, floors, roofs etc. shall each be measured separately. The type and material of the surface to be pointed shall be described.

13.13.6.4 Pointing in a single detached joint as for flashing shall be given in running metres.

13.13.6.5 For jambs, soffits, sills etc. for opening not exceeding 0.5 sqm each in area, ends of joists, beams, posts, girders, steps etc. not exceeding 0.5 sqm each in area and opening not exceeding 3 sqm each deductions and additions shall be made in the following way, in case of pointing on external face only.

(a) No deduction shall be made for ends of joists, beams, posts etc. and openings not exceeding 0.5 sqm each, and no addition shall be made for reveals, jambs, soffits, sills, etc. of these openings.

(b) Deductions for openings exceeding 0.5 sqm but not exceeding 3 sqm each shall be made as follows and no additions shall be made for reveals, jambs, soffits, sills, etc. for these openings.

(c) When both the faces of the wall are pointed with the same pointing deduction shall be made for one face only.

(d) When two faces of wall are pointed with different pointings or if one face is plastered and other is pointed or plastered, deduction shall be made from the plaster or pointing on the side of frames for doors, windows, etc. on which the width of the reveal is less than that on the other side, but no deduction shall be made from the other side.

(e) Where width of reveals on both faces of wall are equal, deduction of 50% of area of opening on each face shall be made from area of pointing or plaster as the case may be.

(f) For opening having door frame equal to or projecting beyond thickness of wall, full deduction for opening shall be made from each pointed face of wall.

13.13.6.6 In case of openings of area above 3 sqm each, deduction shall be made for the openings, but jambs, soffits and sills shall be measured.

13.13.6.7 The following shall be measured separately.

(a) Raking out joints for old work only shall be measured and given in square metres.

(b) Raking out joints of old work built in mud mortar, lime mortar and cement mortar shall each be measured separately.

(c) Raking out joints of different types of old walls, floors etc. shall each be measured separately.

(d) Raking single detached joints as for flashing old work shall be given in running metres.

13.13.7 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above.

13.13A WHITE CEMENT BASED POLYMER MODIFIED MORTAR

13.13A.1 Materials

Polymer modified mortar is a two component polymer modified repair mortar composed of powder component based on cement binder, properly graded aggregates and additives & second component is liquid polymer of approved make it is to be mixed with water on site to produce a highly consistent, high strength cement mortar. It is specially designed for repairs of RCC members like beams & columns, slabs & walls because it provides high compressive strength, high resistance to chlorides and carbon dioxide.

13.13A.2 Scaffolding

Scaffolding as required for the proper execution of the work shall be erected. If work can be done safely with the ladder or jhoola these will be permitted in place of scaffolding.

13.13A.3 Areas of Application

Repair & Reinstatement of Spalled concrete in RCC members beams, columns etc.

13.13A.4 Method of Application

13.13A.4.1 Surface Preparation

- Expose fully any corroded steel in the repair area and remove all scale and corrosion deposits mechanically or ideally by grit blasting.
- Clean the surface and remove loose concrete, any dust, oil paint, grease etc.

13.13A.4.2 Priming

- Apply zinc primer of approved make over the cleaned re-bars & allow to dry before repair.
- The substrate should be primed by applying one neat/clear of bonding agent of approved make.

13.13A.4.3 Mixing

- For normal application use of potable water as per manufacturer's specifications
- First add polymer into water and mix for 2 minutes.
- Then add powder slowly and mix till homogeneous mix is obtained. Mixing must be done with a mixer.

13.13A.4.4 Application

- Apply the mix to the prepared substrate by hand when primer becomes tacky. Ensure that the material has reached evenly behind bars.
- Mix can be applied in required thickness as per item in a single application.
- Mild cure the prepared surface with water for 3 days.

13.13A.5 Measurements

Length and breadth shall be measured correct to a cm. The area shall be calculated in square metre correct to two places of decimal.

Pre- measurements of the patches to be plastered shall be recorded after the old plaster has been cut and surface prepared.

13.13A.6 Rate

The rate includes the cost of all the materials and labour involved in all the operations described above.

13.14 WHITE WASHING WITH LIME

13.14.1 Scaffolding

13.14.1.1 Wherever scaffolding is necessary, it shall be erected on double supports tied together by horizontal pieces, over which scaffolding planks shall be fixed. No ballies, bamboos or planks shall rest on or touch the surface which is being white washed.

13.14.1.2 For all exposed brick work or tile work, double scaffolding having two sets of vertical supports shall be provided. The supports shall be sound and strong, tied together with horizontal pieces over which scaffolding planks shall be fixed.

Note: In case of special type of brick work, scaffolding shall be got approved from Engineer-in-Charge in advance.

13.14.1.3 Where ladders are used, pieces of old gunny bags shall be tied on their tops to avoid damage or scratches to walls.

13.14.1.4 For white washing the ceiling, proper stage scaffolding shall be erected.

13.14.2 Preparation of Surface

Before new work is white washed, the surface shall be thoroughly brushed free from mortar droppings an foreign matter.

In case of old work, all loose particles and scales shall be scrapped off and holes in plaster as well as patches of less than 50 cm area shall be filled up with mortar of the same mix. Where so specifically ordered by the Engineer -in- Charge, the entire surface of old white wash shall be thoroughly removed by scrapping and this shall be paid for separately. Where efflorescence is observed the deposits may be brushed clean and washed. The surface shall then be allowed to dry for atleast 48 hours before white washing is done.

13.14.3 Preparation of Lime Wash

13.14.3.1 The lime wash shall be prepared from fresh stone white lime (Narnaul or Dehradun quality). The lime shall be thoroughly slaked on the spot, mixed and stirred with sufficient water to make a thin cream. This shall be allowed to stand for a period of 24 hours and then shall be screened through a clean coarse cloth. 40 gm of gum dissolved in hot water, shall be added to each 10 cubic dicimetre of the cream. The approximate quantity of water to be added in making the cream will be 5 litres of water to one kg of lime.

13.14.3.2 Indigo (Neel) upto 3 gm per kg of lime dissolved in water, shall then be added and stirred well. Water shall then be added at the rate of about 5 litres per kg. of lime to produce a milky solution.

13.14.4 Application

13.14.4.1 The white wash shall be applied with moonj brushes to the specified number of coats. The operation for each coat shall consist of a stroke of the brush given from the top downwards, another from the bottom upwards over the first stroke, and similarly one stroke horizontally from the right and another from the left before it dries.

13.14.4.2 Each coat shall be allowed to dry before the next one is applied. Further each coat shall be inspected and approved by the Engineer-in-Charge before the subsequent coat is applied. No portion of the surface shall be left out initially to be patched up later on.

13.14.4.3 For new work, three or more coats shall be applied till the surface presents a smooth and uniform finish through which the plaster does not show. The finished dry surface shall not show any signs of cracking and peeling nor shall it come off readily on the hand when rubbed.

13.14.4.4 For old work, after the surface has been prepared as described in para 13.14.2 a coat of white wash shall be applied over the patches and repairs. Then a single coat or two or more coats of white wash as stipulated in the description of the item shall be applied over the entire surface. The white washed surface should present a uniform finish through which the plaster patches do not appear. The washing on ceiling should be done prior to that on walls.

Note : In case of Hessian ceiling, on no account, lime shall be used as it rots cloth and hessian.

13.14.5 Protective Measures

Doors, windows, floors, articles of furniture etc. and such other parts of the building not to be white washed, shall be protected from being splashed upon. Splashings and droppings, if any shall be removed by the contractor at his own cost and the surfaces cleaned. Damages if any to furniture or fittings and fixtures shall be recoverable from the contractor.

13.14.6 Measurements

13.14.6.1 Length and breadth shall be measured correct to a cm. and area shall be calculated in sqm correct to two places of decimals.

13.14.6.2 Measurements for Jambs, Soffits and Fills etc. for openings shall be as described in 13.1.9.

13.14.6.3 Corrugated surfaces shall be measured flat as fixed and the area so measured shall be increased by the following percentages to allow for the girthed area.

Corrugated non-asbestos cement sheet	20%
Semi corrugated non-asbestos cement sheet	10%

13.14.6.4 Cornices and other such wall or ceiling features, shall be measured along the girth and included in the measurements.

13.14.6.5 The number of coats of each treatment shall be stated. The item shall include removing nails, making good holes, cracks, patches etc. not exceeding 50 sq. cm. each with material similar in composition to the surface to be prepared.

13.14.6.6 Work on old treated surfaces shall be measured separately and so described.

13.14.7 Rate

The rate shall include all material and labour involved in all the operations described above.

13.15 SATNA LIME WASHING

13.15.0 Satna lime wash shall be used as a base coat where so specified. The specifications for 'white washing with lime' shall apply except that Satna or Katni quality lime shall be used in place of Narnaul or Dehradun quality lime and the wash will be mixed to a thicker consistency. The other details and specifications described in 13.14 will apply in toto.

13.16 WHITE WASHING WITH WHITING

13.16.1 Preparation of Mix

Whiting (ground white chalk) shall be dissolved in sufficient quantity of warm water and thoroughly stirred to form a thin slurry which shall then be screened through a clean coarse cloth. Two kg of gum and 0.4 kg of copper sulphate dissolved separately in hot water shall be added for every cum of the slurry which shall then be diluted with water to the consistency of milk so as to make a wash ready for use.

13.16.2 Other specifications described in 13.14 shall apply in this case also.

13.17 COLOUR WASHING

13.17.1 The mineral colours, not affected by lime, shall be added to white wash. Indigo (Neel) shall however, not be added. No colour wash shall be done until a sample of the colour wash of the required tint or shade has been got approved from the Engineer-in-Charge. The colour shall be of even tint or shade over the whole surface. If it is blotchy or otherwise badly applied, it shall be redone by the contractor.

For new work, the priming coat shall be of white wash with lime or with whiting as specified in the description of the item. Two or more coats, shall then be applied on the entire surface till it represents a smooth and uniform finish.

For old work, after the surface has been prepared as described in 13.14.2 a coat of colour wash shall be applied over the patches and repairs. Then a single coat, or two or more coats of colour wash, as stipulated in the description of the item shall be applied over the entire surface. The colour washed surface shall present a uniform finish.

The finished dry surface shall not be powdery and shall not readily come off on the hand when rubbed.

13.17.2 Other specifications as described under 13.14.

13.18 DRY DISTEMPERING

13.18.1 Materials

Dry distemper of required colour (IS 427) and of approved brand and manufacture shall be used. The shade shall be got approved from the Engineer-in-Charge before application of the distemper. The dry distemper colour as required shall be stirred slowly in clean water using 6 decilitres (0.6 litre) of water per kg of distemper or as specified by the makers. Warm water shall preferably be used. It shall be allowed to stand for at least 30 minutes (or if practicable over night) before use. The mixture shall be well stirred before and during use to maintain an even consistency.

Distemper shall not be mixed in larger quantity than is actually required for one day's work.

13.18.2 Preparation of Surface

13.18.2.1 Before new work is distempered, the surface shall be thoroughly brushed free from mortar droppings and other foreign matter and sand papered smooth.

13.18.2.2 New plastered surfaces shall be allowed to dry completely, before applying, distemper.

13.18.2.3 In the case of old work, all loose pieces and scales shall be removed by sand papering. The surface shall be cleaned of all grease, dirt, etc.

13.18.2.4 Pitting in plaster shall be made good with plaster of paris mixed with the colour to be used. The surface shall then be rubbed down again with a fine grade sand paper and made smooth. A coat of the distemper shall be applied over the patches. The patched surface shall be allowed to dry thoroughly before the regular coat of distemper is applied.

13.18.3 Priming Coat

A priming coat of whiting (see 13.16) shall be applied over the prepared surface in case of new work, if so stipulated in the description of the item. No white washing coat shall be used as a priming coat for distemper.

The treated surface be allowed to dry before distemper coat is given.

13.18.4 Application

13.18.4.1 In the case of new work, the treatment shall consist of a priming coat of whiting (As per 13.16) followed by the application of two or more coats of distemper till the surface shows an even colour.

13.18.4.2 For old work, the surface prepared as described in para 13.14 shall be applied one or more coats of distemper till the surface attains an even colour.

13.18.4.3 The application of each coat shall be as follows:

The entire surface shall be coated with the mixture uniformly, with proper distemper brushes (ordinary white wash brushed shall not be allowed) in horizontal strokes followed immediately by vertical ones which together shall constitute one coat.

13.18.4.4 The subsequent coats shall be applied only after the previous coat has dried.

13.18.4.5 The finished surface shall be even and uniform and shall show no brush marks.

13.18.4.6 Enough distemper shall be mixed to finish one room at a time. The application of a coat in each room shall be finished in one operation and no work shall be started in any room, which cannot be completed the same day.

13.18.4.7 After each day's work, the brushes shall be washed in hot water and hung down to dry. Old brushes which are dirty or caked with distemper shall not be used.

13.18.5 The specifications in respect of scaffolding, protective measures, measurements and rate shall be as described under 13.14.

13.19 OIL EMULSION (OIL BOUND) WASHABLE DISTEMPERING

13.19.1 Materials

Oil emulsion (Oil Bound) washable distemper (IS 428) of approved brand and manufacture shall be used. The primer where used as on new work shall be cement primer or distemper primer as described in the item. These shall be of the same manufacture as distemper. The distemper shall be diluted with water or any other prescribed thinner in a manner recommended by the manufacturer. Only sufficient quantity of distemper required for day's work shall be prepared.

The distemper and primer shall be brought by the contractor in sealed tins in sufficient quantities at a time to suffice for a fortnight's work, and the same shall be kept in the joint custody of the contractor and the Engineer-in-Charge. The empty tins shall not be removed from the site of work, till this item of work has been completed and passed by the Engineer-in-Charge.

13.19.2 Preparation of the Surface

13.19.2.1 For new work the surface shall be thoroughly cleaned of dust, old white or colour wash by washing and scrubbing. The surface shall then be allowed to dry for at least 48 hours. It shall then be sand papered to give a smooth and even surface. Any unevenness shall be made good by applying putty, made of plaster of paris mixed with water on the entire surface including filling up the undulations and then sand papering the same after it is dry.

13.19.2.2 In the case of old work, all loose pieces and scales shall be removed by sand papering. The surface shall be cleaned of all grease, dirt etc.

Pitting in plaster shall be made good with plaster of paris mixed with the colour to be used. The surface shall then be rubbed down again with a fine grade sand paper and made smooth. A coat of the distemper shall be applied over the patches. The patched surface shall be allowed to dry thoroughly before the regular coat of distemper is applied.

13.19.3 Application

13.19.3.1 ***Priming Coat :*** The priming coat shall be with distemper primer or cement primer, as required in the description of the item. The application of the distemper primer shall be as described in 13.18.4.

Note : If the wall surface plaster has not dried completely, cement primer shall be applied before distempering the walls. But if distempering is done after the wall surface is dried completely, distemper primer shall be applied.

Oil bound distemper is not recommended to be applied, within six months of the completion of wall plaster. However, newly plastered surfaces if required to be distempered before a period of six months shall be given a coat of alkali resistant priming Paint conforming to IS 109 and allowed to dry for atleast 48 hours before distempering is commenced.

For old work no primer coat is necessary.

13.19.3.2 ***Distemper Coat :*** For new work, after the primer coat has dried for at least 48 hours, the surface shall be lightly sand papered to make it smooth for receiving the distemper, taking care not to rub out the priming coat. All loose particles shall be dusted off after rubbing. One coat of distemper properly diluted with thinner (water or other liquid as stipulated by the manufacturer) shall be applied with brushes in horizontal strokes followed immediately by vertical ones which together constitutes one coat.

The subsequent coats shall be applied in the same way. Two or more coats of distemper as are found necessary shall be applied over the primer coat to obtain an even shade.

A time interval of at least 24 hours shall be allowed between successive coats to permit proper drying of the preceding coat.

For old work the distemper shall be applied over the prepared surface in the same manner as in new work. One or more coats of distemper as are found necessary shall be applied to obtain an even and uniform shade.

15 cm double bristled distemper brushes shall be used. After each days work, brushes shall be tho-roughly washed in hot water with soap solution and hung down to dry. Old brushes which are dirty and caked with distemper shall not be used on the work.

13.19.4 The specifications in respect of scaffolding, protective measures and measurements shall be as described under 13.14.

13.19.5 Rate

The rate shall include the cost of all labour and materials involved in all the above operations (including priming coat) described above.

13.19A 1st QUALITY ACRYLIC DISTEMPER

13.19A.1 Materials

1st quality acrylic distemper having VOC content less than 50 gms/litre of approved brand and manufacture shall be used. The acrylic distemper shall be diluted with water or any other prescribed thinner in a manner recommended by the manufacturer. Only sufficient quantity of distemper required for day's work shall be prepared.

The distemper shall be brought by the contractor in sealed tins in sufficient quantities at a time to suffice for a fortnight's work, and the same shall be kept in the joint custody of the contractor and the Engineer-in-Charge. The empty tins shall not be removed from the site of work, till this item of work has been completed and passed by the Engineer-in-Charge.

13.19A.2 Preparation of the Surface

13.19A.2.1 For new work the surface shall be thoroughly cleaned of dust, old white or colour wash by washing and scrubbing. The surface shall then be allowed to dry for at least 48 hours. It shall then be sand papered to give a smooth and even surface. Any unevenness shall be made good by applying putty, made of plaster of paris mixed with water on the entire surface including filling up the undulations and then sand papering the same after it is dry.

13.19A.2.2 In the case of old work, all loose pieces and scales shall be removed by sand papering. The surface shall be cleaned of all grease, dirt etc.

Pitting in plaster shall be made good with plaster of paris mixed with the colour to be used. The surface shall then be rubbed down again with a fine grade sand paper and made smooth. A coat of the distemper shall be applied over the patches. The patched surface shall be allowed to dry thoroughly before the regular coat of distemper is applied.

13.19A.3 Application

13.19A.3.1 ***Priming Coat :*** The priming coat shall be with distemper primer or cement primer, as required in the description of the item. The application of the distemper primer shall be as described in 13.18.4.

Note : If the wall surface plaster has not dried completely, cement primer shall be applied before distempering the walls. But if distempering is done after the wall surface is dried completely, distemper primer shall be applied.

For old work no primer coat is necessary.

13.19A.3.2 ***Distemper Coat :*** For new work, after the primer coat has dried for at least 48 hours, the surface shall be lightly sand papered to make it smooth for receiving the distemper, taking care not to rub out the priming coat. All loose particles shall be dusted off after rubbing. One coat of distemper properly diluted with thinner (water or other liquid as stipulated by the manufacturer) shall be applied with brushes in horizontal strokes followed immediately by vertical ones which together constitutes one coat.

The subsequent coats shall be applied in the same way. Two or more coats of distemper as are found necessary shall be applied over the primer coat to obtain an even shade.

A time interval of at least 24 hours shall be allowed between successive coats to permit proper drying of the preceding coat.

For old work the distemper shall be applied over the prepared surface in the same manner as in new work. One or more coats of distemper as are found necessary shall be applied to obtain an even and uniform shade.

15 cm double bristled distemper brushes shall be used. After each days work, brushes shall be tho-roughly washed in hot water with soap solution and hung down to dry. Old brushes which are dirty and caked with distemper shall not be used on the work.

13.19A.4 The specifications in respect of scaffolding, protective measures and measurements shall be as described under 13.14.

13.19A.5 Rate

The rate shall include the cost of all labour and materials involved in all the above operations (including priming coat) described above.

13.20 CEMENT PRIMER COAT

13.20.0 Cement primer coat is used as a base coat on wall finish of cement, lime or lime cement plaster or on non-asbestos cement surfaces before oil emulsion distemper Paints are applied on them. The cement primer is composed of a medium and pigment which are resistant to the alkalies present in the cement, lime or lime cement in wall finish and provides a barrier for the protection of subsequent coats of oil emulsion distemper Paints.

Primer coat shall be preferably applied by brushing and not by spraying. Hurried priming shall be avoided particularly on absorbent surfaces. New plaster patches in old work should also be treated with cement primer before applying oil emulsion Paints etc.

13.20.1 Preparation of the Surface

The surface shall be thoroughly cleaned of dust, old white or colour wash by washing and scrubbing. The surface shall then be allowed to dry for at least 48 hours. It shall then be sand papered to give a smooth and even surface. Any uneveness shall be made good by applying putty, made of plaster of paris mixed with water on the entire surface including filling up the undulations and then sand papering the same after it is dry.

13.20.2 Application

The cement primer shall be applied with a brush on the clean dry and smooth surface. Horizontal strokes shall be given first and vertical strokes shall be applied immediately afterwards. This entire operation will constitute one coat. The surface shall be finished as uniformly as possible leaving no brush marks. It shall be allowed to dry for at least 48 hours, before oil emulsion Paint is applied.

13.20.3 The Specifications in respect of scaffolding, protective measures, measurements and rate shall be as described under 13.1.4.

13.21 CEMENT PAINT

13.21.1 Material

The cement Paint shall be (conforming to IS 5410) of approved brand and manufacture.

The cement Paint shall be brought to the site of work by the contractor in its original containers is sealed condition. The material shall be brought in at a time in adequate quantities to suffice for the whole work or at least a fortnight's work. The materials shall be kept in the joint custody of the Contractor and the Engineer-in- Charge. The empty containers shall not be removed from the site of work till the relevant item of the work has been completed and permission obtained from the Engineer-in-Charge.

13.21.2 Preparation of Surface

For New Work, the surface shall be thoroughly cleaned of all mortar dropping, dirt dust, algae, grease and other foreign matter by brushing and washing. Pitting in plaster shall be made good and a coat of water proof cement Paint shall be applied over patches after wetting them thoroughly.

13.21.3 Preparation of Mix

Cement Paint shall be mixed in such quantities as can be used up within an hour of its mixing as otherwise the mixture will set and thicken, affecting flow and finish. Cement Paint shall be mixed with water in two stages. The first stage shall comprise of 2 parts of cement Paint and one part of water stirred thoroughly and allowed to stand for 5 minutes. Care shall be taken to add the cement Paint gradually to the water and not *vice versa*. The second stage shall comprise of adding further one part of water to the mix and stirring thoroughly to obtain a liquid of workable and uniform consistency. In all cases the manufacturer's instructions shall be followed meticulously.

The lids of cement Paint drums shall be kept tightly closed when not in use, as by exposure to atmosphere the cement Paint rapidly becomes air set due to its hygroscopic qualities.

In case of cement Paint brought in gunny bags, once the bag is opened, the contents should be consumed in full on the day of its opening. If the same is not likely to be consumed in full, the balance quantity should be transferred and preserved in an airtight container to avoid its exposure to atmosphere.

13.21.4 Application

13.21.4.1 The solution shall be applied on the clean and wetted surface with brushes or spraying machine. The solution shall be kept well stirred during the period of application. It shall be applied on the surface which is on the shady side of the building so that the direct heat of the sun on the surface is avoided. The method of application of cement Paint shall be as per manufacturer's specification. The completed surface shall be watered after the day's work.

13.21.4.2 The second coat shall be applied after the first coat has been set for at least 24 hours. Before application of the second or subsequent coats, the surface of the previous coat shall not be wetted.

13.21.4.3 For new work, the surface shall be treated with three or more coats of water proof cement Paint as found necessary to get a uniform shade.

13.21.4.4 For old work, the treatment shall be with one or more coats as found necessary to get a uniform shade.

13.21.5 Precaution

Water proof cement Paint shall not be applied on surfaces already treated with white wash, colour wash, distemper dry or oil bound, varnishes, Paints etc. It shall not be applied on gypsums, wood and metal surfaces.

If water proofing cement is required to be applied on existing surface, previously treated with white wash, colour wash etc., the surface shall be thoroughly cleaned by scrapping off all the white wash, colour wash etc. completely. Thereafter, a coat of cement primer shall be applied followed by two or more coat of water proof cement.

13.21.6 The specifications in respect of scaffolding, protective measures, measurements and rate shall be as described under 13.14. The coefficient for cement Paint on RCC Jalli shall be the same as provided in Sl. No. 7 of Table 1 under para 13.23.6.4 for painting trellis for Jaffri work.

13.22 EXTERIOR PAINTING ON WALL

13.22.1 Material

The paint shall be (Texured exterior paint/Acrylic smooth exterior paint/premium acrylic smooth exterior paint/100% premium acrylic emulsion paint) of approved brand and manufacture.

This paint shall be brought to the site of work by the contractor in its original containers in sealed condition. The material shall be brought in at a time in adequate quantities to suffice for the whole work or at least a fornight's work. The materials shall be kept in the joint custody of the contractor and the Engineer-in- Charge. The empty containers shall not be removed from the site of work till the relevant item of work has been completed and permission obtained from the Engineer-in-Charge.

13.22.2 Preparation of Surface

For new work, the surface shall be thoroughly cleaned off all mortar dropping, dirt dust, algae, fungus or moth, grease and other foreign matter of brushing and washing, pitting in plaster shall make good, surface imperfections such as cracks, holes etc. should be repaired using white cement. The prepared surface shall have received the approval of the Engineer in charge after inspection before painting is commenced.

13.22.3 Application

Base coat of water proofing cement paint

13.22.3.1 All specifications in respect of base coat of water proofing cement paint shall be as described under 13.21.

13.22.3.2 Before pouring into smaller containers for use, the paint shall be stirred thoroughly in its container, when applying also the paint shall be continuously stirred in the smaller containers so that its consistency is kept uniform. Dilution ratio of paint with potable water can be altered taking into consideration the nature of surface climate and as per recommended dilution given by manufacturer. In all cases, the manufacturer's instructions & directions of the Engineer-in-charge shall be followed meticulously.

The lids of paint drums shall be kept tightly closed when not in use as by exposure to atmosphere the paint may thicken and also be kept safe from dust.

13.22.3.3 Paint shall be applied with a brush on the cleaned and smooth surface. Horizontal strokes shall be given, First and vertical strokes shall be applied immediately afterwards. This entire operation will constitute one coat. The surface shall be finished as uniformly as possible leaving no brush marks.

13.22.4 The specifications in respect of scaffolding, protective measures, measurements and rate shall be as described under 13.14.

13.22A DELUXE MULTI SURFACE PAINT FOR INTERIORS AND EXTERIORS

13.22A.1 Material

The paint shall be (Deluxe multi surface paint for interiors and exteriors) of approved brand and manufacture.

This paint shall be brought to the site of work by the contractor in its original containers in sealed condition. The material shall be brought in at a time in adequate quantities to suffice for the whole work or at least a fornight's work. The materials shall be kept in the joint custody of the contractor and the Engineer-in- Charge. The empty containers shall not be removed from the site of work till the relevant item of work has been completed and permission obtained from the Engineer-in-Charge.

13.22A.2 Preparation of Surface

For new work, the surface shall be thoroughly cleaned off all mortar dropping, dirt dust, algae, fungus or moth, grease and other foreign matter of brushing and washing, pitting in plaster shall make good, surface imperfections such as cracks, holes etc. should be repaired using white cement. The prepared surface shall have received the approval of the Engineer in charge after inspection before painting is commenced.

13.22A.3 Application

Base coat of special primer of same manufacturer shall be used.

13.22A.3.1 All specifications in respect of base coat of water proofing cement paint shall be as described under 13.21.

13.22A.3.2 Before pouring into smaller containers for use, the paint shall be stirred thoroughly in its container, when applying also the paint shall be continuously stirred in the smaller containers so that its consistency is kept uniform. Dilution ratio of paint with potable water can be altered taking into consideration the nature of surface climate and as per recommended dilution given by manufacturer. In all cases, the manufacturer's instructions & directions of the Engineer-in-charge shall be followed meticulously.

The lids of paint drums shall be kept tightly closed when not in use as by exposure to atmosphere the paint may thicken and also be kept safe from dust.

13.22A.3.3 Paint shall be applied with a brush on the cleaned and smooth surface. Horizontal strokes shall be given, First and vertical strokes shall be applied immediately afterwards. This entire operation will constitute one coat. The surface shall be finished as uniformly as possible leaving no brush marks.

13.22A.4 The specifications in respect of scaffolding, protective measures, measurements and rate shall be as described under 13.14.

13.23 PAINTING

13.23.1 Materials

Paints, oils, varnishes etc. of approved brand and manufacture shall be used. Only ready mixed Paint (Exterior grade) as received from the manufacturer without any admixture shall be used.

If for any reason, thinning is necessary in case of ready mixed Paint, the brand of thinner recommended by the manufacturer or as instructed by the Engineer-in-Charge shall be used.

Approved Paints, oil or varnishes shall be brought to the site of work by the contractor in their original containers in sealed condition. The material shall be brought in at a time in adequate quantities to suffice for the whole work or at least a fortnight's work. The materials shall be kept in the joint custody of the contractor and the Engineer-in -Charge. The empties shall not be removed from the site of work, till the relevant item of work has been completed and permission obtained from the Engineer-in-Charge.

13.23.2 Commencing Work

Painting shall not be started until the Engineer -in-Charge has inspected the items of work to be painted, satisfied himself about their proper quality and given his approval to commence the painting work. Painting of external surface should not be done in adverse weather condition like hail storm and dust storm.

Painting, except the priming coat, shall generally be taken in hand after practically finishing all other building work.

The rooms should be thoroughly swept out and the entire building cleaned up, at least one day in advance of the Paint work being started.

13.23.3 Preparation of Surface

The surface shall be thoroughly cleaned and dusted off. All rust, dirt, scales, smoke splashes, mortar droppings and grease shall be thoroughly removed before painting is started. The prepared surface shall have received the approval of the Engineer-in-Charge after inspection, before painting is commenced.

13.23.4 Application

13.23.4.1 Before pouring into smaller containers for use, the Paint shall be stirred thoroughly in its containers, when applying also, the Paint shall be continuously stirred in the smaller containers so that its consistency is kept uniform.

13.23.4.2 The painting shall be laid on evenly and smoothly by means of crossing and laying off, the latter in the direction of the grains of wood. The crossing and laying off consists of covering the area over with Paint, brushing the surface hard for the first time over and then brushing alternately in opposite direction, two or three times and then finally brushing lightly in a direction at right angles to the same. In this process, no brush marks shall be left after the laying off is finished. The full process of crossing and laying off will constitute one coat.

13.23.4.3 Where so stipulated, the painting shall be done by spraying. Spray machine used may be (a) high pressure (small air aperture) type, or (b) a low pressure (large air gap) type, depending on the nature and location of work to be carried out. Skilled and experienced workmen shall be employed for this class of work. Paints used shall be brought to the requisite consistency by adding a suitable thinner.

13.23.4.4 Spraying should be done only when dry condition prevails. Each coat shall be allowed to dry out thoroughly and rubbed smooth before the next coat is applied. This should be facilitated by thorough ventilation. Each coat except the last coat, shall be lightly rubbed down with sand paper or fine pumice stone and cleaned off dust before the next coat is laid.

13.23.4.5 No left over Paint shall be put back into the stock tins. When not in use, the containers shall be kept properly closed.

13.23.4.6 No hair marks from the brush or clogging of Paint puddles in the corners of panels, angles of mouldings etc. shall be left on the work.

13.23.4.7 In painting doors and windows, the putty round the glass panes must also be painted but care must be taken to see that no Paint stains etc. are left on the glass. Tops of shutters and surfaces in similar hidden locations shall not be left out in painting. However, bottom edge of the shutters where the painting is not practically possible, need not be done nor any deduction on this account will be done but two coats of primer of approved make shall be done on the bottom edge before fixing the shutters.

13.23.4.8 On painting steel work, special care shall be taken while painting over bolts, nuts, rivets overlaps etc.

13.23.4.9 The additional specifications for primer and other coats of Paints shall be as according to the detailed specifications under the respective headings.

13.23.5 Brushes and Containers

After work, the brushes shall be completely cleaned of Paint and linseed oil by rinsing with turpentine. A brush in which Paint has dried up is ruined and shall on no account be used for painting work. The containers when not in use, shall be kept closed and free from air so that Paint does not thicken and also shall be kept safe from dust. When the Paint has been used, the containers shall be washed with turpentine and wiped dry with soft clean cloth, so that they are clean, and can be used again.

13.23.6 Measurements

13.23.6.1 The length and breadth shall be measured correct to a cm. The area shall be calculated in sqm (correct to two places of decimal), except otherwise stated.

13.23.6.2 Small articles not exceeding 10 sq. decimetre (0.1 sqm) of painted surfaces where not in conjunction with similar painted work shall be enumerated.

13.23.6.3 Painting upto 10 cm in width or in girth and not in conjunction with similar painted work shall be given in running metres and shall include cutting to line where so required.

Note : Components of trusses, compound girders, stanchions, lattices and similar work shall, however, be given in sq. metres irrespective of the size or girth of members. Priming coat of painting shall be included in the work of fabrication.

13.23.6.4 In measuring painting, varnishing, oiling etc. of joinery and steel work etc. The coefficients as indicated in following tables shall be used to obtain the area payable. The coefficients shall be applied to the areas measured flat and not girthed.

TABLE 13.1
Equivalent Plain Areas of Uneven Surface

S.No	Description of work	How measured	Multiplying coefficient
1	2	3	4
I. Wood work doors, windows Etc.			
1.	Panelled or framed and braced doors, windows etc.	Measured flat (not girthed including)	1.30 (for each side)
2.	Ledged and battened or ledged, battened and braced doors, windows etc.	Chowkhat or frame, Edges, chocks, cleats, etc. shall be deemed to be included in the item.	-do-
3.	Flush doors etc.	-do-	1.20 (for each side)
4.	Part panelled and part glazed or gauzed doors, window etc. (Excluding painting of wire gauze portion)	-do-	1.00 (for each side)
5.	Fully glazed or gauzed doors, windows etc. (Excluding painting of wire gauze portion)	-do-	0.80 (for each side)
6.	Fully venetioned or louvered doors, windows etc.	-do-	1.80 (for each side)
7.	Trellis (or Jaffri) work one way or two way	Measured flat overall, no deduction shall be made for open spaces, supporting members shall not be measured separately	2 (for painting all over)
8.	Carved or enriched work	Measured flat	
9.	Weather boarding	Measured flat (not girthed supporting frame work shall not be measured separately	1.20 (for each side)
10.	Wood shingle roofing	Measured flat (not girthed)	1.10 (for each side)
11.	Boarding with cover fillets and match boarding	Measured flat (not girthed)	1.05 (for each side)
12.	Tile and slate battening	Measured flat overall no deductions shall be made for open spaces	0.80 (for painting all over)
II. Steel work doors, windows Etc.			
13.	Plain sheeted steel doors or windows	Measured flat (not girthed) including frame edges etc.	1.10 (for each side)
14.	Fully glazed or gauzed steel doors and windows (excluding painting of wire gauze portion)	-do-	0.50 (for each side)
15.	Partly panelled and partly glazed or gauzed doors and windows (excluding painting of wire gauze portion)	-do-	0.80 (for each side)
16.	Corrugated sheeted steel doors or windows	-do-	1.25 (for each side)

17.	Collapsible gates	Measured flat	1.50 (for painting all over)
18.	Rolling shutters of interlocked laths	Measured flat (size of opening) all over; jamb guides, bottom rails and locking arrangement etc. shall be included in the item (top cover shall be measured separately)	1.10 (for each side)
III. General			
19.	Expanded metal, hard drawn steel wire fabric of approved quality, grill works and gratings in guard bars, balustrades, railing partitions and MS Bars in windows frames.	Measured flat overall; no deduction shall be made for open spaces; supporting members shall not be measured separately	1 (for Paint all over)
20.	Open palisade fencing and gates including standards, braces, rails stays etc. in timber or steel	-do- (See note No.12)	1 (for Paint all over)
21.	Corrugated iron sheeting in roofs, side cladding etc.	-do- Measured flat (not girthed)	1.14 (for each side)
22.	AC corrugated sheeting in roofs, side cladding etc.	-do-	1.20 (for each side)
23.	AC semi corrugated sheeting in roofs, side cladding etc. or Nainital pattern using plain sheets	-do-	1.10 (for each side)
24.	Wire gauze shutters including painting of wire gauze	-do-	1.00 (for each side)
25.	Hait Cut Bamboo fencing	-do-	1.38 (AV) (for each side)

Explanatory Notes for Table 13.1

(1) Measurements for doors windows etc., shall be taken flat (and not girthed) over all including chowkhuts or frames, where provided. Where Chowkhuts or frames are not provided, the shutter measurements shall be taken.

(2) Where doors, windows etc., are of composite types other than those included in Table 1 the different portion shall be measured separately with their appropriate coefficients, the centre line of the common rail being taken as the dividing line between the two portions.

(3) The coefficients for door and windows shall apply irrespective of the size of frames and shutter members.

(4) In case steel frames are used the area of doors, windows shutters shall be measured flat excluding frames.

(5) When the two faces of a door, window etc. are to be treated with different specified finishes, measurable under separate items, the edges of frames and shutters shall be treated with the one or the other type of finish as ordered by the Engineer-in-Charge and measurement of this will be deemed to be included in the measurement of the face treated with that finish.

(6) In the case where shutters are fixed on both faces of the frames, the measurement for the door frame and shutter on one face shall be taken in the manner already described, while the additional shutter on the other face will be measured for the shutter only excluding the frame.

(7) Where shutters are provided with clearance at top or/and bottom each exceeding 15 cm height, such openings shall be deducted from the overall measurements and relevant coefficient shall be applied to obtain the area payable.
(8) Collapsible gates shall be measured for width from outside to outside of gate in its expanded position and for height from bottom to top of channel verticals. No separate measurements shall be taken for the top and bottom guide rails rollers, fittings etc.
(9) Coefficients for sliding doors shall be the same as for normal types of doors in the table. Measurements shall be taken outside to outside of shutters, and no separate measurements shall be taken for the painting guide rails, rollers, fittings etc.
(10) Measurements of painting as above shall be deemed to include painting all iron fittings in the same or different shade for which no extra will be paid.
(11) The measurements of guard bars, expanded metal, hard drawn steel wire fabric of approved quality, grill work and gratings, when fixed in frame work, painting of which is once measured else where shall be taken exclusive of the frames. In other cases the measurements shall be taken inclusive of the frames.
(12) For painting open palisade fencing and gates etc., the height shall be measured from the bottom of the lowest rail, if the palisades do not go below it, (or from the lower end of the palisades, if they project below the lowest rail), upto the top of rails or palisades whichever are higher, but not up to the top of standards when the latter are higher than the top rails or the palisades.

13.23.6.5 Width of moulded work of all other kinds, as in hand rails, cornices, architraves shall be mea-sured by girth.

13.23.6.6 For trusses, compound girders, stanchions, lattice girders, and similar work, actual areas will be measured in sq. metre and no extra shall be paid for painting on bolt heads, nuts, washers etc. even when they are picked out in a different tint to the adjacent work.

13.23.6.7 Painting of rain water, soil, waste, vent and water pipes etc. shall be measured in running metres of the particular diameter of the pipe concerned. Painting of specials such as bends, heads, branches, junctions, shoes, etc. shall be included in the length and no separate measurements shall be taken for these or for painting brackets, clamps etc.

13.23.6.8 Measurements of wall surfaces and wood and other work not referred to already shall be recorded as per actual.

13.23.6.9 Flag staffs, steel chimneys, aerial masts, spires and other such objects requiring special scaffolding shall be measured separately.

13.23.7 Precautions

All furnitures, fixtures, glazing, floors etc. shall be protected by covering and stains, smears, splashings, if any shall be removed and any damages done shall be made good by the contractor at his cost.

13.23.8 Rate

Rates shall include cost of all labour and materials involved in all the operations described above and in the particular specifications given under the several items.

13.24 PAINTING PRIMING COAT ON WOOD, IRON OR PLASTERED SURFACES

13.24.1 Primer

13.24.1.1 The primer for wood work, iron work or plastered surface shall be as specified in the description of item.

13.24.1.2 Primer for plaster/wood work/Iron & Steel/Aluminium surfaces shall be as specified below:

TABLE 13.2

S.No	*Surfaces*	*Primer to be used*
1.	Wood work (hard and soft wood)	Pink conforming to IS 3536
2.	Resinour wood and plywood	Aluminium primer conforming to IS 3585
3.	(A) Aluminium and light alloys	Zinc chromate primer conforming to IS 104
	(B) Iron, Steel and Galvanized steel	Red Oxide Zinc chromate Primer conforming IS 2074
4.	Cement/Conc/RCC/brick work, Plastered surfaces, non-asbestos surfaces to receive Oil bound distemper or Paint finish.	Cement primer conforming to IS 109

13.24.1.3 The primer shall be ready mixed primer of approved brand and manufacture.

13.24.1.4 Where primer for wood work is specified to be mixed at site, it shall be prepared from a mixture of red lead, white lead and double boiled linseed oil in the ratio of 0.7 kg : 0.7 kg : 1 litre.

13.24.1.5 Where primer for steel work is specified to be mixed at site, it shall be prepared from a mixture of red lead, raw linseed oil and turpentine in the ratio of 2.8 kg : 1 litre : 1 litre.

13.24.1.6 The specifications for the base vehicle and thinner for mixed on site primer shall be as follows:

(a) White Lead : The White lead shall be pure and free from adulterants like barium sulphate and whiting. It shall conform to IS 103.

(b) Red Lead : This shall be in powder form and shall be pure and free from adulterants like brick dust etc. It shall conform to IS 102.

(c) Raw Linseed Oil : Raw linseed oil shall be lightly viscous but clear and of yellowish colour with light brown tinge. Its specific gravity at a temperature of 30 degree C shall be between 0.923 and 0.928.

Note : The oil shall be mellow and sweet to the taste with very little smell. The oil shall be of sufficiently matured quality. Oil turbid or thick, with acid and bitter taste and rancid odour and which remains sticky for a considerable time shall be rejected. The oil shall conform in all respects to IS 75. The oil shall be of approved brand and manufacture.

(d) Double Boiled Linseed Oil : This shall be more viscous than the raw oil, have a deeper colour and specific gravity between 0.931 and 0.945 at a temperature of 30 degree C. It shall dry with a glossy surface. It shall conform in all respects to IS 77. The oil shall be of approved brand and manufacture.

Turpentine : Mineral turpentine i.e. petroleum distillate which has the same rate of evaporation as vegetable turpentine (distillate product of oleeresin of conifers) shall be used. It shall have no grease or other residue when allowed to evaporate. It shall conform to IS 533.

13.24.1.7 All the above materials shall be of approved manufacture and brought to site in their original packing in sealed condition.

13.24.2 Preparation of Surface

13.24.2.1 ***Wooden Surface :*** The wood work to be painted shall be dry and free from moisture.

The surface shall be thoroughly cleaned. All unevenness shall be rubbed down smooth with sand paper and shall be well dusted. Knots, if any shall be covered with preparation of red lead made by grinding red lead in water and mixing with strong glue sized and used hot. Appropriate filler material conforming to IS 345 with same shade as Paint shall be used where specified. The surface treated

for knotting shall be dry before Paint is applied. After obtaining approval of Engineer-in-Charge for wood work, the priming coat shall be applied before the wood work is fixed in position. After the priming coat is applied, the holes and indentation on the surface shall be stopped with glazier's putty or wood putty. Stopping shall not be done before the priming coat is applied as the wood will absorb the oil in stopping and the latter is therefore liable to crack.

13.24.2.2 ***Iron & Steel Surface :*** All rust and scales shall be removed by scrapping or by brushing with steel wire brushes. Hard skin of oxide formed on the surface of wrought iron during rolling which becomes loose by rusting, shall be removed.

All dust and dirt shall be thoroughly wiped away from the surface.

If the surface is wet, it shall be dried before priming coat is undertaken.

13.24.2.3 ***Plastered Surface :*** The surface shall ordinarily not be painted until it has dried completely. Trial patches of primer shall be laid at intervals and where drying is satisfactory, painting shall then be taken in hand. Before primer is applied, holes and undulations, shall be filled up with plaster of paris and rubbed smooth.

13.24.3 Application

The primer shall be applied with brushes, worked well into the surface and spread even and smooth.

The painting shall be done by crossing and laying off as described in 13.22.3.3.

13.24.4 Treatment on Steel for Aggressive Environment

13.24.4.1 A second coat of ready mixed red oxide zinc chromate primer may be applied where considered necessary in aggressive environment such as near Industrial Establishment and Coastal regions where the steel members are prone to corrosion. The second coat (which shall be paid for separately) is to be applied after placing the member in position and just before applying Paint. The second coat of primer is not necessary in case of painting with synthetic enamel Paint as it is applied over an under coat of ordinary Paint.

13.24.4.2 The specifications described under 13.33 shall hold good so far as they are applicable.

13.24A EPOXY PAINT

13.24A.1 Material

This product has got excellent adhesion properties and offers a balanced aesthetic and corrosion protective surface. Epoxy offers good resistance to water and humidity.

Epoxy coating are used because of their outstanding chemical resistance, durability, low porosity and strong bond strength and it provides dry tough and protective coatings. Epoxy coatings are created, by chemical reaction using an epoxide resin and polymine hardener.

13.24A.2 Painting new surface

13.24A.2.1 Surface must be dried, cleaned & made free from oil, grease, dirt, dust & all other contaminants that could interfere with adhesion of coating.

13.24A.2.2 Application

The application of priming coat for relevant steel or cement surface shall be as per the description of para no. 13.24. Epoxy paint is supplied in two parts i.e. (base and hardener). Stir the base and hardener separately. Mix hardener gradually into the base under continuous stirring as per mixing ratio as specified by the manufacturers.

The epoxy paint shall be consumed with in the working pot life as specified by the manufacturers. Part mixing should be avoided.

To achieve optimum performance of the product, minimum 2-3 coats by brushing would be required to get the desired dry film thickness (DFT) as specified by the manufacturer. Relative humidity in the environment should preferably be below 85%.

13.24A.2.3 Cleaning

All equipments/apparatus shall be cleaned immediately after use with thinner especially the hose pipes, gun, all spray equipments etc. All surplus material should be disposed off in compliance with environmental pollution rules etc.

13.24A.2.4 General Safety

Contact of the product with skin specially with eyes should be avoided. Use of face mask is mandatory during whole process. Proper ventilation is required and all safety procedures and precautions are to be adopted for executing epoxy painting process.

13.24A.2.5 Measurement

Measurements, Rate and other details shall be as specified in Para 13.23 as far as they are applicable which shall include the cost of all labour and material involved in all operation including priming coat as described above.

13.25 PAINTING SYNTHETIC ENAMEL PAINT OVER G.S. SHEETS

13.25.0 Synthetic enamel

Paint, suitable for painting over G.S. sheets, of approved brand and manufacture and of the required shade shall be used. New or weathered G.S. sheets shall be painted with a priming coat of one coat of redoxide zinc chromate Paint. Primer shall be applied before fixing sheets in place.

13.25.1 Preparation of Surface

13.25.1.1 ***Painting New Surface :*** The painting of new G.S. sheets shall not usually be done till the sheets have weathered for about a year. When new sheets are to be painted before they have weathered they shall be treated with a mordant solution prepared by mixing 38 gm of copper acetate in a litre of soft water or 13 gm hydrochloric acid in a solution of 13 gm each of copper chloride, copper nitrate and ammonium chloride dissolved in a litre of soft water. This quantity of solution is sufficient for about 235 sqm. to 280 sqm of area and is applied for ensuring proper adhesion of Paint. The painting with the mordant solution will be paid for separately.

Before painting on new or weathered G.S. sheets, rust patches shall be completely cleaned with coarse emery paper and brush. All grease marks shall also be removed and the surface washed and dried and rusted surface shall be touched with synthetic enamel paint of approved brand, manufacturer and shade.

13.25.1.2 ***Painting Old Surface:*** If the old Paint is firm and sound, it shall be cleaned of grease, smoke etc. The surface shall then be rubbed down with sand paper and dusted. Rusty patches shall be cleaned up and touched with synthetic enamel paint.

If the old Paint is blistered and flaked, it shall be completely removed as described in 13.41. Such removal shall be paid for separately and painting shall be treated as on new work.

13.25.2 Application

The number of coats to be applied shall be as in the description of item. In the case of C.G.S. sheets, the crowns of the corrugations shall be painted first and when these get dried the general coat shall be given to ensure uniform finish over the entire surface without the crowns showing signs of thinning.

The second or additional coats shall be applied when the previous coat has dried.

13.25.3 The specifications described in 13.23 shall hold good so far as they are applicable.

13.26 PAINTING CAST IRON RAIN WATER, SOIL, WASTE AND VENT PIPES AND FITTINGS

13.26.1 The primer shall be prepared on site or shall be of approved brand and manufacture as specified in the item.

Paint shall be anti-corrosive bitumastic Paint, aluminium Paint or other type of Paint as specified in the description of the item.

13.26.2 Painting New Surface

13.26.2.1 ***Preparation of Surface :*** The surface shall be prepared for priming coat as described in 13.24.2.2.

13.26.2.2 ***Application :*** The number of coat of painting over the priming coat shall be as stipulated in the description of the item. The application of Paint over priming coat shall be carried out as specified in 13.25.

13.26.2.3 ***Measurements :*** Measurements will be taken over the finished line of pipe including specials etc. in running metres, correct to a cm.

Pipes of different diameters of bore shall be measured and paid for separately.

Specials and fittings such as holder bat clamps, plugs etc. will not be measured separately.

13.26.2.4 ***Rate :*** The rate shall include the cost of all materials and labour involved in all the operations described above, including painting of all specials and fittings.

13.26.2.5 Specifications described in 13.22 shall hold good as far as they are applicable.

13.26.3 Painting on Old Surface

13.26.3.1 The surface shall be prepared as specified in 13.25.1.2.

13.26.3.2 The specifications for application shall be as described in 13.22.3.

13.26.3.3 Measurements, rate and other details shall be as specified in 13.26.2.3.

13.27 PAINTING WITH WOOD PRESERVATIVE

13.27.1 Oil type wood preservative of specified quality and approved make, conforming to IS 218 shall be used. Generally, it shall be creosote oil type-I or anthracene oil.

13.27.2 Painting on New Surface

13.27.2.1 ***Preparation of Surface :*** Painting shall be done only when the surface is perfectly dry to permit of good absorption. All dirt, dust or other foreign matter shall be removed from the surface to be painted. All roughness shall be sand papered and cleaned.

13.27.2.2 ***Application :*** The preservative shall be applied liberally with a stout brush and not daubed with rags or cotton waste. It shall be applied with a pencil brush at the joints of the wood work. The first coat shall be allowed at least 24 hours to soak in before the second (the final) coat is applied. The second coat shall be applied in the same manner as the first coat. The excess of preservative which does not soak into the wood shall be wiped off with a clean dry piece of cloth.

13.27.2.3 The specifications described in 13.23 shall hold good in so far as they are applicable.

13.27.3 Painting on Old Surface

The work shall be done in the same manner as on new surface except that only one coat shall be done.

13.27A FIRE RETARDANT PAINT

13.27A.1 Material

Ready to use, intumescent coating which effectively retards the flame spread and penetration of heat through their intumescent subli mative-ablative and synergetic flame suppressing action. On contact with flame, flame control intumescent fire retardant coating, decomposes and puff up (intumesce) forming a thick, dense, spongy foam layer that retards heat penetration and flame spread.

13.27A.2 Polishing new surface

13.27A.2.1 Preparation of surface

Preparation of surface shall be as described in para 13.23.3. Surface must be dry, free from dust, oil, wax, greases.

13.27A.2.2 Application

To achieve optimum performance of product apply fire retardant paint @ 2.86 litre/10 sqm per coat or as specified by manufacturers in multiple coats with brush etc. using conventional French polish process to achieve good result.

13.27A.2.3 Measurement

Measurements, Rate and other details shall be as specified in 13.23 as far as they are applicable.

13.28 COAL TARRING

13.28.1 Coal tar of approved manufacture conforming to IS 290 shall be used. The tar, to every litre of which 200 gm of unslaked lime has been added, shall be heated till it begins to boil. It must then be taken off the fire and kerosene oil added to it slowly at the rate of one part of kerosene oil to six or more parts by volume and stirred thoroughly. The addition of lime is for preventing the tar from running.

13.28.2 Coal Tarring New Surface

13. 28.2.1 ***Preparation of Surface :*** This shall be done as specified in 13.24.2 except that sand papering is not necessary. Where iron work is to be painted it shall be free from scales and rust before painting.

13.28.2.2 ***Application :*** The mixture shall be applied as hot as possible with a brush. The second coat shall be applied only after the first coat has thoroughly dried up. Where possible, the article to be tarred, shall be dipped in the hot mixture for better results. The quantity of tar to be used for the first or second coat shall be not less than 0.16 and 0.12 litre per sqm respectively. Thinning with kerosene oil shall be suitably done to ensure this.

13.28.2.3 The specifications described in 13.23 shall hold good in all other respects, so far as they are applicable.

13.28.3 Coal Tarring old Surface

The work shall be done in the same manner as specified in 13.28.2 except that only one coat using 0.12 litre per sqm. area shall be done.

13.29 SPRAY PAINTING WITH FLAT WALL PAINT ON NEW SURFACE

13.29.0 The work shall include a priming coat of 'Distempering Primer' or 'Cement Primer' as specified in the description of the item. Flat wall Paint shall normally be applied on walls 12 months after their completion, in which case Distemper primer will suffice. If the walls are to be painted earlier, the primer coat shall consist of cement primer.

13.29.1 The primer and the flat wall Paint shall be of approved brand and manufacture and of the required shade.

13.29.2 The surface shall be prepared as described in 13.20.1.

13.29.3 Application

13.29.3.1 ***Primer Coat :*** The specified primer shall be painted or sprayed over the surface in an even and uniform layer.

13.29.3.2 ***Painting Coats :*** When the surface is dry, the spray painting with the wall Paint in uniform and even layers will be done to the required number of coats. Each coat shall be allowed to dry overnight and lightly rubbed with very fine grade of sand paper and loose particles brushed off before the next coat is sprayed.

Spraying should be done only when dry condition prevails. During spraying the spray gun shall be held perpendicular to the surface to be coated and shall be passed over the surface in a uniform sweeping motion. Different air pressures and fan adjustment shall be tried so as to obtain the best application. The Air pressure shall not be kept too high as otherwise the Paint will fog up and will be wasted.

At the end of the job, the spray gun shall be cleaned thoroughly so as to be free from dirt. Incorrect adjustments shall be set right, as otherwise they will result in variable spray patterns, runs, sags and uneven coats.

If after the final coat of wall Paints, the surface obtained is not upto the mark, further one or more coats as required shall be given after rubbing down the surface and dusting off all loose particles to obtain a smooth and even finish.

If the primer or wall Paint gets thickened during the application, it shall be thinned suitably with the thinner recommended by the manufacture.

Adequate ventilation shall be provided to disperse spray fumes. Fitments and floor shall be protected from the spray.

13.29.4 The specifications described in 13.23 shall hold good for all other details as far as applicable.

13.30 SPRAY PAINTING WITH FLAT PAINT ON OLD SURFACE

13.30.0 Where the old Paint is in sound condition, renewal shall be carried out as described below, otherwise the old Paint shall be completely stripped and spray painting shall be carried out as over new work. Such removal shall be paid for separately.

13.30.1 The flat wall Paint shall be of approved brand and manufacture and of required shade.

13.30.2 Preparation of Surface

The surface shall be washed to remove dust and dirt. A mild detergent solution like soap water shall be used for washing and the surface shall also be rubbed down lightly with abrasive paper when dry. Any patches appearing on the surface shall first be touched up with a coat of Paint. These shall be allowed to dry and then rubbed down lightly.

13.30.3 Application

The Paint shall then be applied with spraying machine in uniform and even layer. A second coat shall be applied if considered necessary by the Engineer-in-Charge but only after the first coat is complete dry and hard.

Spraying should be done only when dry condition prevails. During spraying the spray gun shall be held perpendicular to the surface to be coated and shall be passed over the surface in uniform sweeping motion. Different air pressures and fan adjustment shall be tried so as to obtain the best application. The Air pressure shall not be kept too high as otherwise the Paint will fog up and will be wasted. At the end of the job, the spray gun shall be cleaned thoroughly so as to be free from dirt. Incorrect adjustments shall be set right, as otherwise they result in variable spray patterns, runs, sags and uneven coats.

13.30.4 The specifications described in 13.22 shall hold good for all other details, as far as they are applicable.

13.31 WALL PAINTING WITH PLASTIC EMULSION PAINT

13.31.0 The plastic emulsion Paint is not suitable for application on external, wood and iron surface and surfaces which are liable to heavy condensation. These Paints are to be used on internal surfaces except wooden and steel.

13.31.1 Plastic Emulsion Paint as per IS 5411 of approved brand and manufacture and of the required shade shall be used.

13.31.2 Painting on New Surface

13.31.2.1 The wall surface shall be prepared as specified in 13.23.3.

13.31.2.2 ***Application :*** The number of coats shall be as stipulated in the item. The Paint will be applied in the usual manner with brush, spray or roller. The Paint dries by evaporation of the water content and as soon as the water has evaporated the film gets hard and the next coat can be applied. The time of drying varies from one hour on absorbent surfaces to 2 to 3 hours on non-absorbent surfaces.

The thinning of emulsion is to be done with water and not with turpentine. Thinning with water will be particularly required for the under coat which is applied on the absorbent surface. The quantity of water to be added shall be as per manufacturer's instructions.

The surface on finishing shall present a flat velvety smooth finish. If necessary more coats will be applied till the surface presents a uniform appearance.

13.31.2.3 ***Precautions***

(a) Old brushes if they are to be used with emulsion Paints, should be completely dried of turpentine or oil Paints by washing in warm soap water.
Brushes should be quickly washed in water immediately after use and kept immersed in water during break periods to prevent the Paint from hardening on the brush.

(b) In the preparation of wall for plastic emulsion painting, no oil base putties shall be used in filling cracks, holes etc.

(c) Splashes on floors etc. shall be cleaned out without delay as they will be difficult to remove after hardening.

(d) Washing of surfaces treated with emulsion Paints shall not be done within 3 to 4 weeks of application.

13.31.2.4 Other details shall be as specified in 13.23 as far as they are applicable.

13.31.3 Painting on Old Surface

13. 31.3.1 ***Preparation of Surface :*** This shall be done, generally as specified in 13.24.2.1 except that the surface before application of Paint shall be flattened well to get the proper flat velvety finish after painting.

13.31.3.2 ***Application :*** The number of coats to be applied shall be as in description of item.

The application shall be as specified in 13.31.2.2 except that thinning with water shall not normally be required.

13.31.3.3 Other details shall be as specified in 13.23 as far as applicable.

13.32 PAINTING WITH SYNTHETIC ENAMEL PAINT

13.32.1 Synthetic Enamel Paint (conforming to IS 2933) of approved brand and manufacture and of the required colour shall be used for the top coat and an undercoat of ordinary Paint of shade to match the top coat as recommended by the same manufacturer as far the top coat shall be used.

13.32.2 Painting on New Surface

13.32.2.1 Preparation of surface shall be as specified in 13.24.2 as the case may be.

13.32.2.2 ***Application :*** The number of coats including the undercoat shall be as stipulated in the item.

(a) Under Coat : One coat of the specified ordinary Paint of shade suited to the shade of the top coat, shall be applied and allowed to dry overnight. It shall be rubbed next day with the finest grade of wet abrasive paper to ensure a smooth and even surface, free from brush marks and all loose particles dusted off.

(b) Top Coat : Top coats of synthetic enamel Paint of desired shade shall be applied after the undercoat is thoroughly dry. Additional finishing coats shall be applied if found necessary to ensure properly uniform glossy surface.

13.32.2.3 Other details shall be as specified in 13.22 as far as they are applicable.

13.32.3 Painting on Old Surface

13.32.3.1 ***Preparation of Surface :*** Where the existing Paint is firm and sound it shall be cleaned of grease, smoke etc. and rubbed with sand paper to remove all loose particles dusted off. All patches and cracks shall then be treated with stopping and filler prepared with the specified Paint. The surface shall again be rubbed and made smooth and uniform.

If the old paint is blistered and flaked it will be necessary to completely remove the same as described in para 13.41. Such removal shall be paid for separately and the painting shall be treated as on new surface.

13.32.3.2 ***Painting :*** The number of coats as stipulated in the item shall be applied with synthetic enamel Paint. Each coat shall be allowed to dry and rubbed down smooth with very fine wet abrasive paper, to get an even glossy surface. If however, the surface is not satisfactory additional coats as required shall be applied to get correct finish.

13.32.3.3 Other details shall be specified in 13.22 as far as they are applicable.

13.33 PAINTING WITH ALUMINIUM PAINT

13.33.1 Aluminium Paint shall be (conforming to IS 2339) of approved brand and manufacture. The Paint comes in compact dual container with the paste and the medium separately.

The two shall be mixed together to proper consistency before use.

13.33.2 Preparation of Surface

13.33.2.1 ***Steel Work (New Surfaces) :*** All rust and scales shall be removed by scraping or brushing with steel wire brushes and then smoothened with sand paper. The surface shall be thoroughly cleaned of dust.

13.33.2.2 ***C.G.S. Sheets (New Surfaces) :*** The preparation of surface shall be as specified in 13.25.1.1.

13.33.2.3 ***Steel Work or C.G.S. sheets (Old Surfaces):*** The specifications shall be as described in 13.25.1.2.

13.33.3 Application

The number of coats to be applied shall be as given in the item. Each coat shall be allowed to dry for 24 hours and lightly rubbed down with fine grade sand paper and dusted off before the next coat is applied. The finished surface shall present an even and uniform appearance.

As aluminium paste is likely to settle in the container, care shall be taken to frequently stir the Paint during used. Also the Paint shall be applied and laid off quickly, as surface is otherwise not easily finished.

13.33.4 Other details shall be as specified in 13.23 as far as they are applicable.

13.34 PAINTING WITH ACID PROOF PAINT

13.34.1 Acid proof Paint of approved brand and manufacture and of the required shade shall be used.

13.34.2 Preparation of surface and application shall be as specified under 13.32 for new/old surface as the case may be.

13.34.3 Other details shall be as specified in 13.23 as far as they are applicable.

13.35 PAINTING WITH ANTI-CORROSIVE BITUMASTIC PAINT

13.35.1 Ready mixed Paint (conforming to IS 158) shall be of approved brand and manufacture. It shall be black, lead free, acid-alkali-heat-water resistant.

13.35.2 Preparation of surface and application shall be as specified in 13.32 for painting on new or old surfaces as the case may be.

The drying time between consecutive coats, however, shall be not less than 3 hours.

13.35.3 Other details shall be as specified in 13.23 as far as applicable.

13.36 FLOOR PAINTING

13.36.1 Floor Paint of approved brand and manufacture and of the required colour shall be used.

13.36.2 Preparation of Surface

All dirt, grease shall be removed from the floor by wiping with rags, soaked in turpentine and scraping where necessary and then washing with warm water, containing caustic soda or washing soda in solution. The floor should then be rinsed thoroughly with water and dried. Cracks and holes shall then be filled with specified filler as recommended by the manufacturer and rubbed smooth.

It should be noted that the painting with floor paints shall not be done over concrete surfaces less than two years old.

Old surface shall be prepared as specified in 13.32.3.1

13.36.3 Application

The number of coats as in the description of the item shall be applied. Each coat shall be allowed to dry for not less than 24 hours before the next coat is applied. The flooring should not be brought into use for a week after final coat so that the painted surface can thoroughly harden.

13.36.4 Measurement

Measurements shall be as per actual length and breadth being measured correct to a cm. The details given under 13.23.6 shall hold good as far as applicable.

13.36.5 Other details shall be as specified in 13.23 as far as applicable.

13.37 VARNISHING

13.37.0 Ordinary copal varnish or superior quality spray varnish shall be used. The work includes sizing of transparent wood filler.

13.37.1 Varnish (conforming to IS 347 for the finishing and undercoats shall be of the approved manufacturer.

13.37.2 Varnishing on New Surfaces

13.37.2.1 ***Preparation of Surface :*** New wood work to be varnished shall have been finished smooth with a carpenter's plane. Knots shall be cut to a slight depth. Cracks and holes shall be cleaned of dust. The knots, cracks etc. shall then be filled in with wood putty made as follows:

On a piece of wood say 20 x 15 cm face and on the side where cross grains appear, a small quantity of glue size shall be poured and the surface scraped with the edge of a fine carpenter's chisel. Very fine wood powder shall be mixed with the glue and the stiff paste thus formed shall be used for the filling.

The fillings when dry shall be rubbed down with a carpenter's file and then the entire surface shall be rubbed down perfectly smooth with medium grained and fine sand papers and wiped with dry clean cloth so that it presents uniform appearance. In no case shall sand papers be rubbed across the grains, as in this case even the finest marks will be visible when the varnishing is applied.

13.37.2.2 ***Sizing or Transparent Wood Filler Coat :*** The surface shall then be treated with either glue sizing or with transparent wood filler coat as stipulated in the description of item.

(a) Sizing : When sizing is stipulated, an application of thin clean size shall be applied hot on the surface. When dry, the surface shall be rubbed down smooth with sand paper and cleaned. It shall then be given another application of glue size nearly cold. The sized wood work shall

again be rubbed down smoothly with fine sand paper and cleaned. The surface shall be perfectly dry and all dust shall be removed not only from the surface but also from the edges and joints before varnishing is commenced. If the wood work is to be stained, the staining colour shall be mixed with the second coat of the size which must be applied evenly and quickly keeping the colour on the flow.

Any joining up with work already dry will show badly. The object of application of the glue size is to seal the pores in wood to prevent absorption of the oil in the varnish.

Glue sizing is inadvisable on floors, table tops and other horizontal surfaces likely to carry wet household untensils which are likely to disturb the size coatings and thus expose bare wood.

Where glue sizing is omitted to be done the rate for the work shall be suitably reduced.

(b) *Transparent Wood Filler Coat :* Where instead of glue sizing, transparent wood filler application is stipulated in the item, then the surface prepared as described in 13.37.2.1 shall be given as application of the filler with brush or rag in such a way that the filler fills up all the pores and indentations and levels up the surface. It shall be allowed to dry for 24 hours. Then it shall be cut and rubbed with emery paper so that the surface of the wood is laid bare, with the filler only in the pores and crevices of the wood.

13.37.2.3 ***Application of Varnish :*** The number of coats to be applied shall be as stipulated in the des-cription of the item.

The undercoat shall be with a flatting varnish. This dries hard and brittle and when cut and rubbed down to produce a smooth surface enhances the gloss of the finishing varnish. The top coat shall be given with stipulated brand of finishing varnish.

The varnish shall be applied liberally with a full brush and spread evenly with short light strokes to avoid frothing. If the work is vertical the varnish shall be crossed and recrossed and then laid off, latter being finished on the upstrokes so that varnish, as it sets, flows down and eliminates brush marks, the above process will constitute one coat. If the surface is horizontal, varnish shall be worked in every direction, with light quick strokes and finish in one definite direction so that it will set without showing brush marks, in handling and applying varnish care should be taken to avoid forming froth or air bubbles. Brushes and containers shall be kept scrupulously clean.

Rubbing down and flatting the surface shall be done after each coat except the final coat with fine sand paper.

The work shall be allowed to dry away from droughts and damp air. The finished surface shall then present a uniform appearance and fine glossy surface free from streaks, blister etc.

Any varnish left over in the small container shall not be poured back into the stock tin, as it will render the latter unfit for use.

Special fine haired varnishing brushes shall be used and not ordinary Paint brushes. Brushes shall be well worn and perfectly clean.

13.37.2.4 Other details shall be as specified in 13.23 as far as they are applicable.

13.37.3 Varnishing on Old Surface

13.37.3.1 ***Preparation of Surface :*** If the old varnished surface is firm and sound it shall be cleaned of grease and dirt with turpentine and then rubbed with wet sand paper until the surface is clean and smooth. It shall be dried and wiped clean with a soft cloth. Knots, holes and cracks shall be stopped as specified in 13.37.2.1. The entire surface shall then be rubbed down smooth with sand paper and wiped clean.

If the old varnished surface is peeled or cracked then it will be necessary to remove the entire varnish as described in para 13.41 and such removal shall be paid for separately outside the rate for varnishing. Further the varnishing itself will have to be done like new work and will be paid for as such.

13.37.3.2 ***Application :*** The specification shall be same as described in 13.37.2.3 as far as applicable except that the coats to be applied will be with the stipulated quality of varnish for finishing coat.

13.37.3.3 Other details shall be as specified in 13.23 as far as they are applicable.

13.37A MELAMINE POLISH

13.37A.1 Material

Melamine is an organic compound that is often combined with formaldehyde to produce melamine resin, a synthetic polymer that is fire resistant and heat tolerant. The resin is a versatile material that has a highly stable structure. It is a closed pore polish i.e. it makes the wood **non-breathable product** that protects wood from mainly hot and cold surfaces placed over it.

13.37A.2 Polishing Old Surface

13.27A.2.1 Preparation of surface

The surface shall be thoroughly cleaned. All unevenness shall be rubbed down smooth with sand paper and shall be well dusted. Surface must be dry, free from dust, oil, wax, greases etc.

13.27A.2.2 Application

Mix melamine (matt or gloss) base with the catalyst in the specified ratio as per manufacturers specification. Add melamine thinner upto 30% (as specified by the manufacturer) by volume of mixture. Stir it and allow it to mature for 2-3 minutes. The melamine is sprayed, using spray gun pressure of 45-55 psi, from a distance of 7"-10" from substrate.

Precaution : Avoid eye contact, use of mask is mandatory during whole process.

13.27A.2.3 Measurement

Measurements, Rate and other details shall be as specified in 13.23 as far as they are applicable.

13.38 FRENCH SPIRIT POLISHING

13.38.1 Pure shellac conforming to IS 16 varying from pale orange to lemon yellow colour, free from resin or dirt shall be dissolved in methylated spirit at the rate of 140 gm of shellac to 1 litre of spirit. Suitable pigment shall be added to get the required shade. Ready made polish conforming to IS 348 can also be used.

13.38.2 Polishing New Surface

13.38.2.1 ***Preparation of Surface :*** The surface shall be cleaned. All unevenness shall be rubbed down smooth with sand paper and well dusted. Knots if visible shall be covered with a preparation of red lead and glue size laid on while hot. Holes and indentations on the surface shall be stopped with glazier's putty. The surface shall then be given a coat of wood filler made by mixing whiting (ground chalk) in methylated spirit at the rate of 1.5 Kg of whiting per litre of spirit. The surface shall again be rubbed down perfectly smooth with glass paper and wiped clean.

13.38.2.2 ***Application :*** The number of coats of polish to be applied shall be as described in the item.

A pad of woolen cloth covered by a fine cloth shall be used to apply the polish. The pad shall be moistened with the polish and rubbed hard on the wood, in a series of overlapping circles applying the mixture sparingly but uniformly over the entire area to give an even level surface. A trace of linseed oil on the face of the pad facilitates this operation. The surface shall be allowed to dry and the remaining coats applied in the same way. To finish off, the pad shall be covered with a fresh piece of clean fine cotton cloth slightly damped with methylated spirit and rubbed lightly and quickly with circular motions. The finished surface shall have a uniform texture and high gloss.

13.38.2.3 Measurements, Rate and other details shall be as specified in 13.23 as far as they are applicable.

13.38.3 Polishing Old Surface

13.38.3.1 ***Preparation of Surface :*** If the old polished surface is not much soiled it shall be cleaned of grease and dirt by rubbing with turpentine and then rubbed with fine sand paper.

If the old polished surface is much soiled then it will be necessary to remove the entire polish as described in 13.41 and such removal shall be paid for separately outside the rate of polishing. Further the polishing itself will have to do done like new work and will be paid for as such.

13.38.3.2 ***Application :*** The specifications shall be same as described in 13.38.2.2 as far as applicable.

13.38.3.3 Measurements, Rate and other details shall be as specified in 13.23 as far as they are applicable.

13.39 BEES WAXING OR POLISHING WITH READY MADE WAX POLISH

13.39.1 The polishing shall be done with bees waxing prepared locally or with readymade wax polish of approved brand and manufacture, as stipulated in the description of item.

Where bees waxing is to be prepared locally, the following specifications for the same shall apply.

Pure bees wax free from paraffin or stearine adulterants shall be used. Its specific gravity shall be 0.965 to 0.969 and melting point shall be 63 degree C. The polish shall be prepared from a mixture of bees wax, linseed oil, turpentine and varnish in the ratio of 2 : 1.5 : 1 : 0.5 by weight.

The bees wax and boiled linseed oil shall be heated over a slow fire. When the wax is completely dissolved the mixture shall be cooled till it is just warm and turpentine and varnish added to it in the required proportions and the entire mixture shall be well stirred.

13.39.2 Waxing New Surface

13.39.2.1 ***Preparation of Surface :*** Preparation of surface shall be as described in 13.37.2.1 with the exception that knotting, holes and cracks shall be stopped with a mixture of fine saw dust formed of the wood being treated, beaten up with sufficient bees wax to give it cohesion.

13.39.2.2 ***Application :*** The polish shall be applied evenly with a clean soft pad of cotton cloth in such a way that the surface is completely and fully covered. The surface is then rubbed continuously for half an hour.

When the surface is quite dry, a second coat shall be applied in the same manner and rubbed continuously for one hour or until the surface is dry.

The final coat shall then be applied and rubbed for two hours (more if necessary) until the surface has assumed a uniform gloss and is dry, showing no sign of stickiness.

The final polish depends, largely on the amount of rubbing which should be continuous and with uniform pressure with frequent changes in the direction.

13.39.2.3 Other details shall be as specified in 13.23 as far as they are applicable.

13.39.3 Waxing Old Surfaces

13.39.3.1 ***Preparation of Surface :*** The wood work shall be cleaned of all smoke and grease by washing with lime water. The surface shall then be washed with soap and completely dried. Then it shall be prepared smooth as specified in 13.37.2.1.

13.39.3.2 ***Application :*** The polish shall be applied in the manner specified in 13.39.2.2. In this case one or two coats shall be applied as necessary to get uniform gloss, instead of three coats in the case of new work.

13.39.3.3 Other details shall be as specified in 13.22 as far as they are applicable.

13.40 LETTERING WITH PAINT

13.40.1 Black, Japan Paint (conforming to IS 341) or ready mixed Paint as ordered by the Engineer-in-Charge shall be used. The Paint shall be of approved brand and manufacture. Ordinary ready mixed Paint shall be of the shade required by the Engineer-in-Charge.

13.40.2 Lettering on New Surface

13.40.2.1 ***Application :*** The letters and figures shall be to the heights and width as ordered by the Engineer-in-Charge. These shall be stenciled or drawn in pencil and got approved before painting. They shall be of uniform size and finished neatly. The edges shall be straight or in pleasant smooth curves. The thickness of the lettering shall be as approved by the Engineer-in-Charge. Lettering shall be vertical or slanting as required.

Two or more coats of Paint shall be applied till uniform colour and glossy finish are obtained.

13.40.2.2 ***Measurements :*** Measurements shall be taken in terms of letter cm (the measurement relates to the vertical height of the lettering). The letter heights shall be measured correct to a cm. Dots, dashes, punctuations and other similar marks or lines shall not be measured for payment.

In Devanagari Script Dots & Matras occurring with the letters shall not be measured. Half letter shall be measured as full letter. The height of letters shall be measured excluding the Matras projecting above the heading and matras below the letters.

13.40.2.3 ***Rate :*** Rate shall include the cost of all labour and materials involved in the operations described above. The rate per cm height of letter shall hold good irrespective of the width of the letters or figures or the thickness of the lettering.

The same rate will apply irrespective of whether black Japan or ready mixed Paint of any shade as required is used.

13.40.3 Relettering on Old Surface

13.40.3.1 Painting shall be done over the existing letters and shall accurately follow their lines and curves.

One or more coat of Paints shall be applied till a uniform colour and glossy finish is obtained.

13.40.3.2 Measurements and Rate shall be as specified under 13.40.2.

13.41 REMOVING OLD PAINT

13.41.1 With Patent Paint Remover

13.41.1.1 Patent Paint removers shall consist of volatile organic liquids thickened with waxes and other ingredients to retard the evaporation of the liquid and to enable a substantial layer of remover to be applied to the surface. The Paint remover shall be of a brand and manufacture approved by the Engineer-in-Charge. It shall be free from alkaline matter and non- caustic so that it can be handled by workmen without injury. It shall be of non inflammable quality as far as possible.

13.41.1.2 ***Application :*** Paint remover shall be used where burning off with blow lamp is not suitable. The Paint remover shall be applied liberally with a brush and allowed to remain on the surface for a period depending on the particular brand of remover used and on the thickness of the Paint coating to be removed. When the Paint film lifts and wrinkles under the action of the remover it shall be stripped with a sharp instrument. If the film is not thoroughly removed a second coat of remover may be applied if necessary over such patches and then the film thoroughly scrapped.

After the surface has been stripped, it shall be washed down with mineral turpentine to remove all traces of paraffin wax, which forms one of the ingredients of patent Paint remover and which if left in place will prevent the Paint from drying.

The cleaned surface shall be suitably prepared for application of Paint or other finish.

13.41.1.3 ***Precautions :*** Where the Paint remover used is of the inflammable type, suitable precaution against risk of fire shall be taken.

Neighbouring painted surfaces which are not to be treated should be properly protected from contact with Paint remover.

13.41.1.4 ***Preparation of Surface :*** The surface shall then be prepared as described in 13.24.2.

13.41.1.5 ***Measurements :*** Specification for 13.23.6 shall hold good.

13.41.1.6 ***Rate :*** Rate shall include the cost of all labour and materials involved in all operations described above.

13.41.1.7 Other details shall be as specified 13.23 as far as possible.

13.41.2 With Caustic Soda Solution

13. 41.2.1 ***Application :*** Caustic soda dissolved with 48 times its volume of water shall be applied to the old Paint with a brush and when the Paint film lifts and wrinkles it shall be thoroughly scrapped of in the same way as described in 13.41.1.2. After the surface has been stripped thoroughly, it shall be rinsed with several chances of clean water to remove all traces of alkali, which if allowed to remain are liable to spoil the new Paint applied over it. A little acetic acid or vinegar added to the final change of rinsing water helps to neutralize any remaining alkali.

13.41.2.2 ***Precautions :*** Caustic soda as its name implies is a corrosive liquid and care should be taken to see that no liquid spills over the skin or clothing.

13.41.2.3 Preparation of Surface, Measurements, Rate and other details shall be as specified under 13.41.1.

13.41.3 With Blow Lamp

13.41.3.1 The Paint shall be removed either with a blow lamp or with air acetylene equipment. The flame shall be allowed to play upon the Paint just enough to soften it without charring either the Paint or the background. The softened Paint shall then be removed with a stripping knife following the flame as it is moved up the surface.

Burning off shall begin at the bottom of the vertical surface and shall proceed upwards.

13.41.3.2 ***Precautions :*** Removal with blow lamp shall not be done on narrow or carved under cut surfaces or where there is risk of damage to neighbouring materials such as panes in glazed windows.

13.41.3.3 Preparation of surface, Measurements, Rate and other details shall be as described under 13.41.1.

Neighbouring painted surfaces which are not to be treated should be properly protected from contact with Paint remover.

13.42 WASHED STONE GRIT PLASTER

13.42.1 Scaffolding shall be as specified in 13.1.1.

13.42.2 Preparation of surface shall be as specified in 13.1.2 and 13.4.2.

13.42.3 Materials

13.42.3.1 Stone chippings obtained by crushing hard stone shall be free of dust and deleterious material. 10 mm nominal size stone chippings, where specified, shall pass 100% through 12.5 mm sieve and fully retained on 6.3 mm sieve. Stone chippings shall be thoroughly washed with water and sieved before use.

13. 42.3.2 ***Mortar :*** Cement mortar for under coat and cement mortar to be mixed with stone chippings for top coat shall be as specified in 3.5.

13.42.4 Application of Plaster

13.42.4.1 ***12 mm Under Coat :*** Under coat of cement mortar 1:4 (1 cement : 4 coarse sand) shall be applied as specified in 13.1.3 except that the finishing, after the mortar has been brought to level with the wooden straight edge, shall be done with wooden float only. The surface shall be further roughened by furrowing with a scratching tool. Furrowing shall be done diagonally both ways and shall be about 2 mm deep to provide a key for the top coat. The scratched lines shall not be more than 10 cm apart. The surface shall be kept wet till top coat is applied.

13.42.4.2 ***15 mm Top Coat :*** Top coat comprising cement mortar and stone chippings shall have an overall proportion of 1:0.5:2 (1 cement : 0.5 coarse sand : 2 stone chippings 10 mm nominal size) or as specified. The top coat shall be applied a day or two after the under coat has taken the initial set. The surface of the under coat shall be cleaned and a coat of cement slurry at 2 kg of cement per sqm shall be applied before the application of coat. The top coat shall be applied in uniform thickness on the under coat after the application of slurry and sufficiently pressed with wooden float for proper bonding with the under coat. Vacant space, if any shall be filled with the specified mix.

13.42.5 Finish

The top coat of plaster shall be finished to a true and plumb surface. The surface shall be tested frequently as the work proceeds with a true straight edge not less than 2.5 m long and with plumb bobs. All horizontal lines and surfaces shall be tested with a level and all jambs and corners with a plumb bob as the work proceeds. All the corners angles and junctions shall be truly vertical or horizontal as the case may be. Rounding or chamfering of corners junctions etc. Where required shall be true to template.

Finished surface of the top coat after the mix has taken the initial set, shall be scrubbed and washed with suitable brushes and plain water. Scrubbing and washing shall continue till the stone chippings are sufficiently exposed. Stone chippings which may come out while scrubbing shall be replaced using the specified mortar mix. A sample of the washed stone grit plaster shall be got approved from the Engineer-in-Charge.

13.42.6 Grooves

Grooves of size 15 mm x 15 mm or as specified shall be provided as shown on the drawing or as required by the Engineer-in- Charge. Tapered wooden battens to match the size and shape of the grooves shall be fixed on the under coat with nails before the application of the top coat and these shall be removed carefully so that the edges of the panels of top coat are not damaged. Damage, if any, shall be made good by the contractor.

13.42.7 Curing

Curing shall be started 24 hours after finishing the plaster. The plaster shall be kept wet for a period of seven days. During this period, it shall be suitably protected from all damages at the contractor's expense by such means as the Engineer-in-Charge may approve.

13.42.8 Measurements

13.42.8.1 Length and breadth shall be measured correct to the nearest cm and the area shall be calculated in sqm correct to two places of decimal.

13.42.8.2 Measurements shall be taken for the work actually done with deductions for all openings and addition for all jambs soffits and sills. However, no deduction is to be made for the grooves provided as specified in 13.42.6.

13.42.8.3 Washed stone grit plaster on circular surfaces not exceeding 6 m in radius and on external surfaces at a height greater than 10 m shall be measured separately.

13.42.9 Rates

The rates shall include the cost of all labour and materials involved in all the operations described above except for providing grooves. The length of grooves shall be measured in running metres and paid for separately.

13.43 GYPSUM LIGHT WEIGHT PLASTER

13.43.1 Scaffolding shall be as specified in 13.11.

13.43.2 Preparation of surface shall be as specified in 13.1.2 and 13.4.2.

13.43.3 Materials

13.43.3.1 Premixed light weight plasters essentially consist of retarded hemihydrate gypsum plaster and light weight aggregate which are characterized by low density, high thermal insulation and sound absorption properties. Other additions may be incorporated to impart desired properties. The physical and chemical requirements shall conform to IS 2547 (Pt. II).

13.43.3.2 The minimum recommended water-premixed plaster ratio is 1:2 as per standard practice or as recommended by the manufacturers.

13.43.4 Application of Plaster

13.43.4.1 Application of plaster shall be as specified in 13.1.4.1 to 13.1.4.4.

13.43.5 Thickness

Where the thickness required, as per description of the item is 12 mm, the average thickness of the plaster shall not be less than 12 mm whether wall treated is of brick/block/RCC work.

13.43.6 Finish

The plaster shall be finished as specified in 13.1.7.

13.43.7 Measurement

Measurement of plaster shall be as specified in 13.1.9.1 to 13.1.9.9.

13.43.8 Rate

Rate shall include the cost of all labour & material involved in all the operations described above.

13.44 PAINTING CAST IRON RAIN WATER, SOIL, WASTE AND VENT PIPES AND FITTINGS

13.44.1 The primer shall be prepared on site or shall be of approved brand and manufacture as specified in the item.

Paint shall be anti-corrosive bitumastic paint aluminium paint or other type of paint as specified in the description of the item.

13.44.2 Painting New Surface

13.44.2.1 ***Preparation of Surface:*** The surface shall be prepared for priming coat as described in 13.34.2.2.

13.44.2.2 ***Application:*** The number of coat of painting over the priming coat shall be as stipulated in the description of the item. The application of paint over priming coat shall be carried out as specified in 13.35.

13.44.2.3 ***Measurements:*** Measurements will be taken over the finished line of pipe including specials etc. in running metres, correct to a cm.

Pipes of different diameters of bore shall be measured and paid for separately.

Specials and fittings such as holder bat clamps, plugs etc. will not be measured separately.

13.44.2.4 ***Rate:*** The rate shall include the cost of all materials and labour involved in all the operations described above, including painting of all specials and fittings.

13.44.2.5 Specifications described in 13.22 shall hold good as far as they are applicable.

13.44.3 Painting on Old Surface

13.44.3.1 The surface shall be prepared as specified in 13.25.1.2.

13.44.3.2 The specifications for application shall be as described in 13.25.2.

13.44.3.3 Measurements, rate and other details shall be as specified in 13.23.6.

Note: Clause 13.44 brought from Sub Head 14 (Repairs to buildings) clause no 14.24.

13.45 PAINTING WITH WOOD PRESERVATIVE

13.45.1 Oil type wood preservative of specified quality and approved make, conforming to IS 218 shall be used. Generally, it shall be creosote oil type-I or anthracene oil.

13.45.2 Painting on New Surface

13.45.2.1 Preparation of Surface*:* Painting shall be done only when the surface is perfectly dry to permit of good absorption. All dirt, dust or other foreign matter shall be removed from the surface to be painted. All roughness shall be sand papered and cleaned.

13.45.2.2 Application*:* The preservative shall be applied liberally with a stout brush and not daubed with rags or cotton waste. It shall be applied with a pencil brush at the joints of the wood work. The first coat shall be allowed at least 24 hours to soak in before the second (the final) coat is applied. The second coat shall be applied in the same manner as the first coat. The excess of preservative which does not soak into the wood shall be wiped off with a clean dry piece of cloth.

13.45.2.3 The specifications described in 13.23 shall hold good in so far as they are applicable.

13.45.3 Painting on Old Surface

The work shall be done in the same manner as on new surface except that only one coat shall be done.

Note: Clause 13.45 brought from Sub Head 14 (Repairs to buildings) clause no 14.25

13.46 WALL PAINTING WITH PLASTIC EMULSION PAINT

13.46.0 The plastic emulsion paint is not suitable for application on external, wood and iron surface and surfaces which are liable to heavy condensation. These paints are to be used on internal surfaces except wooden and steel.

13.46.1 Plastic emulsion paint as per IS 5411 of approved brand and manufacture and of the required shade shall be used.

13.46.2 Painting on New Surface

13.46.2.1 The wall surface shall be prepared as specified in 13.31.

13.46.2.2 Application *:* The number of coats shall be as stipulated in the item. The paint will be applied in the usual manner with brush, spray or roller. The paint dries by evaporation of the water content and as soon as the water has evaporated the film gets hard and the next coat can be applied. The time of drying varies from one hour on absorbent surfaces to 2 to 3 hours on non-absorbent surfaces.

The thinning of emulsion is to be done with water and not with turpentine. Thinning with water will be particularly required for the under coat which is applied on the absorbent surface. The quantity of water to be added shall be as per manufacturer's instructions.

The surface on finishing shall present a flat velvety smooth finish. If necessary more coats will be applied till the surface presents a uniform appearance.

13.46.2.3 *Precautions*

(a) Old brushes if they are to be used with emulsion paints, should be completely dried of turpentine or oil paints by washing in warm soap water.
Brushes should be quickly washed in water immediately after use and kept immersed in water during break periods to prevent the paint from hardening on the brush.

(b) In the preparation of wall for plastic emulsion painting, no oil base putties shall be used in filling cracks, holes etc.

(c) Splashes on floors etc. shall be cleaned out without delay as they will be difficult to remove after hardening.

(d) Washing of surfaces treated with emulsion paints shall not be done within 3 to 4 weeks of application.

13.46.2.4 Other details shall be as specified in 13.23 as far as they are applicable.

13.46.3 Painting on Old Surface

13.46.3.1 ***Preparation of Surface :*** This shall be done, generally as specified in 13.31.3.1 except that the surface before application of paint shall be flattened well to get the proper flat velvety finish after painting.

13.46.3.2 ***Application :*** The number of coats to be applied shall be as in description of item.

The application shall be as specified in 13.31.3.2 except that thinning with water shall not normally be required.

13.46.3.3 Other details shall be as specified in 13.23 as far as applicable.

Note: Clause 13.46 brought from Sub Head 14 (Repairs to buildings) clause no 14.26

13.47 PAINTING WITH SYNTHETIC ENAMEL PAINT

13.47.1 Synthetic enamel paint (conforming to IS 2932) of approved brand and manufacture and of the required colour shall be used for the top coat and an undercoat of ordinary paint of shade to match the top coat as recommended by the same manufacturer as far the top coat shall be used.

13.47.2 Painting on New Surface

13.47.2.1 Preparation of surface shall be as specified in 13.25.1.1 as the case may be.

13.47.2.2 ***Application :*** The number of coats including the undercoat shall be as stipulated in the item.

(a) Under Coat : One coat of the specified ordinary paint of shade suited to the shade of the top coat, shall be applied and allowed to dry overnight. It shall be rubbed next day with the finest grade of wet abrasive paper to ensure a smooth and even surface, free from brush marks and all loose particles dusted off.

(b) Top Coat : Top coats of synthetic enamel paint of desired shade shall be applied after the undercoat is thoroughly dry. Additional finishing coats shall be applied if found necessary to ensure properly uniform glossy surface.

13.47.2.3 Other details shall be as specified in 13.23 as far as they are applicable.

13.47.3 Painting on Old Surface

13.47.3.1 ***Preparation of Surface :*** Where the existing paint is firm and sound it shall be cleaned of grease, smoke etc. and rubbed with sand paper to remove all loose particles dusted off. All patches and cracks shall then be treated with stopping and filler prepared with the specified paint. The surface shall again be rubbed and made smooth and uniform.

If the old paint is blistered and flaked it will be necessary to completely remove the same as described in para 13.41. Such removal shall be paid for separately and the painting shall be treated as on new surface.

13.47.3.2 ***Painting :*** The number of coats as stipulated in the item shall be applied with synthetic enamel paint. Each coat shall be allowed to dry and rubbed down smooth with very fine wet abrasive paper, to get an even glossy surface. If however, the surface is not satisfactory additional coats as required shall be applied to get correct finish.

13.47.3.3 Other details shall be specified in 13.23 as far as they are applicable.

Note: Clause 13.47 brought from Sub Head 14 (Repairs to buildings) clause no 14.28

13.48 PAINTING WITH ALUMINIUM PAINT

13.48.1 Aluminium paint shall be (conforming to IS 2339) of approved brand and manufacture. The paint comes in compact dual container with the paste and the medium separately.

The two shall be mixed together to proper consistency before use.

13.48.2 Preparation of Surface

13.48.2.1 Steel Work (New Surfaces) : All rust and scales shall be removed by scraping or brushing with steel wire brushes and then smoothened with sand paper. The surface shall be thoroughly cleaned of dust.

13.48.2.2 C.G.S. Sheets (New Surfaces) ***:*** The preparation of surface shall be as specified in 13.33.2.

13.48.2.3 Steel Work or C.G.S. Sheets (Old Surfaces): The specifications shall be as described in 13.33.2.3.

13.48.3 Application

The number of coats to be applied shall be as given in the item. Each coat shall be allowed to dry for 24 hours and lightly rubbed down with fine grade sand paper and dusted off before the next coat is applied. The finished surface shall present an even and uniform appearance.

As aluminium paste is likely to settle in the container, care shall be taken to frequently stir the paint during used. Also the paint shall be applied and laid off quickly, as surface is otherwise not easily finished.

Note: Clause 13.48 brought from Sub Head 14 (Repairs to buildings) clause no 14.29

SUB HEAD : 14.0

REPAIRS TO BUILDINGS

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LIST OF BUREAU OF INDIAN STANDARD CODES

S. No.	*BIS. No.*	*Subject*
1.	IS 419	Specifications for Putty for use in Window Frames
2.	IS 14900	Specifications for Transparent Float Glass

14.0 REPAIRS TO BUILDINGS

14.1 REPAIRS TO PLASTER

14.1.0 The work includes cutting the patch and preparing the wall surface. Patches of 2.50 square metres and less in area shall be measured under item of 'Repairs to Plaster' under this sub-head. Plastering in patches over 2.5 square metres in area shall be paid for at the rate as applicable to new work under sub head 'Finishing'.

14.1.1 Scaffolding

Scaffolding as required for the proper execution of the work shall be erected. If work can be done safely with the ladder or jhoola these will be permitted in place of scaffolding.

14.1.2 Cutting

The mortar of the patch, where the existing plaster has cracked, crumbled or sounds hollow when gently tapped on the surface, shall be removed. The patch shall be cut out to a square or rectangular shape at position marked on the wall as directed by the Engineer-in-Charge or his authorized representative. The edges shall be slightly under cut to provide a neat joint.

14.1.3 Preparation of Surface

The masonry joints which become exposed after removal of old plaster shall be raked out to a minimum depth of 10 mm in the case of brick work and 20 mm in the case of stone work. The raking shall be carried out uniformly with a raking tool and not with a basuli, and loose mortar dusted off. The surface shall then be thoroughly washed with water, and kept wet till plastering is commenced.

In case of concrete surfaces, the same shall be thoroughly scrubbed with wire brushes after the plaster had been cut out and pock marked as described in 13.1.2. The surface shall be washed and cleaned and kept wet till plastering is commenced.

14.1.4 Application of Plaster

Mortar of specified mix with the specified sand shall be used. The method of application shall be as described for single coat plaster work of the specified mix and under Chapter 13. The surface shall be finished even and flush and matching with the old surrounding plaster. All roundings necessary at junctions of walls, ceilings etc. shall be carried out in a tidy manner as specified in sub-head 13.0.

All dismantled mortar & rubbish etc. shall be disposed off within 24 hours from its dismantling promptly as directed by the Engineer-in-Charge.

14.1.5 Protective Measure

Doors, windows, floors, articles of furniture etc. and such other parts of the building shall be protected from being splashed upon. Splashing and droppings, if any, shall be removed by the contractor at his own cost and the surface cleaned. Damages, if any, to furniture or fittings and fixtures shall be recoverable from the contractor.

14.1.6 Curing

Curing shall be done as per plaster work with special reference to the particular type of plaster mix as described under sub-head 'finishing'.

14.1.7 Finishing

After the plaster is thoroughly cured and dried the surface shall be white washed or colour washed to suit the existing finishing as required unless specified.

14.1.8 Measurements

Length and breadth shall be measured correct to a cm. The area shall be calculated in square metre correct to two places of decimal. Patches below 0.05 square metre in area shall not be measured for payment.

Pre- measurements of the patches to be plastered shall be recorded after the old plaster has been cut and wall surface prepared.

14.1.9 Rate

The rate includes the cost of all the materials and labour involved in all the operations described above including lead as described in the item for disposal of old dismantled plaster /material.

14.2 FIXING DOOR, WINDOW OR CLERESTORY WINDOW CHOWKHATS IN EXISTING OPENING

14.2.1 Making Holes

14.2.1.1 In case of door frames without sills, holes 40 mm deep shall be made in the floor for fixing the lower end of verticals of the frames. For doors with sills, the sill plates shall be partly fixed in the floor so that they project above the floor to the height as directed by the Engineer-in-Charge.

14.2.1.2 For embedding hold fasts of doors, windows or clerestory windows, the requisite number of holes at the correct positions shall be cut out in the masonry. The size of the holes shall be such that the chowkhats with the hold-fasts can be conveniently erected in position. Where necessary, masonry shall be chipped uniformly to facilitate easy insertion of the frame in the opening.

14.2.1.3 Special care shall be taken when holes are made in load bearing pillars or wall portions separated by openings to ensure that beams etc. supported by them are properly propped up. In such portions cutting holes shall be done on one side at a time. The sides of the holes shall be truly parallel and perpendicular to the plane of the wall. Due care shall be taken, not to disturb the adjoining masonry and the masonry under the bearings of lintels and arches etc. spanning the opening. The holes shall then be cleaned of all dust, mortar and brick bats or stone pieces and thoroughly wetted.

14.2.2 Fixing

The sides of chowkhats of door, window or clerestory window abutting against or to be embedded in masonry shall be painted with two coats of coal tar before being placed in position. The chowkhats shall than be inserted in position with their hold-fasts bolted tight. The chowkhats shall than be adjusted to proper line and plumb and secured in position by temporary bracing which shall not be disturbed or removed until the hold fasts are embedded in the masonry and the concrete block has set. The concrete to be used for embedding hold- fasts shall be cement concrete 1:3:6 mix (1 cement : 3 coarse sand : 6 graded stone aggregate 20 mm nominal size).

The minimum size of concrete block in which the hold-fasts will be embedded shall be 30 x 10 x 15 cm for 35 cm long holdfasts. The concrete of the block shall completely fill the hole made in the masonry for the purpose. The chase cut in the floor shall be cut square and construction joint shall be provided filled in with cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size) and rendered smooth at the top and finished to match the existing type of floor.

14.2.3 Finishing

After the surface surrounding the hold-fasts has sufficiently dried it shall be cleaned of dust etc. and wetted. It shall then be plastered with cement mortar 1:4 (1 cement : 4 fine sand) flush and matching with the surrounding plaster work. In case of exposed brick work, stone work, the finishing shall be done to match the surrounding. Any other portion of the wall opening, if damaged, shall be repaired in similar way.

After the cement plaster patches have been thoroughly cured and dried, they shall either be white washed or colour washed as required unless otherwise specified. All malba and debris obtained from cutting etc. shall be disposed off to the nearest dumping ground promptly as directed by Engineer-in-Charge.

14.2.4 Measurements

The chowkhats of doors, window and clerestory windows shall be enumerated separately.

14.2.5 Rate

The rate shall apply irrespective of the size of the chowkhat upto a maximum area of opening 3.75 square metres for doors, 2.5 square metres for windows and 1.2 square metres for clerestory windows. The rate is inclusive of labour and materials involved in all the operations described above, excluding (a) cost of chowkhats and (b) cost of supplying and fixing the hold-fasts including C.C. block and bolts.

14.3 FIXING CHOWKHATS IN EXISTING OPENING IN BRICKS / RCC WALL WITH DASH FASTNERS

14.3.1 In case of door frames without sills, holes 40 mm deep shall be made in the floor for fixing the lower end of verticals of the frames. For doors with sills, the sill plates shall be partly fixed in the floor so that they project above the floor to the height as directed by the Engineer-in-Charge.

14.3.1.1 For fixing dash fastners /chemical fastners of doors, windows or clerestory windows, the requisite number of holes at the correct positions shall be in the masonry/RCC wall. The size of holes shall be such that the fastners can be conveniently placed in position. Where necessary, masonry shall be chiped uniformly to facilitate easy insertion of the frame in the opening.

14.3.1.2 Special care shall be taken when holes are made in load bearing pillars or wall portions separated by openings to ensure that beams etc. supported by them are properly propped up. In such portions cutting holes shall be done on one side at a time. The sides of the holes shall be truly parallel and perpendicular to the plane of the wall. Due care shall be taken, not to disturb the adjoining masonry and the masonry under the bearings of the lintels and arches etc. spanning the opening. The holes shall then be cleaned of all dust, mortar and brick bats or stone pieces and thoroughly wetted.

14.3.2 Fixing

The sides of chowkhats of door, window or clerestory window abutting against or to be embedded in masonry shall be painted with two coats of coal tar before being placed in position. The chowkhats shall then be inserted in position tight. The chowkhats shall then be adjusted to proper line and plumb and secured in position by temporary bracing which shall not be disturbed or removed until the fastners are embedded in the masonry /RCC wall.

14.3.3 Finishing

After the surface surrounding the hold-fasts has sufficiently dried it shall be cleaned of dust etc. and wetted. It shall then be plastered with cement mortar 1:4 (1 cement: 4 fine sand) flush and matching with the surrounding plaster work. In case of exposed brick work, stone work, the finishing shall be done to match the surrounding. Any other portion of the wall opening, if damaged, shall be repaired in similar way.

After the cement plaster patches have been thoroughly cured and have dried, they shall either be white washed or colour washed as required unless otherwise specified. All malba and debris obtained from cutting etc. shall be disposed off to the nearest dumping ground.

14.3.4 Measurements

The chowkhats of doors, window and clerestory windows shall be enumerated separately.

14.3.5 Rate

The rate shall apply irrespective of the size of the chowkhat upto a maximum area of opening 3.75 square metres for doors, 2.5 square metres for windows and 1.2 square metres for clerestory windows. The rate is inclusive of labour and materials involved in all the operations described above, including cost of dash fastners chemical fasteners but excluding cost of chowkhat.

14.4 MAKING OPENING IN THE MASONRY CONSTRUCTION AND FIXING CHOWKHATS FOR DOORS, WINDOWS AND CLERESTORY WINDOWS

14.4.0 Before making opening it is necessary to examine that the wall exclusive of opening is adequate to take the load coming on the structure. All the structural members supported on the walls which have direct bearing over the area in which opening is to be made, shall be properly supported with props to relieve the load from masonry wall till the lintel over the opening is strong enough to take the load. Care should also be taken not to disturb the adjoining masonry.

All precautions as explained in Chapter 15.0 (Demolition and Dismantling) should be followed in case of dismantling the external walls. The portion to be dismantled may be clearly marked on both sides of the wall. Dismantling shall be carried out from top to bottom within the marked area. The sides of the opening shall be as far as possible, parallel and perpendicular to the plane of wall.

14.4.1 Making Opening

14.4.1.1 The openings for fixing door/window frames shall be to the extent of accommodating the hold fast. The hold fasts shall be fixed in cement concrete 1:3:6 (1 cement : 3 coarse sand : 6 stone aggregate 20 mm nominal size) or in masonry as required. Where only opening is to be made in the masonry, the width of the opening shall be such that the sides of the masonry can be built true to line and plumb and such masonry built shall conform to the specifications of the particular type of masonry in which the opening is made with particular reference to size of corner stones etc. In order to get continuity with old masonry, proper key shall be provided. The height of the opening shall be such that it can accommodate the required depth of the RCC lintel also.

14.4.1.2 The sides of opening in masonry shall be cleaned of all dust, mortar, brick bats/loose stones, chips etc. and the surface left rough and thoroughly wetted.

14.4.1.3 The lintel shall be invariably cast first in the opening made for the purpose. One side of the shuttering shall be kept open in the beginning till the concrete is laid. The shuttering shall then be fixed for half of the opening and concreting completed.

14.4.1.4 Curing of lintel casted shall be done for a minimum period of 7 days.

14.4.1.5 Precast RCC lintel or R.S. Joist may also be used if directed by the Engineer-in-Charge.

14.4.2 Fixing Chowkhats

Fixing of chowkhats shall be done as specified in 14.2.2.

14.4.3 Finishing

14.4.3.1 After the surface of the sides of masonry opening and lintel are sufficiently dry and set, it shall be cleaned free of dust, loose mortar etc. and wetted thoroughly. It shall then be plastered or pointed as required flush with the surrounding masonry work. Any other portion of the wall if damaged shall be finished in similar manner.

14.4.3.2 After the cement plaster/pointing has been thoroughly cured and have dried the surface shall be either white or colour washed/painted as required. The surface of the wall which is spoiled due to splashing of mortar shall be cleaned forthwith.

14.4.4 Measurements

The openings made for doors, windows, clerestory windows shall be measured correct to cms and area shall be calculated in square metres correct to two places of decimal.

14.4.5 Rate

The rate shall apply per sqm of opening. The rate is inclusive of labour and material involved in all the operations described above.

Cost of Chowkhats, cost of CC blocks, cost of supplying the hold-fasts bolts, cost of R.C.C lintel or R.S. Joist which shall be paid for separately.

14.5 RENEWING FLOATING GLASS PANES WITH PUTTY AND NAILS

14.5.1 Removing Broken Glass Panes

Old putty shall be raked out with hack knife. The brad (small nails without head) and pieces of broken glass shall be removed from the rebates of the sash bars. The pieces of glass panes as found useful shall be handed over to the Engineer-in-Charge of the work. No glass shall be inserted in frames until they have been primed and prepared for painting so that the wood may not draw oil out of the putty.

14.5.2 Floating Glass Panes

The floating glass panes shall conform to specifications described in IS 14900.

14.5.3 Fixing

The floating glass panes shall be so cut that it fits slightly loose in the frame and as specified in A&B of IS 14900. A thin layer of Putty conforming to IS 419 shall be prepared by mixing one part of white lead with three parts of finely powdered chalk and then adding the boiled linseed oil to the mixture to form a stiff paste and adding varnish to the paste @ 1 litre of varnish to 18 kg. of paste. The putty so prepared in the form of a stiff paste shall be drawn along the inner edge of the rebate, for bedding the back of the glass panes. The glass pane shall then be put in position, pressed home against the thin layer of the putty, and secured in rebate by new brads. The brads shall not be spaced more than 7.5 cm from each corner and not more than 15 cm apart. The putty shall then be applied in the rebate uniformly, sloping from the inner edge of the rebate. In doing this care shall be taken to keep the putty a little within the inner edge of the rebate and surplus putty removed so that none of it is seen through the glass from the inside. The putty so filled in the rebates shall be levelled smooth and finished in a straight line. When dried the putty shall be covered with a coat of paint of approved quality and shade to match the existing finish of joinery work.

The floating glass panes shall be cleaned with methylated spirit. All splashings or droppings of washing and paints shall be removed. All rubbish and unserviceable materials shall be disposed off to the dumping ground promptly as per the direction of Engineer-in-Charge.

Thickness and Tolerance of Floating Glass

Thickness	*Tolerance*
4 mm	± 0.3 mm
5 mm	± 0.3 mm
6 mm	± 0.3 mm

Note : Frosted glass panes should be replaced with frosted glass panes. These shall be fixed with frosted face on the inside.

14.5.4 Measurements

Length and breadth of glass panes shall be measured correct to a cm. The area of the glass panes as fixed shall be calculated in square metre correct to two places of decimal.

14.5.5 Rate

The rate shall include the cost of labour and materials involved in all the operations described above.

14.6 RENEWING FLOATING GLASS PANES WITH WOODEN FILLETS

14.6.1 Removing Broken Glass Panes

The specifications shall be the same as in para 14.5.1 except that the wooden fillets including nails shall be taken out carefully.

14.6.2 Glazing

The specifications for glass panes and their fixing shall be the same as per IS 14900. The fillet shall either be fixed flush or projected uniformly to match with the existing work by means of nails (brads).

The new fillet provided shall be painted or finished otherwise to match with the existing finish of the joinery work.

The glass panes shall be cleaned with methylated spirit of all sorts of splashing and droppings of wash and paints.

All rubbish and unserviceable materials shall be disposed off in the dumping ground promptly as per the direction of Engineer-in-Charge.

14.6.3 Measurements

Length and breadth of glass panes shall be measured correct to a cm. The area of the glass panes as fixed shall be calculated in square metre correct to two places of decimal. The new wooden fillets fixed shall be measured in running metres correct to a cm.

14.6.4 Rate

The rates shall include the cost of labour and material involved in all the operations described above except that the cost of new wooden fillets used in the work and their finishing shall be paid for separately.

14.7 RENEWING FLOATING GLASS PANES AND REFIXING EXISTING WOODEN FILLETS The specifications shall be same as described in 14.6 above.

14.8 PROVIDING NEW WOODEN FILLETS

14.8.1 The fillets shall be of wood, as specified in the item of work, these shall be cut and planed smooth to the required shape and dimensions.

14.8.2 Fixing

The specifications for glass panes and their fixing shall be the same as given in 9.6.4.6. The fillet shall either be fixed flush or projected uniformly to match the existing work.

The fillet shall be painted or finished otherwise to match with the existing finish of the joinery work.

The glass panes shall be cleaned with methylated spirit of all sorts of splashing and dropping of wash and paints.

14.8.3 Measurements

The fillets shall be measured in running metres. The lengths shall be measured correct to a cm.

14.8.4 Rate

The rate shall include the cost of all labour and materials involved in all the operations described above. The rate shall also include the cost of removal of worn out fillets, when these are met with in old work. The rate shall vary according to the class of wood used.

14.9 RENEWAL OF OLD PUTTY OF GLASS PANES

14.9.1 The old putty shall be removed as specified in 14.5.1 and new putty fixed as specified in 14.5.3.

14.9.2 Measurements

The work shall be measured in running metres. The length along the rebate shall be measured correct to a cm.

14.9.3 Rate

The rate shall include the cost of labour and materials involved in all the operations described above.

14.10 REFIXING OLD GLASS PANES WITH PUTTY AND NAILS

14.10.1 Specification same as described in 14.5 above. Except for the glass panes, old glass panes will be used for which nothing extra will be paid.

14.11 FIXING OLD GLASS PANES WITH WOODEN FILLETS

14.11.1 Specifications same as described in para no. 14.6 above except for the glass panes. Old glass panes will be used for which nothing extra shall be paid.

14.12 FIXING FAN CLAMPS IN EXISTING R.C.C. SLABS

14.12.1 The fan clamps to be fixed in an existing R.C.C. slab shall be of type shown in Fig. 14.1. These shall be made of 16 mm dia M.S. bar.

14.12.2 Fixing

A 15 x 7.5 cm size chase shall be cut from the ceiling to expose the reinforcement and upto 2.5 cm clear round the reinforcement bar as directed. This shall be done without any damage to adjoining portion of the ceiling.

The two arms at the ends of the clamps shall be passed through the space over the reinforcement bar from the bottom of the slab. Then the two arms shall be bent down about 1.5 cm by means of a crow bar. The clamp shall be held in position and chase in the ceiling filled with cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size). The ceiling shall then be finished to match the existing surface and properly cured.

The exposed portion of the clamp shall be given two or more coats of paint including one priming coat of shade as directed by the Engineer-in-Charge.

14.12.3 Measurements and Rate

Clamps shall be counted in numbers. The rate per fan clamp shall include the cost of labour and materials involved in all the operations described above. The rate shall apply irrespective of the thickness of the slab.

14.13 REGRADING OF MUD PHUSKA TERRACING

14.13.1 Dismantling

The specified area of roof as directed by the Engineer-in-Charge shall be dismantled carefully so that the minimum of tiles or bricks are damaged. The serviceable tiles or bricks shall be cleaned and stacked on places as directed by the Engineer-in-Charge, or on the parapet wall if convenient and safe or otherwise carried to ground and stacked as directed by the Engineer-in-Charge for which nothing extra shall be paid.

All unserviceable tiles and debris shall be disposed off to the dumping ground as directed by the Engineer-in-Charge. Suitable earth shall be stacked separately for reuse.

14.13.2 Laying

Mud phuska shall be removed, cleaned of all foreign matter and brought to the ground. After approval of the Engineer-in-Charge it shall then be reduced to fine powder and then mixed with additional soil for regrading and additional fibrous reinforcing materials such as chopped straw or fresh bhusa at the rate of 8 kg/cum of mud mortar shall be mixed with old earth. The choppings used shall not be more than 20 mm in length. A pit shall be dug where the mixture shall be added and allowed to mature for a period of not less than 7 days. During this period the mixture shall be worked up at interval with feet and spades so as to get pugged into homogeneous mass free from lumps and clods. The consistency of the mortar shall be adjusted by taking it in a trowel and observing how it slides off the face of the trowel. The mortar shall readily slide off, but at the same time shall be so wet as to part into large drops before falling.

14.13.3 Leeping Plaster

Shall be prepared by mixing soil which is free from coarse sand with approximately equal volume of cow dung and adding the required quantity of water. The mixture shall work to a homogeneous mass. The quantity of gobar used in gobri leeping shall not be less than 0.03 cum per 100 sqm of plaster area.

14.13.4 Laying Tile Bricks and Grouting

The specifications shall be as described in 12.11.4 except that new tile as necessary to replace the broken tiles shall be used. Half or cut brick tiles shall not be used except where necessary to complete the bond. New work shall be finished in level with surrounding surface.

14.13.5 Curing and Measurements

Shall be as specified in 12.11.5 and 12.11.6.

14.13.6 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above except for new tiles or bricks which shall be paid for separately.

14.14 REPLACING RED OR WHITE SAND STONE SLABS IN ROOFING

14.14.1 Dismantling Roof

The general specifications given in 15.1 shall apply. The cracked or decayed stone slabs as marked by the representative of the Engineer-in-Charge shall be removed after dismantling the tile covering with mud phuska over it if any, or other type of covering over the stone slabs.

Mud phuska terracing with tile brick covering shall be dismantled as per 14.13.1 over the specified cracked or decayed tiles to an area extending 15 cm on all sides of stone slabs. This area may be increased by the Engineer-in-Charge, if found necessary. Stone slabs shall then be dismantled and carried down and stacked properly.

In case the stone slabs are not covered at top with mud phuska or lime terracing, the decayed or cracked stone slabs shall be dismantled and carried down or lowered with ropes and stacked properly.

14.14.2 Relaying of Stone Slab Roofing

Before placing the stone slab the condition of the existing wooden battens shall be checked by suitable methods and replaced if required by Engineer-in-Charge. The upper surface of the wooden battens and beams supporting the stone slab, shall be painted with two coats of coal tar if not already treated and with one coat of coal tar if originally treated.

The specifications for stone slabs, laying, finishing and curing, shall be as described under 12.15.

14.14.3 Relaying of Mud Phuska with Tile

The specifications shall be as described in 14.13.2 to 14.13.4 and shall be paid for separately.

14.14.4 Curing and Measurements

Shall be done as described in 12.11.5 and 12.11.6.

14.14.5 All unserviceable material shall be disposed off to the dumping ground as directed by the Engineer-in-Charge.

14.14.6 Rate

The rate shall include the cost of materials and labour involved in all the operations described above, except the cost of wooden battens which shall be paid for separately.

14.15 RENEWING WOODEN BATTENS /BEAMS IN ROOFS

14.15.1 Dismantling Wooden Battens / Beams

Dismantling shall be done as described in para 15.1 of dismantling and demolishing. Proper scaffolding shall be erected and got inspected by Engineer-in -Charge. Propping and bracing as directed should be done adequately and members required to be dismantled should be removed carefully including nails/bolts etc. and dismantling of masonry wall. The dismantled members should not be thrown or dropped but lowered with ropes carefully and stacked properly.

14.15.2 Relaying of Wooden Battens

The wooden battens/beams of required section and size should be placed at proper interval and surface of the wooden batten/beams shall be painted with oil type wood preservative of approved brand and manufacture and as per the direction of Engineer-in-Charge.

14.15.3 All serviceable material shall be stacked properly and all the unserviceable material shall be deposited with the Engineer-in-Charge.

14.15.4 Measurement

The work shall be measured in cubic meters. The length, breadth and depth shall be measured correct to a cm.

14.15.5 Rate

The rate shall include the cost of materials and labour involved in the operations described above.

14.16 PANELLED GLAZED OR PANELLED AND GLAZED SHUTTERS

14.16.0 Pannelled or glazed shutters for doors, windows, ventilators and cupboards shall be constructed in the form of timber frame work of stiles and rails with panel inserts of timber, plywood, block board, veneered particle board, fibre board wire gauze or sheet glass. The shutters may be single or multipanelled, as shown in the drawings or as directed by the Engineer-in-Charge. Timber for frame work, material for panel inserts and thickness of shutters shall be as specified. All members of the shutters shall be straight without any warp or bow and shall have smooth well planed face at right angles to each other.

Any warp or bow shall not exceed 1.5 mm. The right angle for the shutter shall be checked by measuring the diagonals and the difference between the two diagonals should not be more than ± 3 mm.

14.16.1 Frame Work

14.16.1.1 Timber for stiles and rails shall be of the same species and shall be sawn in the directions of grains. Sawing shall be truly straight and square. The timber shall be planed smooth and accurate to the required dimensions. The stiles and rails shall be joined to each other by plain or haunched mortise and tenon joints and the rails shall be inserted 25 mm short of the width of the stiles. The bottom rails shall have double tenon joints and for other rails single tenon joints shall be provided. The lock rails of door shutter shall have its centre line at a height of 800 mm from the bottom of the shutters unless otherwise specified. The thickness of each tenon shall be approximately one- third the finished thickness of the members and the width of each tenon shall not exceed three times its thickness.

14.16.1.2 ***Gluing of Joints :*** The contact surfaces of tenon and mortise shall be treated, before putting together, with bulk type synthetic resin adhesive conforming to IS 851 suitable for construction in wood or synthetic resin adhesive (Phenolic and aminoplastic) conforming to IS 848 or polyvinyl acetate dispersion based adhesive conforming to IS 4835 and pinned with 10 mm dia hardwood dowels or bamboopins or star shapped metal pins; after the frames are put together and pressed in position by means of press.

14.16.1.3 Stiles and bottom rail shall be made out of one piece of timber only. Intermediate rail exceeding 200 mm in width may be out of one or more pieces of timber. The width of each piece shall be not less than 75 mm. Where more than one piece of timber is used for rails, they shall be joined with a continuous tongued and grooved joint glued together and reinforced with metal dowels at regular intervals not exceeding 200 mm.

TABLE 14.1
Dimensions of Components of Frame Work

Sl. No.	*Description*	*Width*	*Thickness*
		Mm	*mm*
A. DOOR SHUTTERS			
(a)	Stile, top and freeze rail	100	35 or 40
(b)	Lock rail	150	35 or 40
(c)	Bottom rail	200	35 or 40
(d)	Muntin	100	35 or 40
(e)	Glazing bar	40	35 or 40
B. WINDOW, VENTILATOR & CUPBOARD SHUTTERS			
(a)	Stile, top and freeze rail	80	20, 25 or 30
(b)	Bottom rail	80	20, 25 or 30
(c)	Muntin	60	20, 25 or 30
(d)	Glazing bar	40	20, 25 or 30

14.16.2 Muntin and glazing bars where required shall be stubtenoned to the maximum depth which the size of the member would permit or to a depth of 25 mm whichever is less. Unless otherwise specifed the finished dimensions of the components of frame work of shutters shall be as given in Table 14.1. The tolerance on width of styles and rail shall be ± 3 mm. The tolerance in thickness will be ± 1 mm. The thickness of all components of frame work shall be the same as the thickness of the shutter. Tolerance on over all dimensions of the shutter shall be ± 3 mm.

14.16.3 Rebating

The shutters shall be single-leaf or double leaved as shown in the drawings or as directed by the Engineer-in-Charge. In case of double leaved shutters, the meeting of the stiles shall be rebated by one-third the thickness of the shutter. The rebating shall be either splayed or square type as shown in Fig. 14.2.

14.16.4 Panelling

The panel inserts shall be either framed into the grooves or housed in the rebate of stiles and rails. Timber, plywood, hard board and particle board panels shall be fixed only with grooves. The depth of the groove shall be 12 mm and its width shall accommodate the panel inserts such that the faces are closely fitted to the sides of the groove. Panel inserts shall be framed into the grooves of stiles and rails

to the full depth of the groove leaving on space of 1.5 mm. Width and depth of the rebate shall be equal to half the thickness of stiles and rails. Glass panels, asbestos panels wire gauze panels and panel inserts of cupboard shutters shall be housed in the rebates of stiles and rails.

14.16.4.1 ***Timber Panels :*** Timber panels shall be preferably made of timber of large width; the minimum width and thickness of the panel shall be 150 mm, and 15 mm respectively. When made from more than one piece, the pieces shall be jointed with a continuous tongued and grooved joint glued together and reinforced with headless nails at regular intervals not exceeding 100 mm. Depth and thickness of such joint shall be equal to one- third of thickness of panel. The panels shall be designed such that no single panel exceeds 0.5 square metre in area. The grains of timber panels shall run along the longer dimensions of the panels. All panels shall be of the same species of timber unless otherwise specified.

14.6.4.2 ***Plywood Panels :*** Plywood boards used for panelling of shutters shall be BWP type or grade as specified in 9.2.2. Each panels shall be a single piece of thickness, 9 mm for two or more panel construction and 12 mm for single panel construction unless otherwise specified.

14.16.4.3 ***Block Board Panels :*** Block board used for panelling of shutters shall be Grade I (Exterior Grade) bonded with BWP Type Synthetic resin adhesives as specified in 9.2.2. Each panel shall be a single piece of thickness 12 mm unless otherwise specified.

14.16.4.4 ***Veneered Particle Board Panels*** **:** Veneered Particle board used for panelling of shutters shall be Exterior Grade bonded with BWP type synthetic resin adhesive as specified in 9.2.4.2. Each panel shall be a single piece of thickness 12 mm unless otherwise specified.

14.16.4.5 ***Fibre Board Panels :*** Fibre board used for panelling of shutters shall be Exterior Grade bonded with BWP type synthetic resin adhesive as specified in 9.2.8.2. Each fibre board panel shall be a single piece of thickness 10 mm unless otherwise specified.

14. 16.4.6 ***Wire Gauze Panels :*** Wire Gauze used for panelling of shutters shall be woven with 0.63 mm dia galvanised mild steel wire to form average aperture size of 1.40 mm as specified in 9.2.10. Wire gauze shall be securely housed into the rebates of stiles and rails by giving right angles bend turned back and fixed by means of suitable staples at intervals of 75 mm and over this wooden beading shall be fixed. The space between the rebate and the beading shall be fixed with putty to give a neat finish. Each wire gauze panel shall be a single piece, and the panels shall be so designed that no single panels exceeds 0.5 sqm in area. However, care shall be taken to prevent sagging of wire gauge, of panel by providing and fixing 20 x 20 mm square or equivalent beading to the external face in the required patterns as decided by the Engineer-in-Charge.

14.16.4.7 ***Glass Panels :*** Glass panelling (Glazing) shall be done with float sheet glass as per IS 14900. Glazing in the shutters of doors, windows and ventilators of bath, WC and Lavatories shall be provided with frosted glass the weight of which shall be not less than 10 kg/sqm. Frosted glass panes shall be fixed with frosted face on the inside. Glass panels shall be fixed by providing a thin layer of putty conforming to IS 419 applied between glass pane and all along the length of the rebate and also between glass panes and wooden beading.

14.16.4.8 Putty can be prepared by mixing one part of white lead with three parts of finely powdered chalk and then adding boiled linseed oil to the mixture to form a stiff paste and adding varnish to the paste at the rate of 1 litre of varnish to 18 kg of paste. Fixing of glass panes without beading shall not be permitted. Glazing shall be done after the shutters have been primed and prepared for painting, so that wood may not draw oil out of putty.

14.16.4.9 ***Finish :*** Panels of shutters shall be flat and well sanded to a smooth and level surface.

14.16.5 Beading

Beadings in panelled shutter shall be provided where specified in architectural drawings or directed by the Engineer-in -Charge. Each length of beading shall be single piece. Joints at the corners shall be mitred and exposed edges shall be rounded. Beading shall be fixed with headless nails at 75 mm intervals. For external shutters, the beading shall be fixed on the outside face.

14.16.6 Machine/Factory made Shutters

Machine made shutters, where specified, shall be procured from an approved factory. For machine made shutters, operations like sawing, planning, making tongue and tenons, cutting grooves, mortises and rebates, drilling holes and pressing of joints shall be done by suitable machines. Machines made shutters shall be brought to the site fully assembled but without any priming coat. Panel inserts of sheet glass and wire gauze may, however, be fixed at site.

14.16.7 Fixing of Shutters

For side hung shutters of height upto 1.2 m, each leaf shall be hung on two hinges at quarter points and for shutter of height more than 1.2 m, each leaf shall be hung on three hinges one at the centre and the other two at 200 mm from the top and bottom of the shutters. Top hung and bottom hung shutters shall be hung on two hinges fixed at quarter points of top rail or bottom rail. Centre hung shutter shall be suspended on a suitable pivot in the centre of the frame. Size and type of hinges and pivots be as specified. Flap of hinges shall be neatly counter sunk into the recesses cut to the exact dimensions of flap. Screws for fixing the hinges shall be screwed in with screw driver and not hammered in. Unless otherwise specified, shutters of height more than 1.2 m shall be hung on butt hinges of size 100 mm and for all other shutters of lesser height butt hinges of size 75 mm shall be used. For shutter of more than 40 mm thickness butt hinges of size 125 × 90 × 4 mm shall be used. Continuous (piano) hinges shall be used for fixing cup-board shutters where specified.

14.16.8 Fittings

Fittings shall be provided as per schedule of fittings decided by Engineer-in- Charge. Appendix H (P-361/SH 9.0) gives for guidance the schedule of fittings and screws usually provided. Cost of providing and fixing shutter shall include cost of hinges and necessary screws for fixing the same. All other fittings shall be paid for separately. The fittings shall conform to specifications laid down in 9.6.8. Where the fittings are stipulated to be supplied by the department free of cost, screws for fixing these fittings shall be provided by contractor and nothing extra shall be paid for the same.

14.16.9 Wooden Cleats and Blocks

Wooden cleats and blocks shall be fixed to doors and windows as directed by Engineer-in-Charge, as per size and shape approved by him. These are included in the cost of providing and fixing the shutters.

14.16.10 Measurements

Framework and panelling shall be measured separately.

14.16.10.1 ***Frame Work of Shutters :*** The overall length and width of the framework of the shutters shall be measured nearest to a cm in fixed position (overlaps not to be measured in case of double leaved shutters) and the area calculated in square metres correct to two places of decimeter. No deduction shall be made to form panel openings or louvers. No extra payments shall be made for shape, joints and labour involved in all operations described above.

14.16.10.2. For panelling of each type or for glazed panel length and width of opening for panels inserts or glazed panels shall be measured correct to a cm before fixing the beading and the area shall be calculated to the nearest 0.01 sq.m. The portions of the panel inserts or glazed panel inside the grooves or rebates shall not be measured for payment.

14.16.11 Rate

Rate includes the cost of materials and labour involved in all the operations described above. The frame work and panelling of each type or glazed panels shall be paid separately. The rate for frame work includes the cost of butt hinges and necessary screws as specified in 9.6.7. However, extra shall be paid for providing moulded beading where specified. Nothing extra shall be paid for plain beading as stated in 9.6.5 when specified in drawing.

14.17 TRELLIS (JAFFRI) WORK

14.17.0 Specified timber shall be sawn in the direction of the grains. Sawing shall be truly straight and square. The timber shall be plained smooth and accurate to the full dimensions, rebates, roundings, and mouldings as shown in the drawings made, before assembly. Patching or plugging of any kind shall not be permitted except as provided.

14.17.1 Plain Trellis (Jaffri)

This shall consist of wooden strips or laths 35 x 10 mm section unless otherwise specified plained and nailed together at every alternate crossing. The strips shall cross each other at right angle and shall be spaced 35 mm apart, so as to form 35 × 35 mm square opening or as shown in the drawing. These shall be fixed with nails to the frame. To cover the ends of strips, 50 × l2 mm beading shall be fixed to the frame with screws. The finished work with a tolerance of ± 1 mm may be accepted.

14.17.2 Trellis (Jaffri) Doors and Windows Shutters

Shutter frame of specified timber shall consist of two stiles and top, lock and bottom rails, each of section 75 × 35 mm unless otherwise specified. The stiles and rails shall be properly mortised and tenoned. The tenons shall pass through the stiles for at least 3/4th of the width of the stile. Shutter frame shall be assembled and passed by the Engineer-in-Charge before jointing. The joints shall be pressed and secured by bamboo pins of about 6 mm diameter. To this frame, plain trellis (Jaffri) work as described in 9.11.1 shall be fixed as shown in the drawings or as directed by the Engineer-in-Charge. Fixing, fittings, wooden cleats and blocks shall be provided as specified under 9.6.

14.17.3 Measurements

Width and height of plain trellis work and trellis shutters shall be measured overall correct to a cm. The area shall be calculated in square metres nearest to two places of decimal. In case of shutters, the measurement shall be as specified in 9.11.2.

14.17.4 Rate

It includes the cost of materials and labour required in all the operations described above.

14.18 FITTINGS

14.18.0 Fitting shall be of mild steel brass, aluminium or as specified. Some mild steel fittings may have components of cast iron. These shall be well made, reasonably smooth, and free from sharp edges and corners, flaws and other defects. Screw holes shall be counter sunk to suit the head of specified wood screws. These shall be of the following types according to the material used.

(a) Mild Steel Fittings
These shall be bright satin finish black stone enamelled or copper oxidised (black finish), nickel chromium plated or as specified.

(b) Brass Fittings
These shall be finished bright satin finish or nickel chromium plated or copper oxidised or as specified.

(c) Aluminium Fittings
These shall be anodised to natural matt finish or dyed anodic coating not less than grade AC 10 of IS 1868.

The fittings generally used for different type of doors and windows are indicated in Appendix H (P-361/SH 9.0) attached. The fittings to be actually provided in a particular work shall, however, be decided by the Engineer-in-Charge.

Screws used for fittings shall be of the same metal, and finish as the fittings. However, chromium plated brass screws or stainless steel screws shall be used for fixing aluminium fittings. These shall be of the size as indicated in respective figures.

Fittings shall be fixed in proper position as shown in the drawings or as directed by the Engineer-in-Charge. These shall be truly vertical or horizontal as the case may be. Screws shall be driven home with screw driver and not hammered in. Recesses shall be cut to the exact size and depth for the counter sunking of hinges.

14.18.1 Butt Hinges

(a) Cast brass butt hinges light/ordinary or heavy.

14.18.1.1 ***Cast Brass Butt Hinges :*** These shall be light/ordinary or heavy as specified. These shall be well made and shall be free from flaws and defects of all kinds. These shall be finished bright or chromium plated or oxidised or as specified. These shall generally conform to IS 205.

Hinge Pin **:** Hinge pin shall be made of brass or of phosphor bronze. The hinge pins shall be firmly rivetted and shall be properly finished. The movement of the hinge pin shall be free, easy and square and shall not have any play or shake.

Knuckles : The number of knuckles in each hinge shall not be less than five. The number of knuckles in case of sizes less than 40 mm shall be three. The sides of the knuckles shall be straight and at right angle to the flap. The movement of the hinge pin shall be free and easy and working shall not have any play or shake.

Screw Holes : The screw holes shall be clean and counter sunk and of the specified size for different types and size of hinges. The size of the holes shall be such that when it is counter sunk it shall be able to accommodate the full depth of counter sunk head of wood screw specified.

14.18.1.2 ***Sampling and Criteria for Conformity :*** The number of butt hinges to be selected from a lot shall depend on the size of lot and shall be in accordance with Table 10. Butt hinges for testing shall be taken at random from at least 10 per cent of the package subject to a minimum of three, equal number of hinges being selected from each package. All butt hinges selected from the lot shall be checked for dimensional and tolerance requirements. Defects in manufacture and finish shall also be checked. A lot shall be considered conforming to the requirements of this specification if the number of defective hinges among those tested does not exceed the corresponding number given in Table 14.2.

TABLE 14.2

Lot size	*Sample size*	*Permissible No. of defective hinges*
Upto 200	15	0
201 to 300	20	1
301 to 500	30	2
501 to 800	40	2
801 and above	55	3

Note: Any hinge which fails to satisfy the requirements of any one or more of the characteristics shall be considered as defective hinge.

14.18.2 Spring Hinges : (Single or double acting)

14.18.2.1 These shall be single acting when the shutter is to open on one side only or double acting when the shutter opens on both sides. These shall be made of M.S. or brass as specified, and shall generally conform to IS 453.

Hinges shall work smoothly and shall hold the door shutter truly vertical in closed position. Each double-acting spring hinge shall withstand the following tests which shall be carried out after fixing it to a swing door in the normal manner.

(a) When the door is pushed through 90° and released 2000 times on each side in quick succession the hinge shall show no sign of damage or any appreciable deterioration of the components during or on completion of the test.

(b) The door shall require a force of 2.0 ± 0.5 kg for 100 mm hinges and 3.0 ± 0.5 kg for 125 mm and 150 mm hinges at a distance of 4.5 cm from the hinge pin to move the door through 90º.

The size of spring hinge shall be taken as the length of the plate.

14.18.2.2 These shall be of the following type :

(a) Mild Steel : The cylindrical casing shall be made either from M.S. sheet of 1.60 mm thickness, lap jointed and brazed, welded and rivetted, or from solid drawn tube of thickness, pressed to from the two casing. It shall be stove enamelled black or copper oxidized or as specified.

(b) Cast Brass : The cylindrical casing shall be made either from brass sheet of 1.60 mm thickness, lap jointed and brazed, or from solid drawn brass tube of not less than 1.60 mm thickness. It shall be satin, bright nickle — plated or copper oxidized or as specified.

14.18.2.3 *Sampling :* The number of spring hinges shall be selected from the lot and this number shall depend on the size of the lot and shall be in accordance with Table 14.3.

TABLE 14.3

Lot size	*Sample size*	*Permissible No. of defective spring hinges*
1 to 25	3	0
26 to 50	6	0
51 to 100	12	0
101 to 200	15	0
201 to 300	20	1
301 to 500	30	2
501 to 800	40	2
801 and above	55	3

14.18.3 Flush Bolts (Fig. 14.3)

14.18.3.1 These should generally conform to IS 5187. These shall be of cast brass, cast aluminium alloy or extruded aluminium alloy as specified. Only one material shall be used in the manufacture of all the components of flush bolts except spring which shall be of phosphor bronze or steel strip.

When the rod is completely in its maximum bolting position it shall be retained in that position by the spring. The length of the bolt shall be such that, when the bolt is pulled down, the top of the bolt shall be flush with the top of the lip face. The top of the bolt shall be given a taper of 45° to enable easy pull or push.

14.18.3.2 Brass flush bolts shall be satin or bright polished. Alternatively they may be nickel or chromium plated as specified in IS 4827 or copper oxidised in accordance with IS 1378. Aluminium flush bolts shall be anodised and the quality of the anodised finish shall not be less than grade AC 15 of IS 1868.

Note : The working of flush bolts is found satisfactory only in case of shutters made of high quality timber like teakwood properly seasoned and when there is no warping due to changes in weather Brass flush bolts which give a more satisfactory performance are costly and uses scarce materials. Hence use of flush bolts is to be discouraged.

14.18.4 Floor Door Stopper (Fig. 14.4)

14.18.4.1 The floor door stopper shall conform to IS 1823. This shall be made of cast brass of overall size as specified and shall have rubber cushion. The shape and pattern of stopper shall be approved by the Engineer-in-Charge. It shall be of brass finished bright, chromium plated or oxidised or as specified. The size of floor stopper shall be determined by the length of its plate. It shall be well made and shall have four counter sunk holes for fixing the door stoppers to the floor by means of wood screws. The body or housing of the door stopper shall be cast in one piece and it shall be fixed to the cover plate by means of brass or mild steel screws and cover plate shall be of casting or of sheet metal. The spring shall be fixed firmly to the pin. Tongue which would be pressed while closing or opening of the door shall be connected to the lower part by means of copper pin. On the extreme end a rubber piece shall be attached to absorb shock. All parts of the door stopper shall be of good workmanship and finish, burrs and sharp edges removed. It shall be free from surface and casting defects. Aluminium stopper shall be anodised and anodic film shall not be less than grade AC-10 of IS 1868.

14.18.4.2 ***Sampling and Criteria for Conformity :*** It shall be same as specified in 9.21.1.4.

TABLE 14.4
Requirements for Rubber

Particulars	*Requirements*	*Testing procedure*
Relative density Max	1.3	IS 3400 (Part IX)
Hardness	60 ± 5	IS 3400 (Part II)
Change in initial hardness ageing for 24 hours at 100° ± 1° C	+5	IS 3400 (Part II)

14.18.5 Hanging Rubber Door Stopper

14.18.5.1 These shall be of cast brass, finished bright, chromium plated or as specified. Aluminium stopper shall be anodised and the anodic coating shall not be less than grade AC-10 of IS:1868. The size and pattern of the door stopper shall be approved by the Engineer-in-Charge. The size shall be determined by its length.

14.18.6 Casement Brass Stays (Straight Peg Type) (Fig. 14.5)

14.18.6.1 These shall be made of mild steel, cast brass, aluminium (extruded section) or plastic (Polypropylene) as specified. Mild steel casement stays shall be a copper oxidised(black finish) or as specified. Cast brass stays shall be finished bright or chromium plated or as specified. Aluminium stays shall be anodised and the anodic coating shall not be less than grade AC-10 of IS 1868. Aluminium and M.S. stays shall be made from channel section. The stays shall not weigh less than that indicated below :

200 mm	0.24 kg each
250 mm	0.28 kg each
300 mm	0.33 kg each

14.18.6.2 The shape and pattern of the stays shall be approved by the Engineer-in-Charge. The size of stays shall be determined by its length as shown in the plate. The plastic (Polypropylene) stays shall conform to IS 6318.

14.18.7 Fan Light Pivots

14.18.7.1 These shall generally conform to IS 1837. These shall be of mild steel or cast brass or Aluminium or as specified. The brass, fan light pivots shall be finished bright, chromium plated or as specified. M.S. fan light pivot shall be copper oxidized (black finish) or as specified. The base and socket plate of M.S. fan light pivots shall be made from minimum 3.0 mm M.S. sheet and the pivot shall be of round M.S. bar of minimum 10 mm diameter projecting out by minimum 12 mm length and firmly rivetted to the base plate.

14.18.7.2. The base and socket plate of cast brass fan light pivots shall be made from minimum 3.0 mm thick brass plate and the projected pivot shall not be less than 12 mm diameter and 12 mm length, cast in single piece with the base plate.

14.19 Clause shifted to Sub Head 13 (Finishing) as clause no. 13.14

14.20 Clause shifted to Sub Head 13 (Finishing) as clause no. 13.18

14.21 Clause shifted to Sub Head 13 (Finishing) as clause no. 13.19

14.22 Clause shifted to Sub Head 13 (Finishing) as clause no. 13.21

14.23 PAINTING READY MIXED PAINT OVER G.S. SHEETS

14.23.0 Ready mixed paint, suitable for painting over G.S. sheets, of approved brand and manufacture and of the required shade shall be used. New or weathered G.S. sheets shall be painted with a priming coat of one coat of redoxide zinc chromate paint. Primer shall be applied before fixing sheets in place.

14.23.1 Preparation of Surface

14.23.1.1 ***Painting New Surface :*** The painting of new G.S. sheets shall not usually be done till the sheets have weathered for about a year. When new sheets are to be painted before they have weathered they shall be treated with a mordant solution prepared by mixing 38 gm of copper acetate in a litre of soft water or 13 gm hydrochloric acid in a solution of 13 gm each of copper chloride, copper nitrate and ammonium chloride dissolved in a litre of soft water. This quantity of solution is sufficient for about 235 sqm. to 280 sqm of area and is applied for ensuring proper adhesion of paint. The painting with the mordant solution will be paid for separately.

Before painting on new or weathered G.S. sheets, rust patches shall be completely cleaned with coarse emery paper and brush. All grease marks shall also be removed and the surface washed and dried and rusted surface shall be touched with readymixed paint of red lead.

14.23.1.2 ***Painting Old Surface :*** If the old paint is firm and sound, it shall be cleaned of grease, smoke etc. The surface shall then be rubbed down with sand paper and dusted. Rusty patches shall be cleaned up and touched with red lead.

If the old paint is blistered and flaked, it shall be completely removed as described in 13.41. Such removal shall be paid for separately and painting shall be treated as on new work.

14.23.2 Application

The number of coats to be applied shall be as in the description of item. In the case of C.G.S. sheets, the crowns of the corrugations shall be painted first and when these get dried the general coat shall be given to ensure uniform finish over the entire surface without the crowns showing signs of thinning.

The second or additional coats shall be applied when the previous coat has dried.

14.23.3 The specifications described in 13.23 shall hold good so far as they are applicable.

14.24 Clause shifted to Sub Head 13 (Finishing) as clause no. 13.44

14.25 Clause shifted to Sub Head 13 (Finishing) as clause no. 13.45

14.26 Clause shifted to Sub Head 13 (Finishing) as clause no. 13.46

14.27 PAINTING WITH ENAMEL PAINT

14.27.1 Enamel Paint (conforming to IS 2933) of approved brand and manufacture and of the required colour shall be used.

For the under coat, the paint of same quality but of shade to suit that of the top coat shall be used.

14.27.2 Preparation of surface and application shall be as specified under 13.32 for painting on new surfaces or old surfaces, as the case may be.

14.27.3 Other details shall be as specified in 13.23 as far as applicable.

14.28 Clause shifted to Sub Head 13 (Finishing) as clause no. 13.47

14.29 Clause shifted to Sub Head 13 (Finishing) as clause no. 13.48

14.30 Clause shifted to Sub Head 13 (Finishing) as clause no. 13.35

14.31 VARNISHING

14.31.0 Ordinary copal varnish or superior quality spray varnish shall be used. The work includes sizing of transparent wood filler.

14.31.1 Varnish (conforming to IS 347) for the finishing and undercoats shall be of the approved manufacturer.

14.31.2 Varnishing on New Surfaces

14.31.2.1 ***Preparation of Surface :*** New wood work to be varnished shall have been finished smooth with a carpenter's plane. Knots shall be cut to a slight depth. Cracks and holes shall be cleaned of dust. The knots, cracks etc. shall then be filled in with wood putty made as follows:

On a piece of wood say 20 x 15 cm face and on the side where cross grains appear, a small quantity of glue size shall be poured and the surface scraped with the edge of a fine carpenter's chisel. Very fine wood powder shall be mixed with the glue and the stiff paste thus formed shall be used for the filling.

The fillings when dry shall be rubbed down with a carpenter's file and then the entire surface shall be rubbed down perfectly smooth with medium grained and fine sand papers and wiped with dry clean cloth so that it presents uniform appearance. In no case shall sand papers be rubbed across the grains, as in this case even the finest marks will be visible when the varnishing is applied.

14.31.2.2 ***Sizing or Transparent Wood Filler Coat :*** The surface shall then be treated with either glue sizing or with transparent wood filler coat as stipulated in the description of item.

(a) Sizing : When sizing is stipulated, an application of thin clean size shall be applied hot on the surface. When dry, the surface shall be rubbed down smooth with sand paper and cleaned. It shall then be given another application of glue size nearly cold. The sized wood work shall again be rubbed down smoothly with fine sand paper and cleaned. The surface shall be perfectly dry and all dust shall be removed not only from the surface but also from the edges and joints before varnishing is commenced. If the wood work is to be stained, the staining colour shall be mixed with the second coat of the size which must be applied evenly and quickly keeping the colour on the flow.

Any joining up with work already dry will show badly. The object of application of the glue size is to seal the pores in wood to prevent absorption of the oil in the varnish.

Glue sizing is inadvisable on floors, table tops and other horizontal surfaces likely to carry wet household untensils which are likely to disturb the size coatings and thus expose bare wood. Where glue sizing is omitted to be done the rate for the work shall be suitably reduced.

(b) *Transparent Wood Filler Coat :* Where instead of glue sizing, transparent wood filler application is stipulated in the item, then the surface prepared as described in 13.37.2.1 shall be given as application of the filler with brush or rag in such a way that the filler fills up all the pores and indentations and levels up the surface. It shall be allowed to dry for 24 hours. Then it shall be cut and rubbed with emery paper so that the surface of the wood is laid bare, with the filler only in the pores and crevices of the wood.

14.31.2.3 *Application of Varnish* : The number of coats to be applied shall be as stipulated in the description of the item.

The undercoat shall be with a flatting varnish. This dries hard and brittle and when cut and rubbed down to produce a smooth surface enhances the gloss of the finishing varnish. The top coat shall be given with stipulated brand of finishing varnish.

The varnish shall be applied liberally with a full brush and spread evenly with short light strokes to avoid frothing. If the work is vertical the varnish shall be crossed and recrossed and then laid off, latter being finished on the upstrokes so that varnish, as it sets, flows down and eliminates brush marks, the above process will constitute one coat. If the surface is horizontal, varnish shall be worked in every direction, with light quick strokes and finish in one definite direction so that it will set without showing brush marks, in handling and applying varnish care should be taken to avoid forming froth or air bubbles. Brushes and containers shall be kept scrupulously clean.

Rubbing down and flatting the surface shall be done after each coat except the final coat with fine sand paper.

The work shall be allowed to dry away from droughts and damp air. The finished surface shall then present a uniform appearance and fine glossy surface free from streaks, blister etc.

Any varnish left over in the small container shall not be poured back into the stock tin, as it will render the latter unite unfit for use.

Special fine haired varnishing brushes shall be used and not ordinary paint brushes. Brushes shall be well worn and perfectly clean.

14.31.2.4 Other details shall be as specified in 13.23 as far as they are applicable.

14.31.3 Varnishing on Old Surface

14.31.3.1 *Preparation of Surface :* If the old varnished surface is firm and sound it shall be cleaned of grease and dirt with turpentine and then rubbed with wet sand paper until the surface is clean and smooth. It shall be dried and wiped clean with a soft cloth. Knots, holes and cracks shall be stopped as specified in 13.37.3. The entire surface shall then be rubbed down smooth with sand paper and wiped clean.

If the old varnished surface is peeled or cracked then it will be necessary to remove the entire varnish as described in para 13.41 and such removal shall be paid for separately outside the rate for varnishing. Further the varnishing itself will have to be done like new work and will be paid for as such.

14.31.3.2 *Application :* The specification shall be same as described in 13.37.3.2 as far as applicable except that the coats to be applied will be with the stipulated quality of varnish for finishing coat.

14.31.3.3 Other details shall be as specified in 13.23 as far as they are applicable.

14.32 Clause shifted to Sub Head 13 (Finishing) as clause no. 13.40

14.33 DOUBLE SCAFFOLDING

Specifications are same as described in sub head RCC work. (Figure 14.6)

14.34 FIXING OLD WIND TIES

14.34.1 Specified same as described in 14.5 above. Except for the old wind tie will be used for which nothing extra will be paid. The old wind tie shall be properly cleaned off and anticorrosive bituminous paint shall be applied before fixing the same at required location of the roof sheets with new J hook and bolts and washers for resisting water from dripping through bolt of same size as existing in the bolt tie to securing the same imposition.

14.34.2 Measurement

Work shall be measured in running meter

14.34.3 Rate

The rates are include the cost of labours and materials in all the operations described above.

14.35 BRICK WORK IN MUD MORTAR

14.35.1 Selection of clay for mud mortar

The clay or mixture of clays should preferably conform to the following mechanical composition. Grain size analysis shall be done in accordance with the method given in IS 2720 (Part 4): 1986.

Clay 18-22 percent by weight

Silt 40-45 percent by weight

Sand 30-40 percent by weight

The total content of clay and silt be preferably not less than 60 percent by weight.

Note:- In case of soils which are more sandy or clayey than the limits specified above, the same should be blended with more plastic clay or non-plastic materials as the case may be so as to bring the mechanical composition within the above specified limits.

Since the mud mortar is susceptible to weathering mud mortar masonry may be used for temporary structures and low rise structures having adequate lateral stability.

Thickness of mud mortar should not be more than 20mm in case of brick masonry works and 30mm in case of stone masonry works.

The masonry should preferably be plastered or pointed by cement or lime mortar externally to avoid erosion of mortar from joints.

Concentrated load should be distributed by providing plain concrete or RCC bed blocks or by using cement mortar masonry below the concentrated loads.

Note:- For mud mortar construction in seismic zones refer IS 4326 : 1976.

14.35.2 Preparation of Mortar

The soil for preparation of mud mortar should be processed so as to free from gravel coarse sand (particle size greater than 2mm) lime and kankar particles vegetable matter, etc.

Coarse grit, kankar etc. if present should be removed by wet sieving.

The sieved clay should be allowed to dry and then blended with plastic clay or a non-plastic locally available material (like rice husk, jute waste, wheat husk etc.) as the case may be so as to bring the mechanical composition within the limits specified above.

Where wet sieving is not necessary, the soil shall be lightly broken up and wetted. The wet mass shall be tempered over under the feet, repeatedly turned over big spades and then thoroughly kneaded. The kneaded mass shall than be left for rempering for at least 24 hrs with the soil being preferably covered with wet gunny bags.

Immediately before use in the masonry a small quantity of the prepared soil shall be mixed with a further quantity of water to obtain the decide consistency and workability. The total moisture content of the prepared mortar shall be in the range of 35 to 40 percent by weight of soil.

14.35.3 Field Test

For quick field observation and intermittent chicks, sample test as given in Annex-B may be made.

If the ball prepared as given in Annex-B as deformed on drying and crumbles easily when pressed lightly, it may be inferred that sand content excessive.

.If the ball is hard but shows cracks on the surface, then the sand content is insufficient.

If the soil is not found suitable, as inferred above the test should be repeated after modifying the composition of the soil, such as by mixing different proportions of two soils or by addition of sand or clay whichever is needed, for checking the stability.

ANNEX B
FIELD TEST FOR SOIL FOR MASONRY MUD MORTAR

B-1 The soil should be ground to a fine powder and mixed with sufficient water, added in small quantities. The mix should than be kneaded into a plastic mass of the required consistency.

B-2. Take a handful of the soil prepared in B-1 and form into a ball of about 80mm diameter.

B-3. Keep the ball in the sun for drying. When dried, examine the ball for loss of shape and surface cracks, if any.

14.35.4 Measurements

Brick work shall be measured in cubic metres unless otherwise specified. Any extra work over the specified dimensions shall be ignored. Dimensions shall be measured correct to the nearest 0.01 m i.e. 1 cm. Areas shall be calculated to the nearest 0.01 sq mtrs and the cubic contents shall be worked out to the nearest 0.01 cubic metres. All other specifications of brick work for such as bond, laying, finishing of joints, scaffolding, measurements shall be followed same as a regular brick work. The thickness of joints shall be kept 12mm uniformerly

14.35.5 ***Rate:*** The rate shall include the cost of all materials and labour involved in all the operations described above.

14.36 BRASS CURTAIN RODS

14.36.1 Material

The brass curtain rods of required dia 20mm/25mm with wall thickness 1.25mm shall be provided with 2 no. brass brackets fixed with brass screws to the wall by means of wooden plugs/PVC Rawl Plugs. The size of brass screws shall not less than 60mm length.

14.36.2 Measurements

Curtain road shall be measured in running meter two nos. brass brackets including necessary screw.

14.36.3 ***Rate:*** The rate shall include the cost of all materials and labour involved in all the operations described above.

14.37. FIXING MS ROUND OR SQUARE BARS IN WOODEN FRAME OF WINDOW

The MS Square or Round Bars of 12mm shall be properly fixed on 50x6mm inner frame. The outer frame shall be made with 50x6mm flat with clear distance of 50mm from the inner frame. Both the frames should be fixed with a flat of 50x6mm with proper welding at a spacing of 30cm centre to centre all around the frame. The 4 corners of the both frames shall be diagonally connected with 50x6mm flat with proper thorough welding and removal of sludge and proper grinding with machine to have a smooth surface. The spacing of MS bars shall be kept 10cm centre to centre and the MS flats shall be fixed to the wooden frame with the MS screws of 50mm size at a 30cm spacing along the entire periphery of the outer frame. The frame should be properly cleaned with sand paper to receive the coat of primer of ready mix zinc chromate yellow primer shall be applied on the entire surface properly. The payment of the steel grill work shall be paid by weight.

14.37.1 Measurements

Steel grid shall be measured in Kg.

14.37.2 Rate

It includes the cost of labour and material involved in all the operations described above including fixing including coat of yellow zinc primer.

14.38 WOODEN KARRIES FOR ROOFING

The required size wooden karries of designated wood shall be procured. These should be properly seasoned before using in the work and shall be hoisted with suitable hoisting by means of mechanical/ manual arrangements with suitable safety measures. A RCC band minimum 50mm thick shall be laid on top of brick wall over which the wooden karries shall be placed at required spacing depending upon the design/load of roof. The both end of the wooden karries having bearing on the wall to be painted with bituminous paint.

The good quality wood preservative shall be applied all round the wooden karries.

14.38.1 Measurements

Wooden karries shall be made in cubic meter and it includes every cost of material and labour/ T&P required for fixing the karries in position.

14.38.2 Rate

It includes the cost of labour and material involved in all the operations described above.

14.39. DOUBLE SCAFFOLDING SYSTEM UPTO SEVEN STOREY HEIGHT MADE WITH MS TUBE

The double scaffolding made with 40mm dia and 25mm dia pipe shall be erected along the wall surface. The MS pipe of heavy duty with wall thickness 4mm shall be used for the scaffolding. The scaffolding shall be erected in double row system and at every 9m height the extra 1 row of 40mm dia pipe perpendicular to wall surface shall be provided to secure the both layer of vertical pipe in the wall for better stability. It should be strong enough to with stand all coming load / wind pressure/tilt etc. The double scaffolding consist of 2 rows of vertical with horizontal and diagonal bracing forming essentially a structure independent of the building. The bottom of the scaffolding shall be fixed in suitable MS chair on base plate of minimum 12mm thick and 25x25cm size. The plate should be properly placed firm plate concrete floor. The frame work of scaffolding made with 40mm dia MS tube 1.5m centre to centre horizontal and vertical joint with cup and lock system and MS fixtures etc. MS

tube challies and MS tube staircase in scaffolding for working platform etc. shall also be provided. The scaffolding system shall be stiffened with bracings, runners, connection with the building etc. wherever required for inspection of work at required locations with essential safety features for the workman etc. complete as per directions and approval of Engineer-in-charge.

Note:- 1. The condition of MS tube and required claddings should be in good condition and should not have been used more than the specified time/nos. Scaffolding system shall remain the property of the contractor after completion of work.

2. This item to be used for maintenance work judicially, necessary deduction for scaffolding in the existing item to be done.

14.39.1 Measurement & Rate

The elevational area of the scaffolding shall be measured for payment in sqm. The payment will be made once irrespective of duration of scaffolding.

14.40 REPAIR TO PLASTER IN PATCHES.

The repair to plaster of thickness 12mm to 20mm in patches of area upto 2.5 sqm shall be done with white cement polymer modified self curing mortar. Before applying the mortar cutting the patch in proper regular (square/ rectangle) shape, racking out joints and preparing the wall to receive the plaster shall be done. The payment shall be made in area of patches measured in sqm.

14.40.1 Measurements

Patch repair shall be measured in sqm.

14.40.2 ***Rate:*** The rate shall include the cost of all materials and labour involved in all the operations described above.

14.41 – CLEANING

14.41.1 CLEANING OF WATER STORAGE TANKS

14.41.1.1 The Water Storage Tanks at terrace upto 2000 lt. capacity at all heights shall be cleaned with pressure water jetting with chemical mixed water with suitable pump arrangement and followed by coconut brushes, duster etc. including removal of silt, rubbish from the tank and cleaning the tank with fresh water disinfecting with bleaching powder @0.5gm per litre capacity of tank including marking the date of cleaning on the side of tank body with the help of stencil and paint and disposing of malba all complete as per direction of Engineer-in-charge. (The old date already written on tank should be removed with paint remover or black paint and if date is not written with the stencil or old date is not removed deduction will be made Rs.0.10 per litre) (if during cleaning any GI fittings or ball cock is damaged that is to be replaced by contractor at his own cost and nothing extra will be paid on this account).

14.41.1.2 Measurement

Cleaning of water storage tank shall be measured in litre.

14.41.1.3 Rate: The rate shall include the cost of all materials and labour involved in all the operations described above.

14.41.2 CLEANING AND DE-SILTING OF GULLY TRAP

14.41.2.1 The gully trap/chamber shall be cleaned and de-silted in following manner:

1. Removal of rubbish mixed with earth by deployment of sufficient manual labour.
2. Disposal of the accumulated malba, rubbish to the approved dumping ground with the help of trolley/wheel barrows properly lined with PVC sheet to avoid splashes of the sewage/ rubbish on the ground.

All above mentioned 2 operations shall be done by making all adequate safety arrangement to the labour including providing them medical aid, rubber gloves, helmets, masks, oxygen cylinder etc. and make the site neat and clean after completion of work.

The payment to be making is inclusive of all operation like labour, material and T&P whichever is required.

14.41.2.2 Measurement & Rate

Cleaning and de-silting of gully trap shall be measured and payment in numbers. The payment to be making is inclusive of all operations like labours, materials and T&P whichever is required.

14.41.3 CLEANING OF CHOCKED SEWER LINE

14.41.3.1 The chocked / blocked sewer line shall be cleaned in following steps:

1. The manhole covers shall be kept open for same time before the cleaning of sewer line so as to escape the foul gases.
2. Sucking the chocked malba material by diesel running, vehicle mounting hydraulic operated suction/jetting cleaning machine with appropriate capacity as per requirement.
3. Disposal of the accumulated malba, rubbish to the approved dumping ground with the help of trolley/wheel barrows properly lined with PVC sheet to avoid splashes of the sewage/ rubbish on the ground.

   All above mentioned 2 operations shall be done in presence of supervisor and by making all adequate safety arrangement to the labour including providing them medical aid, rubber gloves, helmets, masks, oxygen cylinder etc.

14.41.3.2 Measurement & Rate

Cleaning and desilting of sewer line shall be measured and payment in numbers. The payment to be making is inclusive of all operations like labours, materials and T&P whichever is required.

14.41.4 CLEANING OF UNDERGROUND SUMP, OVER HEAD R.C.C. TANK

The process of cleaning of underground sump, Over Head R.C.C. Tank (independent staging) will be done in following operations:-

1. Tank shall be emptied of water by pumping & bottom shall be cleaned of silt and other deposits.
2. Entire surface area of the sump shall be cleaned with pressure jetting of water mixed with cleaning chemical atleast two times and thoroughly etc. and finally washing with simple water jet to clean properly the wall surface.
3. Chlorination of RCC internal surface by liquid chlorine.
4. The treated surface shall be dried using air jetting and all loose particles shall be removal from the surface.
5. Finally the surface shall be treated with ultraviolet radiation etc. as per direction of Engineer-in-Charge.

   All above mentioned four (4) operations shall be done by making all adequate safety arrangement to the labour including providing them medical aid, rubber gloves, helmets, masks etc.

14.41.4.1 Measurement

Cleaning of internal surface area of underground sump, Over Head RCC tanks shall be measured in sqm.

14.41. 4.2 Rate: The rate shall include the cost of all materials and labour and T&P involved in all the operations described above.

14.42 DISCONNECTING DAMAGED OVERHEAD/TERRACE

The execution/operation of the item is as under:

1. Closing the water supply line tank by means gate valve /stop cock etc.
2. Emptying the water tank completely.
3. The Water tank supply connection will be disconnected and the delivery pipe line shall also be disconnected by removing all the fitting and fixtures completely.
4. The delivery pipes from the bottom of the tank shall also be disconnected from the tank.
5. Removing the water storage tank from terrace and shifting it to the ground floor by mechanical means or by manual with all safety reasons as directed by Engineer-in-charge.

14.42.1 Measurement & Rate

The measurements of overhead/ terrace PVC water storage tanks of any size shall be measured in numbers and payment shall be made on each basis.

14.43 REPLACEMENT OF OLD DAMAGED W.C. SEATS

The execution/operation of the item is as under:

1. Dismantling and taking out the old WC seat and “S” or “P” trap at site complete with all operations including all necessary materials, labour and disposal of dismantled material i/c malba, debris etc. including lead upto dumping ground.
2. Providing “S” or “P” trap and water closet squatting pan (Indian type) of approved brand of good quality.
3. Fixing the W.C. with trap in position along with trap by making all arrangement of connecting it to the flushing cistern. Thereafter the gap left in the filled up portion is to be leveled by cement concrete 1:5:10 and floor tiles of same shade are also to be provided over it to match the floor of the toilet.

14.43.1 Measurement & Rate

The measurements and payment of replaced W.C Seats shall be made on each basis

14.44 CUTTING HOLES OF REQUIRED SIZE IN BRICK MASONRY WALL

Cutting holes of required size in brick masonry wall for fixing of exhaust fan including providing and fixing 300mm dia PVC pipe conforming BIS-12818 and making good the same etc. complete. The hole shall be cut with cutting tool by marking hole all round the circle with the help of power drill machine so that the adjoining wall should not get damaged.

14.44.1 Measurement & Rate

The measurements and payment of cutting holes and finishing etc. shall be made on each basis

14.45 DISMANTLING W.C. PAN OF ALL SIZES

Dismantling W.C. Pan of all sizes including disposal of dismantled materials i/c malba all complete as per directions of Engineer-in-Charge. The W.C. seat is taken out along with trap and the area is to be cleaned off all dust and rubbish etc. Thereafter the hole left in the flooring is to be leveled by cement concrete 1:5:10 and floor tiles of same shade are also to be provided over it to match the floor of the toilet room.

14.45.1 Measurement & Rate

The measurements and payment of dismantling W.C. Pan of all sizes shall be made on each basis.

14.46 HACKING OF CC FLOORING

Hacking the CC flooring including cleaning the surface etc. complete as per direction of the Engineer-in-Charge. The hacking of CC flooring is done with chisel and hammer to make the top surface of flooring rough before laying tile/ marble/granite flooring etc. The hacking should be at least 10 nos. in 30x30cm area of the floor.

14.46.1 Measurement & Rate

The measurements and payment of hacking of CC flooring shall be made on sqm.

14.47 DISMANTLING 15 TO 40MM DIA G.I. PIPE

Dismantling 15 to 40mm dia G.I. pipe including stacking of dismantled pipes (within 50 metres lead) as per direction of Engineer-in-Charge. The pipe dismantling is done from tap point to main line. The 15mm dia is to be dismantled first and thereafter the dismantling/taking out the pipe shall proceed towards bigger dia pipe at the last. The pipe is removed from its joints/sockets/T-section gently with pipe wrench/tool so that the old pipe is not get damaged and the same can be reused where required. The old dismantle pipe will be stacked dia wise and connected fittings are also to be stored properly for reuse.

14.47.1 Measurement & Rate

The measurements and payment of **Dismantling G.I. pipe** shall be made on meter.

14.48 TAKING OUT EXISTING WOODEN DOOR SHUTTER AND RE-FIXING THE SAME AFTER REPAIRS

Taking out existing wooden door shutter, repair by de-screwing hinges etc. and re-fixing the repaired door shutters to existing door frames, including replacement of hinges with screws etc. as required, all complete as per the direction of the Engineer-in-charge. The old shutter is to be taken out by removing the screws from the hinges by screw driver/screw fixing equipment (electric driven). Thereafter, the damaged part of the shutters such as styles/ panels/veneering etc. is replaced with new one and the door shutter is prepared for re-fixing to the door frame. During re-fixing the position of hinges if required may be shifted for proper anchorage with 50mm stainless steel screw with cross head. The re-fixing with butt hinges by means of screws is done with the help of electric driven screw driving equipment. The whole door including chokhat is to be re-painted with required colour to match the door and shutter with the same shade.

14.48.1 Measurement & Rate

The measurements and payment shall be made on each basis.

14.49 WATER PROOFING TREATMENT WITH APP (ATACTIC POLYPROPYLENE POLYMERIC) MEMBRANE

Water proofing treatment of roofs with APP modified polymeric membrane shall be either five course, seven course as specified in the item. In selecting the combinations of layers of APP membrane, consideration shall be given to the type and construction of buildings, climate and atmospheric conditions and the degree of permanence required. Five course treatment is a normal treatment suitable to moderate rainfall conditions (less than 50 cm.) and seven course treatment is suitable for heavy rainfall (50 cm and above). Seven course treatment with APP modified polymeric membrane 2.00 mm thick and weight 3.00 kg./sqm. to suitable for very heavy conditions of rainfall (more than 150 cm.).

14.49.1 Materials

14.49.1.1 The bitumen primer shall conform to the requirements laid down in IS 3384.

14.49.1.2 APP Modified Membrane: It is a polymeric water proofing membrane manufactured to high standards. It is five layered APP modified polymeric membrane with centre core as 20 micron HMHDPE/ 100 micron HMHDPE High Molecular High Density Polythylene Film, is the heart of the membrane and protects against water and moisture. The centre core is sandwiched on both sides by high quality polymeric mix with properties of high softening point, high heat resistance and cold resistively to make it ideal for all water proofing treatment. The polymeric mix is protected on both sides with 20 micron HMHDPE film. The membrane is available in variable thickness and weights. Usual width is 1.0 m.

Important physical and chemical parameter of the membrane shall be as given in Table 14.5 for guidance.

TABLE 14.5

Centre Core	Film	Thickness	Weight
20 micron HMHPDE	20 micron HMHPDE	1.5 mm	2.25 kg/ sqm.
100 micron HMHPDE	20 micron HMHPDE	2.00 mm	3.00 kg./ sqm.

Where proprietary brands Atactic Polyproplene modified polymeric membrane is proposed to be used by the contractor, they shall conform in all respect to the specification in the preceding paras and manufactured by a company of repute.

14.49.1.3 Bonding Material: This shall consist of blown type bitumen conforming to IS 702 or residual bitumen 85/25 conforming to IS 73 heated to the correct working temperature of 180°C. The penetration of the bitumen shall not be more than 40 when tested in accordance with IS 1203, unless otherwise specified each coat of bonding material shall be of blown type bitumen of grade 85/25 heated to a working temperature of 180 degree C and applied @ 1.20 kg. per square metre of the surface area.

14.49.1.4 Surface Finish: Surface finish shall be with brick tiles of class designation 100 grouted with cement mortar 1:3 (1 cement : 3 fine sand) with 2% integral water proofing compound by weight of cement over a 12 mm thick layer of cement mortar 1:3 (1 cement: 3 fine sand) and finished neat, as shown in Fig. 14.7. Surface finish shall be measured and paid for separately.

14.49.1.5 Preparation of Surface: The surface to be treated shall have a minimum slope of 1 to 120. This grading shall be carried out with cement concrete or cement plaster with coarse sand, as desired, to the average thickness required and finished smooth. Such grading shall be paid for separately.

Junctions between the roof and vertical faces of parapet walls, chimneys etc. shall be chased by running triangular fillets 7.5 x 7.5 cm. size, cement concrete. At the drain mouths, the fillets shall be suitably cut back and rounded off for easy application of water proofing treatment and easy flow of water. Cement concrete where shall be 1:2:4 mix (1 Cement: 2 Coarse sand: 4 Graded stone aggregate 20 mm. Nominal size). The provision of fillets shall be deemed to be covered by the item of water proofing and shall not be measured or paid for separately.

In existing roof where gola and drip course are provided at the junction of roof and vertical face of parapet wall, chimney stacks, etc. These shall be dressed suitably and finished smooth so as to ensure an easy and gradual turning of the flashing. Any dismantlement or forming and finishing smooth the junction for forming the base of the flashing shall not be measured or paid for separately and shall be deemed to form part of the preparation of the surface.

While the grading of roof surface is being done, it shall be ensured that the outlet drain pipe have been fixed and mouth at the entrance have been eased and rounded off properly for easy flow of water. When any pipe passes through the roof to be treated, angular fillet of shape shown in Fig. 22.11 shall be built around it for the water proofing treatment to be taken over it. These fillets shall not be measured or paid for separately. For carrying over and tucking in the water proofing felts into the parapet walls, chimneys stacks etc. a horizontal groove 6.5 cm. deep, 7.5 cm. wide section with its lower edge at not less than 15 cm. above the graded roof surface shall be left on the inner face of the same; during construction if possible. When such groove has not been left, the same shall be cut out neatly and the base at rear of the groove shall be finished smooth with cement plaster 1:4 (1 cement: 4 coarse sand). Such cutting of the groove and its finishing smooth shall be part of the water proofing or paid for separately. No deduction shall be made either for not making the groove or when the latter has already been left in the masonry by the construction agency. Tucking in the water

proofing felt will be required where the parapet wall exceeds 45 cm. in the height from the graded surface. Where the height is 45 cm. or less, no groove will be required as the water proofing treatment will be carried over the top of the parapet wall to its full thickness. In the case of low dividing walls of height 30 cm. or less, outlets therein shall be cut open for full height and the bottom and sides shall be rendered smooth and corners rounded and such treatment shall not be measured and paid for separately. Where expansion joints are left in the slab the provision of dwarf walls and/or RCC slabs for covering them and finishing the surface smooth shall be the responsibility of the construction agency, which had laid the roof slab and will not be included in the operation of water proofing. The graded surface of the roof and concrete fillets and the faces of walls shall be thoroughly cleaned with wire brushed and all loose scales etc. removed. The surface shall then be dusted off. Any crack in the roof shall be cut to V section, cleaned and filled up flush with cement mortar slurry 1:4 (1 cement : 4 coarse sand) or blown type petroleum bitumen of IS grade 85/25, or approved quality conforming to IS 702. Such cleaning of the surface or treating the cracks shall not be paid for separately.

14.49.1.6 Treatment: The water treatment shall be of five or seven course as specified.

In seven course treatment, the first four courses shall be the same as for five course treatment. The fifth course shall be a layer of APP modified polymeric membrane. The sixth course shall be a coat of bonding material and the top most seventh course shall be of specified surface finish.

14.49.1.7 Laying

(a) First course shall be a coat of bitumen primer @ 0.40 kg per sqmt followed by subsequent course as per treatment required.

(b) Drain outlets shall be given a four or six course treatment as specified for the roof in the description of the item in the manner specified for the flat roof surface. Water proofing treatment shall be carried into the drain pipe or outlets by at least 10 cm. The water proofing treatment laid on the roof surface shall overlap the upper edge of the water proofing treatment in the drain outlets by at least 10 cm.

(c) The APP modified polymeric membrane shall be cut to the required length, brushed clean of dusting material and laid out flat on the roof to eliminate curls and subsequent stretching. The membrane shall normally be laid in length in the direction of the slope and laying shall be commenced at the lowest level and worked up to crest. The membrane shall not be laid in single piece of very long lengths as they are likely to shrink; 6 to 8 m are suitable lengths. The roof surface shall be cleaned and dry before starting the membrane treatment. Each length of membrane shall be laid in position and rolled up for a distance of half its length. The hot bonding material shall be poured on the roof across the full width of the rolled membrane as the latter is steadily rolled out and pressed down. The pouring shall be so regulated that the correct weight of bonding material per unit area is spread uniformly over the surface. Excess bonding material that gets squeezed out at the ends shall be levelled up as laying proceeds. When the first half of the strip of felt has been bonded to the roof, the other half shall be rolled up and then unrolled on the hot bonding material in the same way. Subsequent strips shall also be laid in the same manner.

Each strip shall overlap the preceding one by at least 7.5 cm. at the longitudinal edges and 10 cm. at the ends. All overlaps shall be firmly bonded with a blow lamp and levelling down unevenness. The fourth layer of bonding material in the five course treatment shall be carried out in a similar manner after the flashing has been completed.

(d) In a seven course treatment the fifth layers of membrane shall be laid in the manner already described, taking care that laps in the membrane are staggered from those in the earlier layer. The sixth layer of bonding material shall be carried out after the flashing is done.

(e) High Parapet Walls, Chimney Stacks etc.: Membrane shall be laid as flashing wherever junctions of vertical and horizontal surfaces occur. Longitudinal laps shall be 10 cm. The lower layer of flashing membrane in a six course treatment shall overlap the roof water proofing by not less than 20 cm. while the upper layer shall overlap the roofing felt by 10 cm. The minimum overlap of the flashing membrane in five course treatment over the roofing membrane shall be 10 cm.

The flashing shall consist of the same five or seven course treatment as for the roof except that the final course shall be replaced by an application of 12 mm thick cement plaster 1:3 on the vertical and sloping faces only, of the flashing as shown in Fig 14.8. The overlap along the length of flashing shall stagger with those in the second layer of flashing membrane (in a seven course treatment and with the joints in the roof membrane).

The upper edge of the finishing membrane shall be well tucked into the flashing grooves in the parapet, chimney stacks etc. to a depth of not less than 6.5 cm. Corresponding applications of bonding material shall also be made. The flashing treatment shall be firmly held in place in the grooves with wood edges at intervals and the grooves shall be filled up with cement mortar 1:4 (1 cement: 4 coarse sand) or cement concrete 1:2:4 (1 cement: 2 coarse sand : 4 graded stone aggregate 6 mm nominal size) and surface finished smooth with the rest of the wall. The cement work shall be cured for 7 days. When dry, the exposed plaster joints of grooves shall be painted with bitumen and two coats of bituminous solution shall be applied on the vertical and sloping surface of flashing (see Fig. 14.7).

After the top flashing membrane layer has been fixed, the penultimate layer of bonding material shall be applied over the roofing membrane and the horizontal overlaps and vertical and sloping surfaces of the flashing at the specified rate.

(f) Low Parapet Walls: Where parapet walls are of height 45 cm. or less, membrane flashings shall be provided in the same manner as for flashings in the case of high parapet walls except that the upper edge shall be carried upto the full height of the wall and taken right across the top of the parapet and down on the external vertical faces to a minimum distance of 5 cm. (see Fig 14.8).

(g) Low Dividing Walls: Where low dividing walls or inverted beams are met with, the same shall be covered with a four or six layer treatment as for the main roof, the latter bearing carried down both sides of the wall and overlapping the roofing treatment as in the case of flashing of high parapet walls (see Fig. 14.10).

Drain outlets where formed in the low dividing walls, shall be given water proofing treatment of the same number of courses as specified for the flat roof surface. The bottom and sides shall be so treated that all overlaps are in the direction of flow of drainage.

(h) Expansion Joints: Where the expansion joints are provided in the slabs, the joints and their cover slabs shall be suitably treated with water proofing. A typical sketch of an expansion joint with the RCC slabs on either side of the joint turned vertically up and dwarf walls by not less than 7.5 cm. and are provided with throatings on their underside along their length. The water proofing treatment shall be taken up the sloping junction fillets and the vertical faces of the walls to the underside of the cover slabs. The cover slabs are given the water proofing treatment like the roofs slabs, after the cross joints between adjacent cover slabs are first sealed with 15 cm width of roofing felt struck to them with bitumen. The water proofing treatment shall be carried down the sides of the cover slabs to their full thickness. Care shall be taken to see that overlaps if any in the roofing over the cover slabs stagger with the joints between cover slabs.

The formation of the expansion joints and provision of the cover slabs shall be the responsibility of the construction agency. The formation of the junction fillets and the water proofing treatment of the joint and cover slabs shall be carried out by the water proofing agency. Nothing agency extra shall be paid for the sealing of the cross joints in the cover slab with 15 cm. width of bitumen strips.

(i) Pipes: Where vertical pipe outlets are met with, 7.5 x 7.5 cm fillets of lime or cement concrete of the type and section shown in Fig. 14.10 shall be provided and flashing of four or six course treatment, same as for the roofing treatment shall be laid.

The upper edge of the flashing shall be laid sloping down forward and butted against the pipe and annular depression so formed shall be filled with hot bitumen. A circular metal collar in the shape of an inverted truncated cone shall be fixed on the pipe to throw off the rain water clear of the flashing and this shall be paid for separately.

14.49.1.8 Measurement: Length and breadth shall be measured correct to a cm. The area shall be calculated in square metres correct to two places of decimal. Measurements shall be taken over the entire exposed area of roofing and flashing treatment including flashing over low parapet walls, low dividing walls and expansion joints and at pipe projections etc. Overlaps and tucking into flashing grooves shall not be measured. Vertical and sloping surfaces of water proofing treatment shall also be measured under the five or seven course treatment as the case may be, irrespective of the fact that the final course is replaced by bitumen primer. No deduction in measurements shall be made for either openings or recesses for chimney stacks, roof lights and the like, for areas upto 0.4 sqm nor anything shall be paid for forming such openings. For areas exceeding 0.40 sqm deduction will be made in measurements for full opening and nothing extra shall be paid for forming such openings.

14.49.1.9 Rate: The rate shall include the cost of all labour and materials involved in all the operations described above. The top most layer shall be paid for separately.

Clause 14.49 brought from Sub Head 22 (Water Proofing) clause no 22.11

14.50 FIVE LAYERED WATER PROOFING TREATMENT WITH ATACTIC POLYPROPYLENE POLYMER MODIFIED PREFABRICATED MEMBRANE

14.50.1 Atactic Polypropylene Polymer modified prefabricated five layer water proofing membrane shall be of thickness as specified. In selecting thickness of membrane due consideration shall be given to the type and construction of building, climate and atmospheric condition and permanence required. Five layered treatment 2.00 mm thick with glass fibre is with a normal duly treatment suitable for pitched roofs. Five layered 3.00 mm thick with glass fibre matt treatment is suitable for moderate condition of rainfall (50 to 150 mm) and fine layered 3.00 mm thick with non-woven polyester matt treatment is suitable for heavy condition of rainfall.

14.50.1.1 Materials

Bitumen primer for bitumen membrane shall have density at 25°C in the range of 0.87 - 0.89 kg./litre and viscosity of 70-160 CPS primer shall be applied @ of 0.40 litre/sqm.

14.50.1.2 Atactic Polypropylene Polymer Modified Prefabricated Membrane: It is a polymeric water proofing membrane. This shall be one of the following types:

(i) 2 mm thick with glass fibre matt.

(ii) 3 mm thick glass fibre matt.

(iii) 3 mm thick with non-woven polyester matt.

It is prefabricated five layered black finish water proofing membrane comprising of centre core of 50 gsm. Glass fibre matt/170 gsm nonwoven polyester matt sandwiched on both sides by APP polymer modified bitumen which is protected on both sides by 20 micron thermofusible polyethylene sheet. Composite thickness of the membrane including all five layers shall be 2/3 mm with glass fibre matt and 3 mm with non woven polyester matt. It is available in 1 m width and variable lengths.

Physical and chemical parameters of the membrane shall be as given in Table 14.6

TABLE 14.6

Sl. No.	No. of Layers	Thickness	Elongation at 23° C in longitudinal transverse direction	Joint strength in longitudinal and Transverse direction	Tear strength in longitudinal Transverse direction	Softening Point	Cold flexibility
1	2	3	4	5	6	7	8
1	Five Layered reinforced with fibre glass	2 mm	3 N/5 cm.	350/300 N/5 cm.	60/80 N	150°	-2°C
2	Five layered reinforced with fibre glass	3 mm	3.3 N/5 cm.	350/3000 N/5 cm.	60/80 N	150°	-3°C
3	Five layered reinforced with non-woven polyester matt.	3 mm	40/50 N/5 cm.	650 N/450 N/5 cm.	300/250 N	150°	-2°C

When tested Atactic polypropylene modified black finished is proposed to be used shall conform in all respects to the specification in the preceding paras. The work should be got done through authorized applicator/ specification agency.

14.50.1.3 Preparation of Surface: The surface to be treated shall have a minimum slope of 1 in 120 or as specified, provision specified in clause 14.49.1.5 shall apply for preparation of surface except for pitched roof where surface shall be cleaned off any loose material dust etc.

To ensure good adhesion between the surface and water proofing treatment suitable method to dry the surface shall be adopted. All hair line cracks in the surface should be filled with approved sealant.

14.50.1.4 Treatment: The water proofing shall consist of prefabricated five layered 2 mm / 3 mm membrane as shown in Fig. 14.11. The choice of 2 mm or 3 mm membrane will depend on the type of roof i.e. pitched or flat and importance of building, durability, cost and rainfall etc.

14.50.1.5 Laying: Bitumen primer @ 0.40 lts/sqm shall be applied to the prepared roof, drain and all other surfaces where polymer modified membrane is to be laid. The five layered water proofing membrane shall be laid using Butane torch and sealing all joints and preparing the surface complete. Drain outlets shall be given same treatment as specified for the roof in the description of the item in the manner specified for the flat roof surface. Water proofing treatment shall be carried into the drain pipe or outlets by at least 10 cm. The water proofing treatment laid on the roof surface shall overlap the upper edge of the water proofing treatment in the drain outsets by at least 10 cm.

The APP polymer modified prefabricated water proofing membrane shall be cut to the required length. Water proofing membrane shall normally be laid in length in the direction of the slope and laying shall be commenced at the lowest level and worked upto crest. APP water proofing membrane shall be laid in 6 to 8 m lengths. The roof surface shall be cleaned and bitumen primer shall be applied in the correct quantity, over this specified water proofing membrane shall be laid with butane torch after allowing 24 hours for primer to dry. Each strip shall overlap the preceding one by at least 10 cm. at the longitudinal edges and 15 cm. at the ends. All overlaps shall be firmly bonded with bitumen primer and levelled by heating the overlap with butane torch.

If the roof is accessible the treatment is protected by brick tiles laid over 12 mm thick cement mortar of specified grade bedding and joints sealed with cement mortar of which shall be measured and paid for separately.

APP water proofing membrane shall be laid as flashing wherever junction of vertical and horizontal surfaces occur. Longitudinal laps shall be 10 cm. The upper edge of flashing membrane shall be well tucked into the flashing grooves in the parapets, chimney stack etc. to a depth of not less than 6.5 cm; corresponding applications of primer coat shall also be made. The flashing treatment shall be firmly held in the grooves and it shall be sealed with the approved sealant after terminating the membrane.

Where parapet walls are of height 45 cm or less AP water proofing membrane flashing shall be provided in the same manner as for splashing in the core of high parapet walls except that upper edge shall be carried out the full height of the wall and taken right across the top of the parapet and down on the external vertical faces to a minimum distance of 5 cm.

Where low dividing walls or inverted beams are met with, the same treatment shall be provided as for the main roof, the lateral bearing carried down both sides of the wall and overlapping the roof treatment.

Drain outlets where formed in the low dividing walls, shall be given water proofing treatment same as for the main roof.

Where the expansion joints are provided in the slabs, the joints and their cover slabs shall be suitably treated with water proofing treatment. A typical sketch of an expansion joint with the RCC slabs on either side of the joint turned vertically up and covered with precise RCC cover slabs as given in Fig. 14.10. The cover slabs shall cover the vertical turned up dwarf walls by not less than 7.5 cm and are provided with throatings on their underside along their length. The water proofing treatment shall be taken up the slopping junction fillets and the vertical faces of the walls to the underside of the cover slabs are given the water proofing treatment like the roof slabs, after the cross joints between adjacent cover slabs are first sealed with 15 cm. width of roofing felt struck to them with bitumen. The water proofing treatment shall be carried down the sides of the cover slabs to their full thickness. Care shall be taken to see that overlaps if any in the roofing over the cover slabs stagger with the joints between cover slabs.

The formation of the expansion joints and provision of cover slabs shall be the responsibility of construction agency. The formation of the junctions fillets and the water proofing treatment of the joint and cover slabs shall be carried out by the water proofing agency. No extra shall be paid for the junction fillets or for the sealing of the cross joints in the cover slab with 15 cm. width of bitumen strips.

14.50.1.6 Measurements: Length and breadth shall be measured correct to a cm. The area shall be calculated in square metres correct to two places of decimal.

Measurement shall be taken over the entire exposed area of roofing and flashing treatment including flashing over low parapet walls, low dividing walls and expansion joints at pipe projections etc. overlaps and tucking into flashing grooves shall not be measured.

No deduction in measurements shall be made for either openings or recesses for chimney stacks, roof lights and the like, for areas upto 40 square decimeter (0.4. sqm.) nor any thing shall be paid for forming such openings. For areas exceeding 0.40 sqm. deductions will be made in measurements for full opening and nothing extra shall be paid for forming such openings.

14.50.1.7 Rate: The rates shall include the cost of all labour and materials involved in all the operations described above.

Clause 14.50 brought from Sub Head 22 (Water Proofing) clause no 22.12

14.51 EXTRA FOR COVERING OF APP MODIFIED PREFABRICATED MEMBRANE WITH GEOTEXTILE

14.51.1 If the water proofing treatment of flat roof has been done with APP modified five layered membrane and the roof is accessible, a separation layer on top of membrane should be laid before any protected treatment is done. Brick tiles in cement mortar or 25 mm thick cement concrete 1:2:4 shall be laid as final layer as shown in Fig. 14.11.

Geotextile 120 gm. Non woven 100% polyester of thickness 1.0 to 1.25 mm manufactured by a company of repute shall be used.

Geotextile of the specified thickness is bonded to the water proofing membrane with intermittent touch by heating the membrane by Butane torch as per manufacturing recommendations.

14.51.2 Measurements: Length and breadth shall be measured correct to two places of decimal, measurement shall be taken over the entire exposed area of roofing.

14.51.3 Rate: The rate shall include the cost of all labour and material involved in all the operation described above. Final layer of brick tiles or 25 mm thick cement concrete shall be measured and paid for separately.

Clause 14.51 brought from Sub Head 22 (Water Proofing) clause no 22.13

14.52 PROVIDING ROUND THE CLOCK SECURITY GUARD WITHOUT GUN

Providing round the clock healthy security guard without gun for watch & ward of Government premises and its all belongings by deploying neatly dressed security guards in 8 hour's shift including necessary T&P like torch, lathi and uniform etc. complete, as per the direction of Engineer-in-charge.(One job means 8 hour's duty). Minimum qualification of security guard should be 10th class passed.

14.53 PROVIDING ROUND THE CLOCK SECURITY GUARD WITH GUN

Providing round the clock healthy security guard with gun for watch & ward of Government premises and its all belongings by deploying neatly dressed security guards in 8 hour's shift including necessary T&P like torch, lathi and uniform etc. complete, as per the direction of Engineer-in-charge.(One job means 8 hour's duty). Minimum qualification of security guard should be 10th class passed.

The suggestive condition for item no. 14.52 & 14.53 are as under:-

1. The agency should have been registered with M/o Defence or Registrar Office for purpose of watch & ward.
2. The Manpower deployed for the watch & ward will be in proper uniform.
3. The agency should get the employees under valid insurance till whole period of agreement.
4. During period of watch & ward any kind of loss / theft / damage to the govt. property / premises will be compensated by the agency.
5. In case of any loss of material/damage of the property during the watch & ward period the FIR to the police will be lodged immediately.
6. The Manpower deployed for the work shall be well equipped with torch, lathi, whistle, gun of valid license from appropriate authority whatsoever as per requirement of the work.

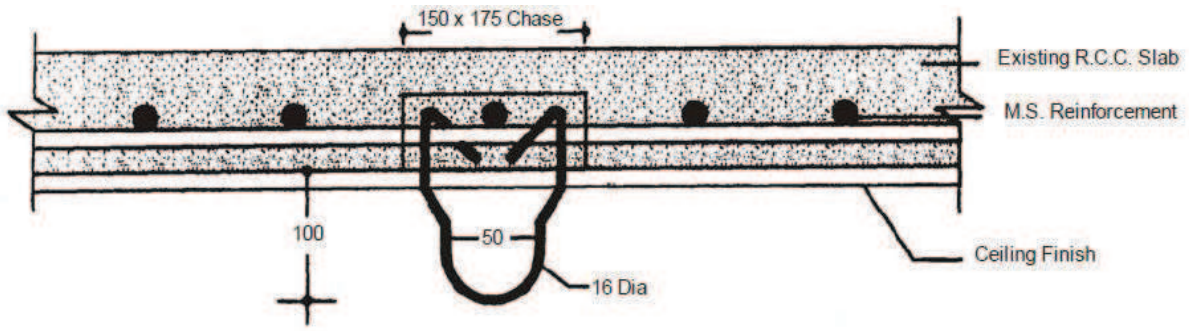
14.53.1 *Measurements:*

The mode of measurements of security guard shall be measured on job/shift basis around the clock (8hrs x 3 shifts for 24 hours) and complete month.

14.53.2 *Rate:* The rate of security guards on job basis and i/c the cost of all labour and T&P involved in all the operation described above.

FIXING OF FAN CLAMPS IN EXISTING R.C.C. SLABS

Sub Head : Repairs to Buildings
Clause : 14.12

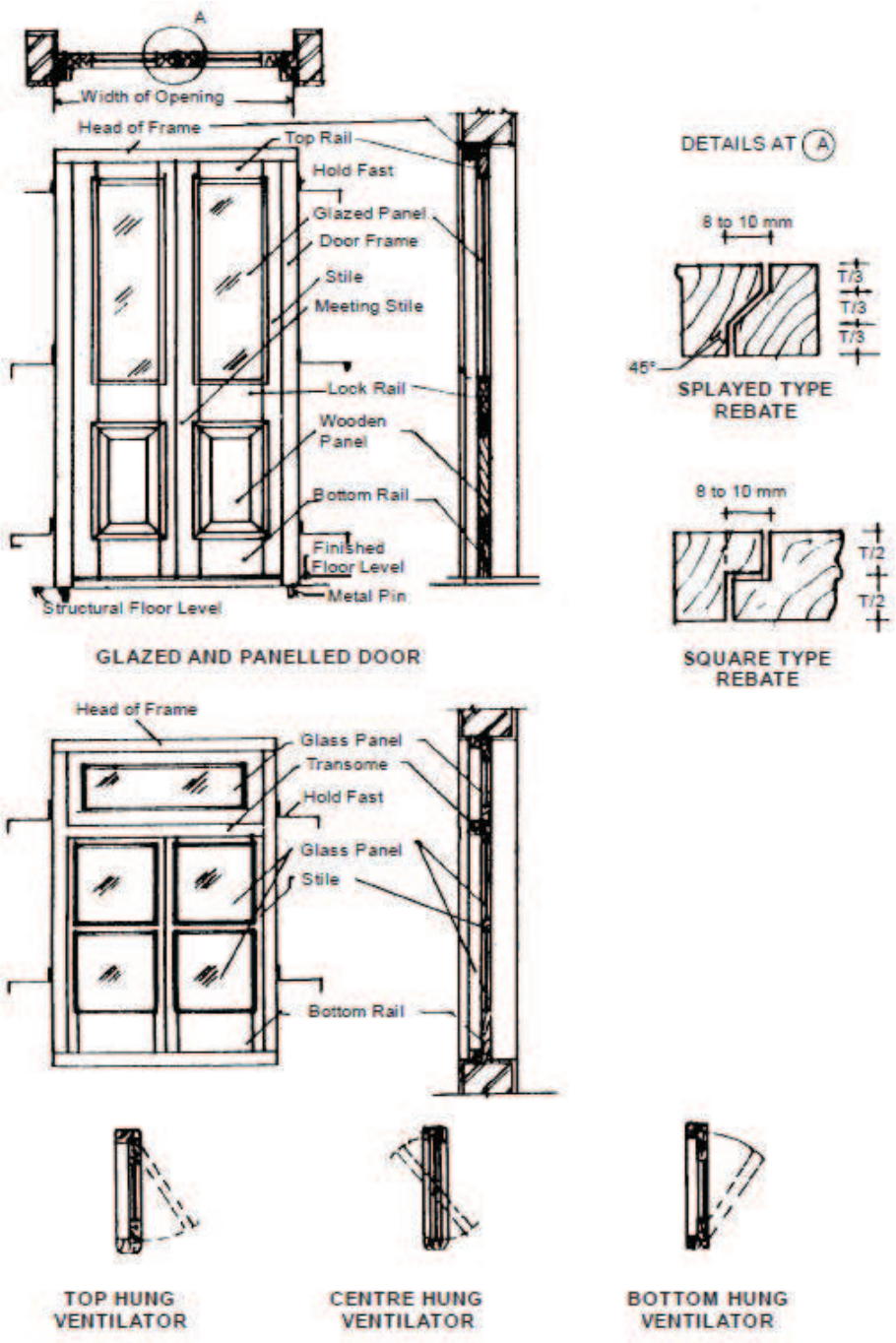


Drawing Not to Scale
All dimensions are in mm

Fig. 14.1 : Fixing of Fan Clamps in Existing R.C.C. Slabs

TERMINOLOGY TIMBER DOOR, WINDOW & VENTILATOR COMPONENTS

Sub Head : Repairs to Buildings
Clause : 14.16

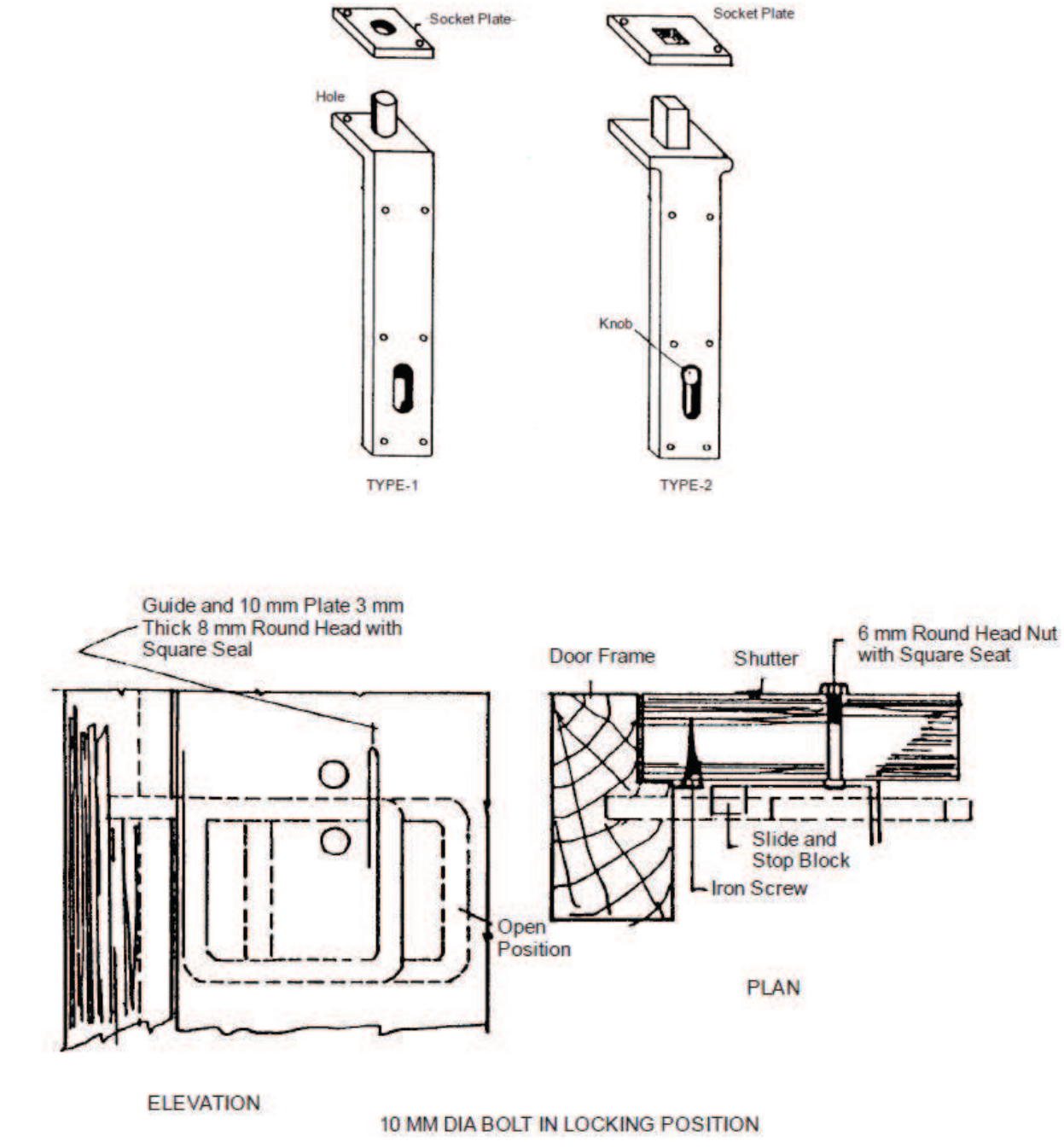


Drawing Not to Scale
All dimensions are in mm

Fig. 14.2 : Terminology Timber Door, Window & Ventilator Components

FLUSH BOLTS

Sub Head : Repairs to Buildings
Clause : 14.18.3

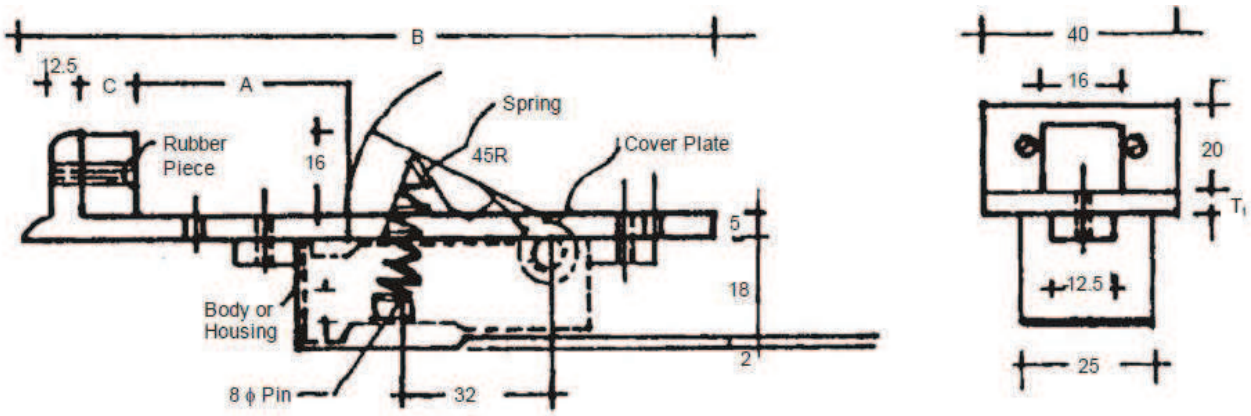


Drawing Not to Scale

Fig. 14.3 : Flush Bolts

FLOOR DOOR STOPPER

Sub Head : Repairs to Buildings
Clause : 14.18.4



Floor Door Stopper - Cast Type

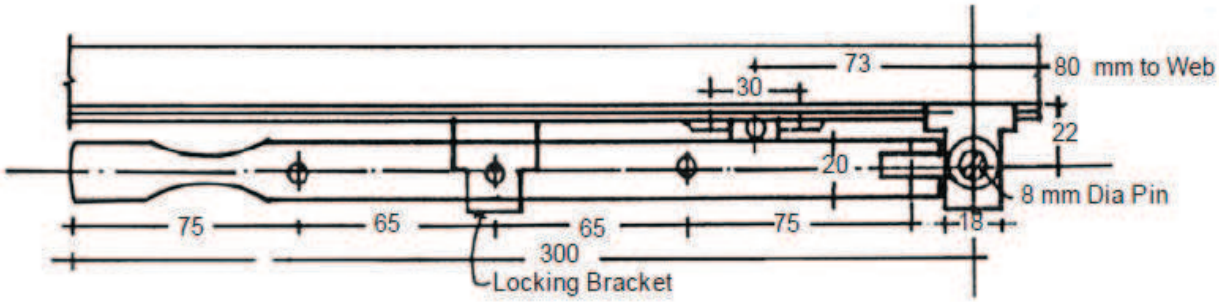
Dimensions						
Thickness of Door Shutter	A	B	C	Casting T_1	Screw Designation No.	No. of Holes For T_1
30	35.0 ± 0.5	140.0 ± 0.5	13	4.5 $^{\pm 0.3}_{-0}$	9	4
35	40.0 ± 0.5	140.0 ± 0.5	8	4.5 $^{\pm 0.3}_{-0}$	9	4
40	45 ± 0.5	150.0 ± 0.5	13	4.5 $^{\pm 0.3}_{-0}$	9	4
45	50.0 ± 0.5	150.0 ± 0.5	8	4.5 $^{\pm 0.3}_{-0}$	9	4

Drawing Not to Scale
All dimensions are in mm

Fig. 14.4 : Flush Door Stopper

WINDOW STAY

Sub Head : Repairs to Buildings
Clause : 14.18.6

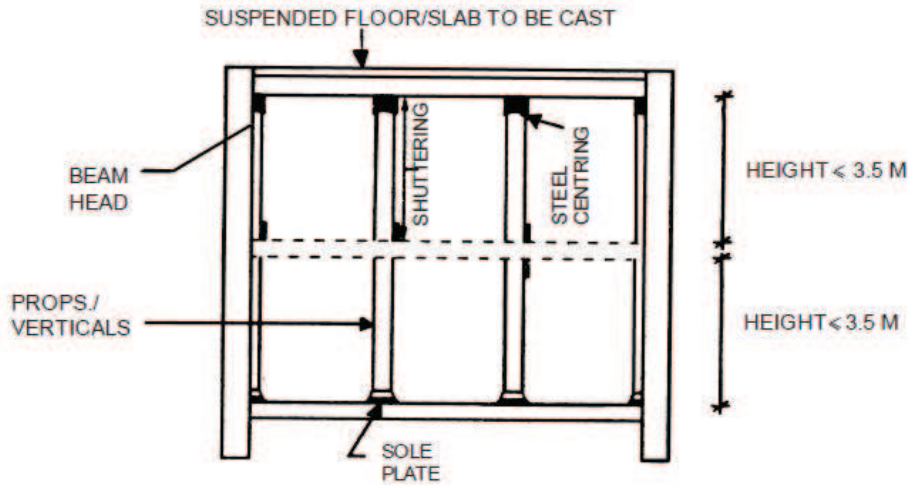


Drawing Not to Scale
All dimensions are in mm

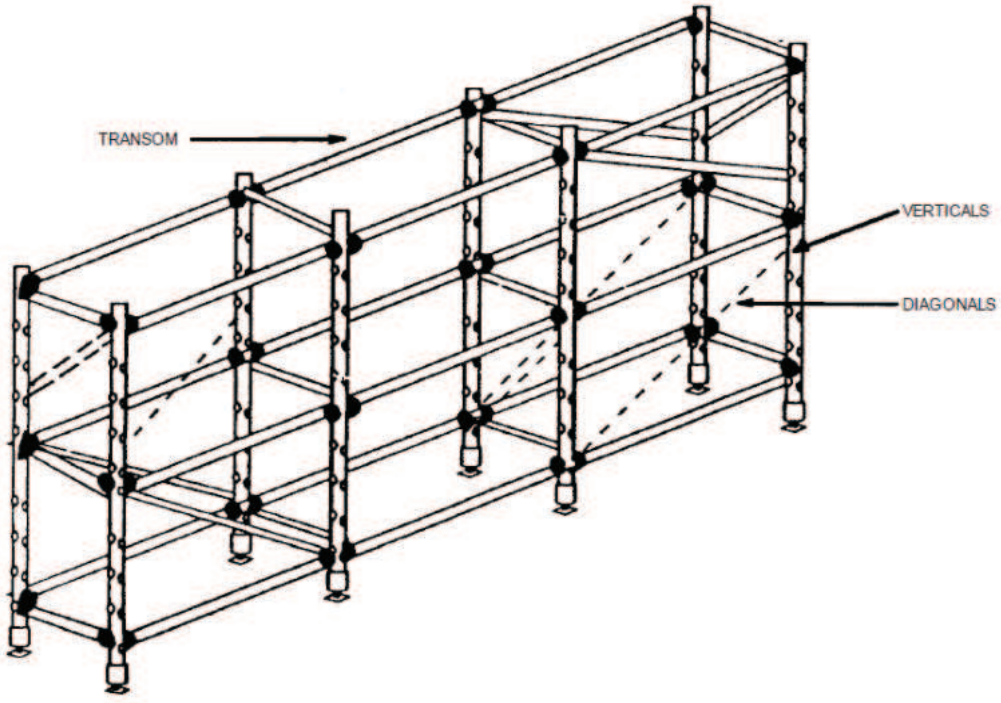
Fig. 14.5 : Window Stay

TYPICAL DETAILS OF MULTI-STAGE SHUTTERING

Sub Head : Repairs to Buildings
Clause : 14.33



SUSPENDED FLOOR-MULTI STAGE SHUTTERING (VERTICAL SECTION)



All Members are of Steel

Fig. 14.6 : Typical Details of Multi-Stage Shuttering

Sub Head : Repairs to Buildings
Clause : 14.49

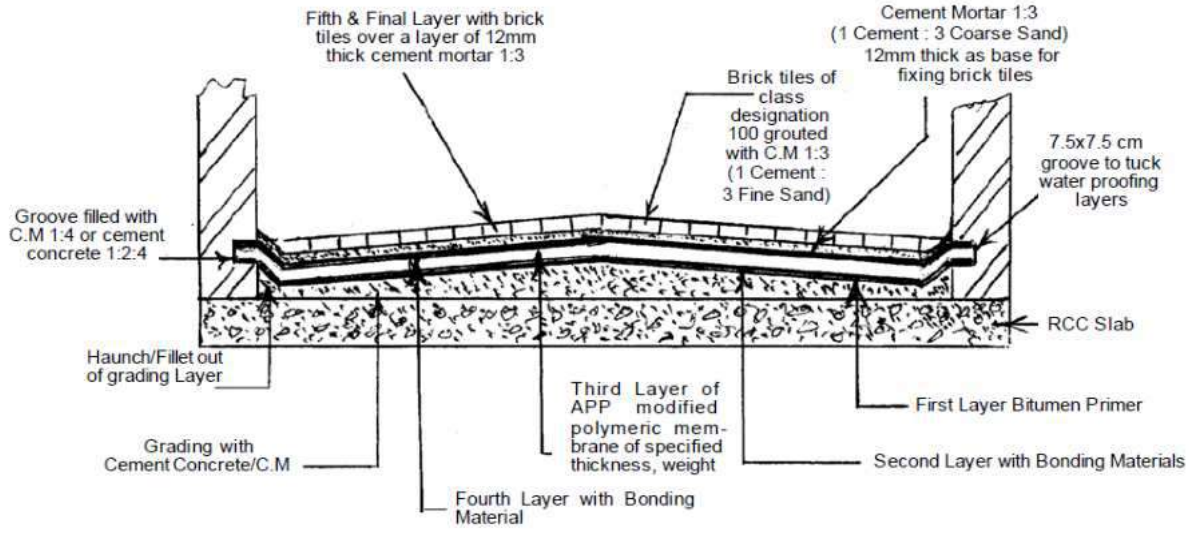


Fig. 14.7 : Five Course Water Proofing Treatment with APP Modified Polymeric Membrane

Sub Head : Repairs to Buildings
Clause : 14.49.1.7

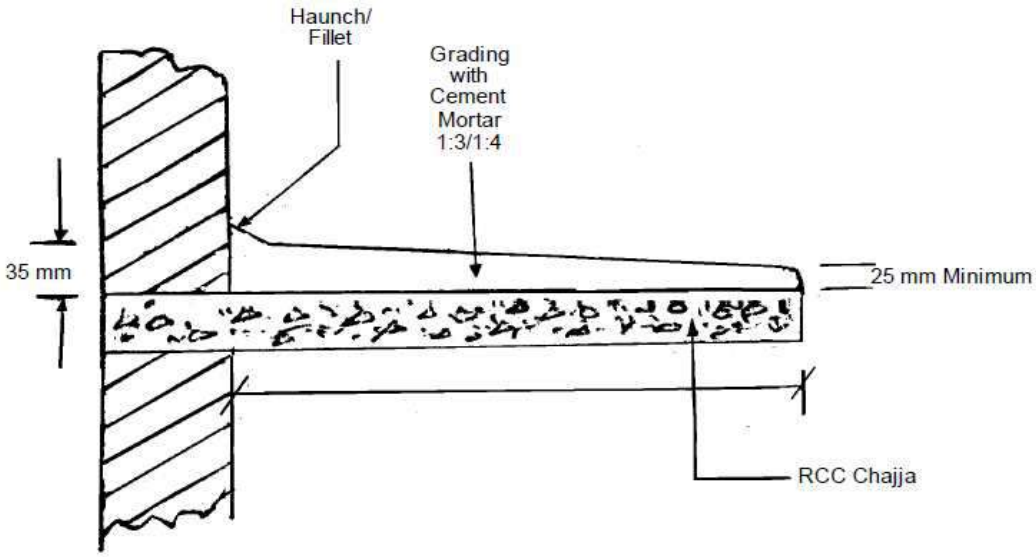


Fig. 14.8 : Grading Chajja with Cement Mortar 1:3/1:4

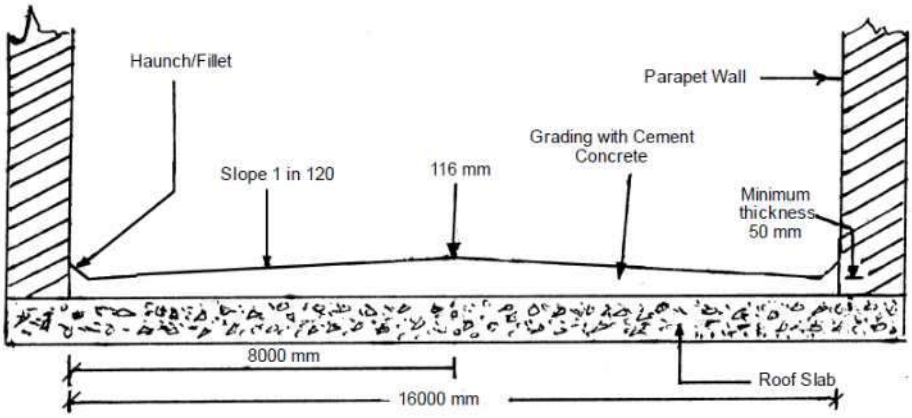
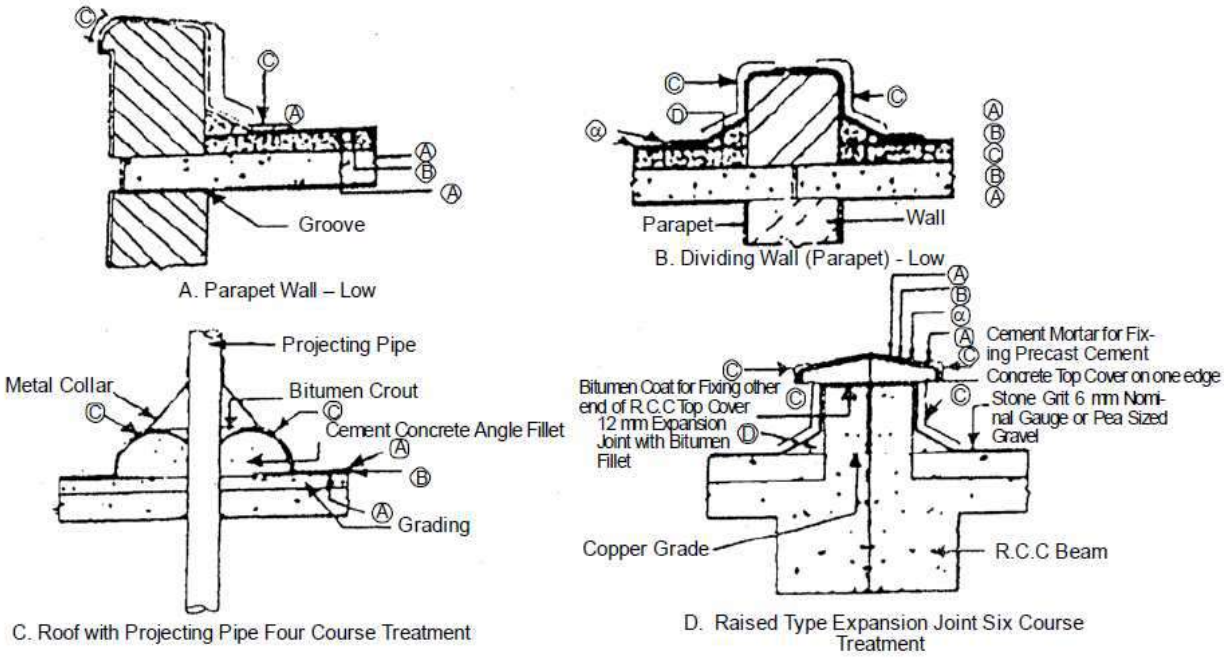


Fig. 14.9 : Grading Roof Slab with Cement Concrete

Sub Head : Repairs to Buildings
Clause : 14.49.1.7



Diagrams Not to Scale
All dimensions are in mm

Fig. 14.10 : Water Proofing

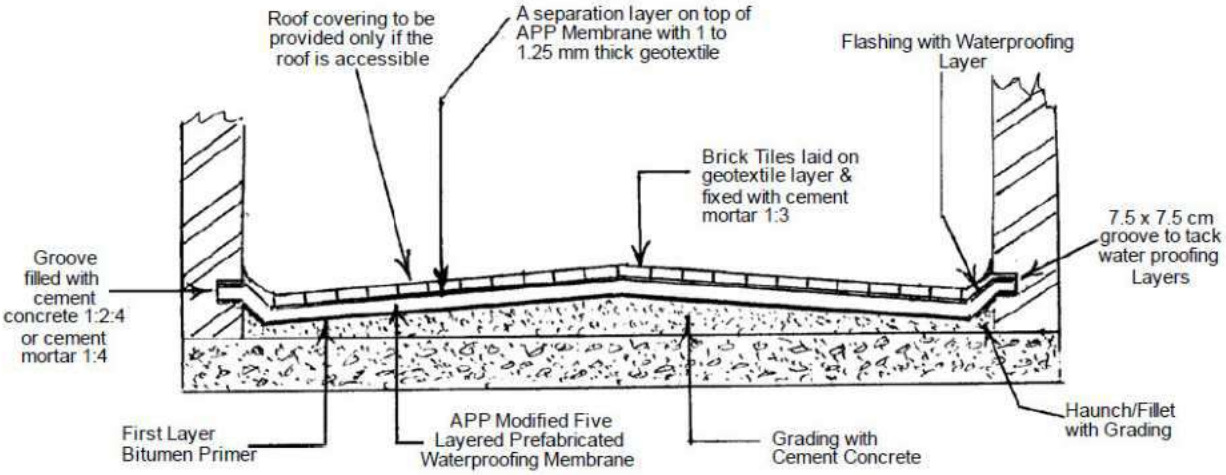


Fig. 14.11 : Five Layers Water-Proofing Treatment with APP Modified Prefabricated Membrane

SUB HEAD : 15.0

DISMANTLING AND DEMOLISHING

CONTENTS

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LIST OF BUREAU OF INDIAN STANDARD CODES

S. No.	*BIS. No.*	*Subject*
1.	IS 1200 (Pt - XVIII)	Method of Measurements of Building and Civil Engineering Works (Part -XVIII) Demolition and Dismantling
2.	IS 4130	Demolition of Buildings-

15.0 DISMANTLING AND DEMOLISHING

15.0 TERMINOLOGY

(i) Deconstruction – Means a selective demolition in which salvage, reuse and recycling of demolished structure is maximized. The term 'Dismantling' implies carefully separating the parts without damage and removing. This may consist of dismantling one or more parts of the building as specified or shown on the drawings.

(ii) Demolition: The term 'Demolition' implies breaking up. This shall consist of demolishing whole or part of work either manually or using mechanical force (various equipment) or by implosion using explosion, including all relevant items as specified or shown on the drawings.

15.1 GENERAL

This chapter relates to buildings only.

15.1.1 Precautions

15.1.1.1 All materials obtained from dismantling or demolition shall be the property of the Government unless otherwise specified and shall be kept in safe custody until they are handed over to the Engineer-in-Charge/ authorized representative.

15.1.1.2 The demolition shall always be well planned before hand and shall generally be done in reverse order of the one in which the structure was constructed. The operations shall be got approved from the Engineer-in-Charge before starting the work.
Due care shall be taken to maintain the safety measures prescribed in IS 4130 and construction and demolition waste management rules 2016 shall be followed.

15.1.1.3 Necessary propping, shoring and or under pinning shall be provided to ensure the safety of the adjoining work or property before dismantling and demolishing is taken up and the work shall be carried out in such a way that no damage is caused to the adjoining work or property. Wherever specified, temporary enclosures or partitions and necessary scaffolding with suitable double scaffolding and proper cloth covering shall also be provided, as directed by the Engineer-in-Charge. It shall be ensured that no dust is generated while demolishing. Demolition Rules – 2016 shall be followed.

15.1.1.4 Necessary steps shall be taken to keep noise and dust nuisance to the minimum. All work needs to be done under the direction of Engineer-in-Charge. Helmets, goggle, safety belts etc., should be used whenever required and as directed by the Engineer-in-Charge. The demolition work shall be proceeded with in such a way that it causes the least damage and nuisance to the adjoining building and the public. Barricading shall be provided as per NGT guidelines.

15.1.1.5 Dismantling shall be done in a systematic manner. All materials which are likely to be damaged by dropping from a height or by demolishing roofs, masonry etc. shall be carefully removed first. Chisels and cutters may be used carefully as directed. The dismantled articles shall be removed manually or otherwise, lowered to the ground (and not thrown) and then properly stacked as directed by the Engineer-in-Charge.

15.1.1.6 Where existing fixing is done by nails, screws, bolts, rivets, etc., dismantling shall be done by taking out the fixing with proper tools and not by tearing or ripping off.

15.1.1.7 Any serviceable material, obtained during dismantling or demolition, shall be separated out and stacked properly as directed by the Engineer-in-Charge within a lead of 50 meters. All unserviceable materials, rubbish etc. shall be disposed offat authorized locations by urban local bodies as directed by the Engineer-in-Charge.

15.1.1.8 The contractor shall maintain/disconnect existing services, whether temporary or permanent, wherever required by the Engineer-in-Charge.

15.1.1.9 No demolition work should be carried out at night especially when the building or structure to be demolished is in an inhabited area.

15.1.1.10 Appropriate screens shall be placed where necessary to prevent injuries due to falling pieces.

15.1.1.11 Water spray shall be used to reduce dust while tearing down plaster from brick work.

15.1.1.12 Safety belts shall be used by labourers while working at higher level to prevent falling from the structure. Wherever, possible mechanized working platform shall be used.

15.1.1.13 First-aid equipment shall be made available at all demolition works of any magnitude.

15.2 RECOMMENDATIONS FOR DEMOLITION OF CERTAIN SPECIAL TYPES AND ELEMENTS OF STRUCTURES

15.2.1 Roof Trusses If a building has a pitched roof, the roof structure should be removed to wall plate level by hand method. Sufficient purlins and bracing should be retained to ensure stability of the remaining roof trusses while each individual truss is removed progressively.

15.2.1.1 Temporary bracing should be added, where necessary, to maintain stability. The end frame opposite to the end where dismantling is commenced, or a convenient intermediate frame should be independently and securely guyed in both directions before work starts.

15.2.1.2 On no account should the bottom tie of roof trusses be cut until the principal rafters are prevented from making outward movement.

15.2.3 Heavy Floor Beams Heavy bulks of timber and steel beams should be supported before cutting at the extremities and should then be lowered to a safe working place.

15.2.4 Jack Arches Where tie rods are present between main supporting beams, these should not be cut until after the arch or series of arches in the floor have been removed. Particular care should be exercised and full examination of this type of structure undertaken before demolition is commenced (see Fig. 15.1). The floor should be demolished in strips parallel to the span of the arch. rings (at right angles to the main floor beams).

15.2.5 Brick Arches

15.2.5.1 Expert advice should be obtained and at all stages of the demolition, the closest supervision should be given by persons fully experienced and conversant in the type of work to ensure that the structure is stable at all times.

15.2.5.2 As much dead load as possible may be removed provided it does not interfere with the stability of the main arch rings but it should be noted that the load-carrying capacity of many old arches relies on the filling between the spandrels. On no account should the restraining influence of the abutments be removed before the dead load of the sprandrel fill and the arch rings are removed.

15.2.5.3 The normal sequence of demolition is as shown in Fig. 15.2-A, namely:

(a) Remove spandrel in filling down to the springing line,

(b) Remove the arch. rings and

(c) Remove the abutment.

15.2.5.4 Special temporary support shall be provided in the case of skew bridges.

15.2.5.5 A single span arch. can be demolished by hand by cutting narrow segments progressively from each springing parallel to the span of the arch until the width of the arch has been reduced to a minimum which can then be collapsed (see Fig. 15.2B).

15.2.5.6 Where it is impossible to allow debris to fall to the ground below, centering designed to carry the load should be erected and the arch demolished progressively. The design of the centering should make appropriate allowance for impact.

15.2.5.7 Where deliberate collapse is feasible the crown may be broken by the demolition ball method working progressively from edges to the centre (see Fig. 15.2C).

15.2.5.8 Collapse of the structure can be effected in one action by the use of explosives. Charges should be inserted into boreholes drilled in both arch and abutments. This method is the most effective for demolition of tall viaducts.

15.2.5.9 In multi-span arches before individual spans are removed, lateral restraint should be provided at the springing level. Demolition may then proceed as for a single span, care being taken to demolish the spandrels down to the springing line as the work proceeds (see Fig. 15.2D). Where explosives are used it is preferable to ensure the collapse of the whole structure in one operation to obviate the chance of leaving unstable portions standing.

15.2.6 Cantilevers (Not part of a Framed Structure)

A cantilever type of construction depends for its stability on the super imposed structure. Canopies, cornices, staircases and balconies should be demolished or supported before the tailing down load is removed.

15.2.7 In-situ Reinforced Concrete

15.2.7.1 Before commencing demolition, the nature and condition of the concrete, the condition and position of reinforcement, and the possibility of lack of continuity of reinforcement should be ascertained.

15.2.7.2 Attention should be paid to the principles of the structural design to determine which parts of the structure depend on each other to maintain overall stability.

15.2.7.3 Demolition should be commenced by removing partitions and external non-load bearing cladding. It should be noted that in some buildings the frame may rely on the panel walls for stability.

15.2.7.4 Where hard demolition methods are to be used, the following procedures should be used.

(a) Reinforced Concrete Beams

For beams,a supporting rope should be attached of preferably at two or three locations to the beam. Then the concrete should be removed from both ends by pneumatic drill and the reinforcement exposed. The reinforcement should then be cut in such a way as to allow the beam to be lowered under control to the floor (see Fig. 15.3A).

(b) Reinforced Concrete Columns

For columns, the reinforcement should be exposed at the base after restraining wire guy ropes have been placed round the member at the top. The reinforcement should then be cut in such a way as to allow the column to be pulled down to the floor under control. (see Fig. 15.3B for sequence of operations).

(c) Reinforced Concrete Walls Reinforced concrete walls should be cut into strips and demolished as for columns (Fig. 15.3C).

15.3 MEASUREMENTS

15.3.1 All work shall be measured net in the decimal system, as fixed in its place, subject to the following limits, unless otherwise stated hereinafter.

(a) Dimensions shall be measured correct to a cm.

(b) Areas shall be worked out in sqm correct to two places of decimal.

(c) Cubical contents shall be worked out to the nearest 0.01 cum.

15.3.2 Parts of work required to be dismantled and those required to be demolished shall be measured separately.

15.3.3 Measurements of all work except hidden work shall be taken before demolition or dismantling and no allowance for increase in bulk shall be allowed.

15.3.4 Specifications for deduction for voids, openings etc. shall be on the same basis as that adopted for new construction of the work.

15.3.5 Work executed in the following conditions shall be measured separately.

(a) Work in or under water and/or liquid mud

(b) Work in or under foul position.

15.3.6 Roofs

(i) Roof coverings generally including battens boarding, mats, bamboo jaffari or other subsidiary supports shall be measured in square metres except lead sheet roof covering which shall be measured in quintals (15.2.3) and stone slab roof covering which shall be measured in cubic metres.

(ii) Ridges, hips and valleys shall be girthed and included with the roof area. Corrugated or semi corrugated surfaces shall be measured flat and not girthed.

(iii) Mud phuska on roofs shall be measured in cubic metres.

(iv) Lead sheets in roofs shall be measured in quintals and hips, valleys, flashings, lining to gutter etc. shall be included in this weight.

(v) R.B. or R.C.C. roofs shall be measured as specified in 15.3.11.

(vi) Supporting members, such as rafters, purlins, beams joists, trusses etc. of wood shall be measured in cubic metres and steel or iron sections, in quintals.

15.3.7 Ceiling

(i) The stripping of ceilings shall be measured in square metres.

(ii) Dismantling of supporting joists, beams, etc. shall be measured in cubic metres or in quintals as specified in 15.3.6(vi).

(iii) Height above floor level, if it exceeds 3.5 m shall be paid for separately.

15.3.8 Flooring and Pavings

Dismantling of floors (except concrete and brick floors) shall be measured in square metres. Supports such as joints, beams etc. if any shall be measured as per 15.3.6(vi). Concrete and bricks paving shall be measured as per 15.3.9.

15.3.9 Concrete and Brick Roofs and Suspended Floors

Demolition of floors and roofs of concrete or brick shall be measured in cubic metres. Beams cantilevers or other subsidiary supports of similar materials, shall be included in the item. In measuring thickness of roofs provided with water proofing treatments with bitumen felts, the thickness of water proofing treatment shall be ignored.

15.3.10 Walls and Piers

(i) Taking down walls and independent piers or columns of brick, stone or concrete shall be measured, in cubic metres. All copings, corbels, cornices and other projections shall be included with the wall measurements.

(ii) In measuring thickness of plastered walls, the thickness of plaster shall be ignored.

(iii) Ashlar face stones, dressed stone work, pre-cast concrete articles, etc. if required to be taken down intact shall be so stated and measured separately in cubic metres.

(iv) Cleaning bricks stacking for measurements including all extra handling and removal and disposing off the rubbish as stated shall be enumerated in thousand of cleaned bricks.

(v) Cleaning stone obtained from demolished/dismantling stone masonry of any description including ashlar facing dressed stone work, stone slabs or flagging and pre-cast concrete blocks including all extra handling and disposing off the rubbish as stated shall be measured in cubic meters of cleaned stone.

(vi) Honey comb works or cavity walls of bricks stone or concrete shall be measured as solid.

15.3.11 Reinforced Concrete and Brick Work

Reinforced concrete structures and reinforced brick roofs and walls shall be measured in cubic meters and if reinforcement is required to be salvaged, it shall be so stated.
Where reinforcement is required to be separated, scraped and cleaned, the work shall be measured separately in quintal of salvaged steel.

15.3.12 Partitions, Trellis Work etc.

Partitions or light walls, of lath and plaster, trellis work, expanded metal, thin concrete or terracotta slabs and other similar materials including frame work if any shall be measured in square meters stating the over all thickness.

15.3.13 Wood Work

All wood work including karries average 40 sq cm or over in section, shall be measured in cubic meters, while that under 40 sq cm in section, in running meters. Ballies shall be measured in running meters.

Boarding including wooden chajjas and sun shades along with supports shall be measured in square meters in its plane.

15.3.14 Steel and Iron Work

(i) All steel and iron work shall be measured in quintals. The weight shall be computed from standard tables unless the actual weight can readily be determined.

(ii) Riveted work, where rivets are required to be cut, shall be measured separately.

(iii) Marking of structural steel required to be re-erected shall be measured separately.

(iv) In framed steel items, the weight or any covering material or filling such as iron sheets and expanded metal shall be included in the weight of the main article unless such covering is not ordered to be taken out separately.

15.3.15 Doors and Windows

Dismantling of doors, windows, clerestory windows, ventilators etc. (wood or metal) whether done separately or along with removal of wall by making recess in the wall shall be enumerated. Those exceeding 3 sqm each in area shall be measured separately. The item shall include removal of chowkhats architraves, holdfasts and other attachments.

If only shutters are to be taken out it shall be measured separately.

15.3.16 Pipes and Sewer Lines

(i) Water pipe lines including rain water pipes with clamps and specials, sewer lines (salt glazed ware or concrete) etc. shall be described by their diameter and length measured in running metres inclusive of joints.

(ii) If the joints, special and fittings etc. are required to be separated, it shall be so stated and enumerated.

(iii) Pucca drains shall be measured under relevant items.

(iv) Valve cistern, public fountain platform, fire hydrants, etc. shall be enumerated.

(v) Manholes and inspection chambers shall be enumerated stating the size and depth of manhole/inspection chamber. They shall be classified into different groups depending upon the depth, in unit of half and one metre depth. The depth of the manhole shall be the distance between the top of manhole cover and invert level of the drain.

(vi) Ventilating shafts, gully traps, flushing cisterns and other appurtenant items of work shall be enumerated.

15.3.17 Posts or Struts

Posts or struts (wood, steel or RCC) section including taking out embedded portion shall be measured in running meters.

15.3.18 Fencing Wire Mesh

Wire mesh fencing of any type with frame shall be measured in square metres.

15.3.19 Glazing

Taking out any portion of serviceable glass except polished plate, from old sashes, skylights, etc. (any thickness, weight or size) raking out old putty, etc. shall be measured in square meters.
Irregular circular panes shall be measured as rectangle or square enveloping the same. The width and height being measured correct to the nearest 0.5 cm.

15.3.20 Road Work

(i) Different types of road surfaces shall be measured separately.

(ii) Road surfaces metalling or soling (base) shall be measured in square meters.

(iii) Concrete paving shall be measured as in 15.3.8 or 15.3.9 as the case may be.

15.4 Rates

The rate shall include the cost of all labour involved and tools used in demolishing and dismantling including scaffolding. The rate shall also include the charges for separating out and stacking the serviceable material properly and disposing off unserviceable material within a distance of 50 meters. The rate shall also include for temporary shoring for the safety of portions not required to be pulled down, or of adjoining property, and providing temporary enclosures or partitions, where considered necessary.

DEMOLITION OF JACK ARCHES

Sub Head : Dismantling and Demolition
Clause : 15.2.4

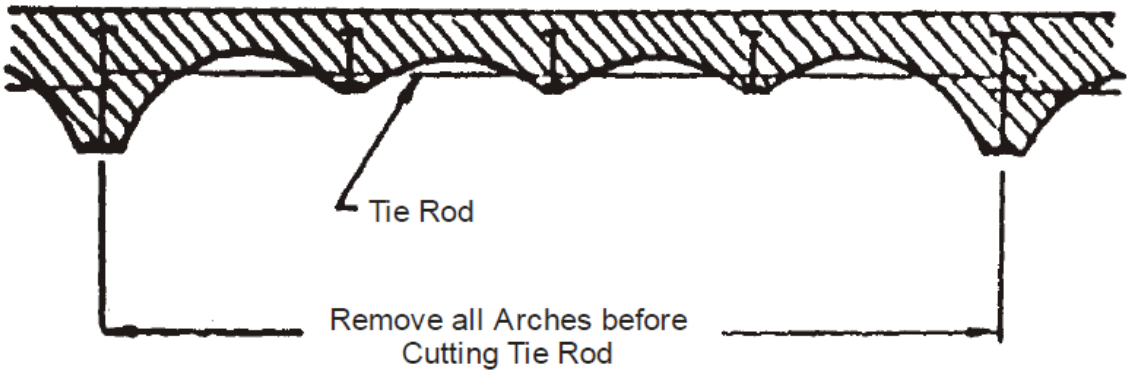


Fig. 15.1 : Demolition of Jack Arches

DEMOLITION OF MASONRY AND BRICKWORK ARCHES

Sub Head : Dismantling and Demolition
Clause : 15.2.4 and 15.2.5

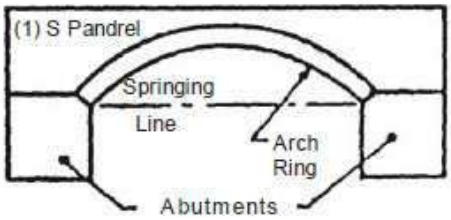


Fig. 15.2A

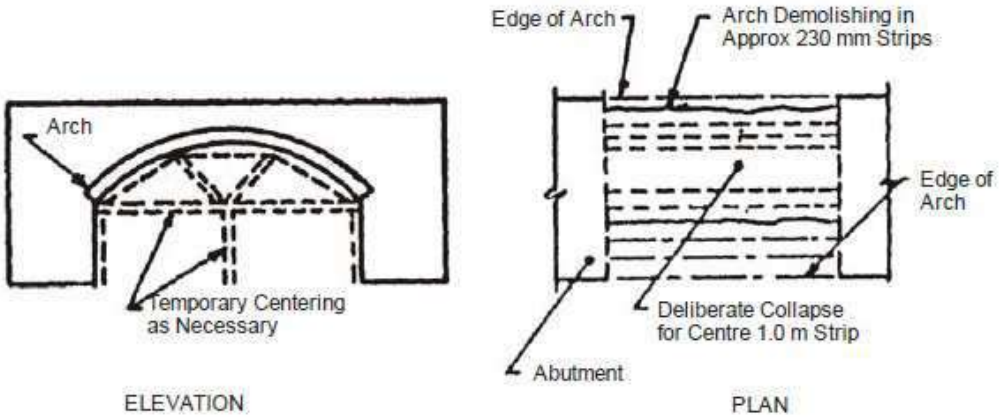


Fig. 15.2B

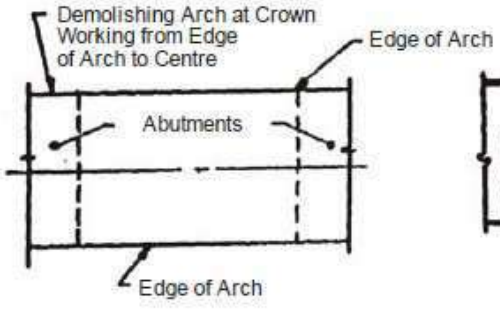


Fig. 15.2C

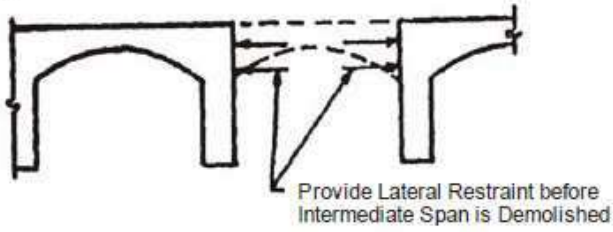


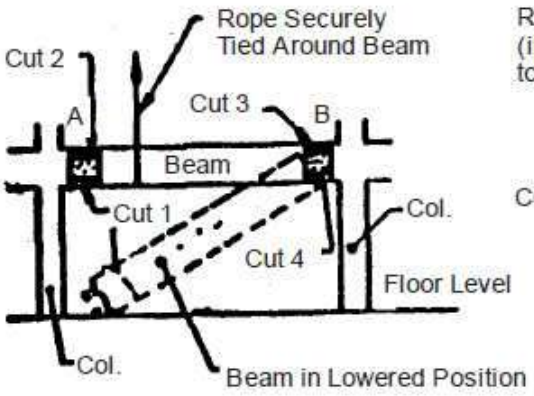
Fig. 15.2D

Note: Order of Demolition

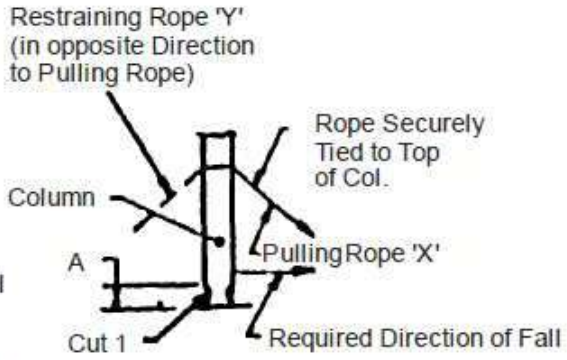
Fig. 15.2 : Demolition of Masonry and Brickwork Arches

HAND DEMOLITION OF IN-SITU CONCRETE STRUCTURE

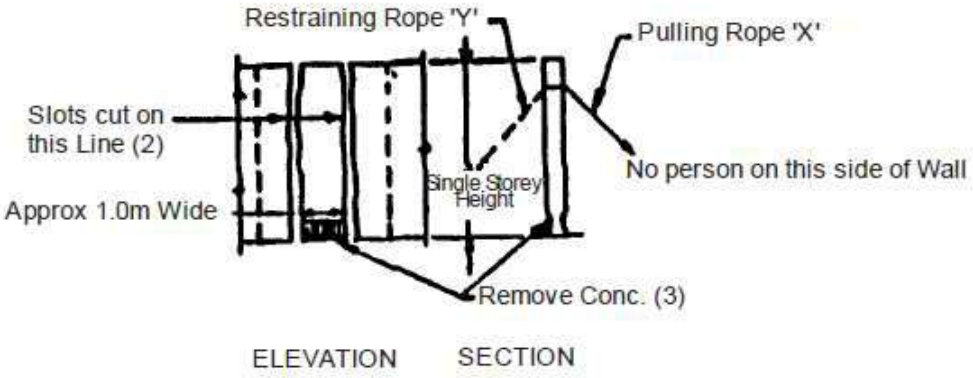
Sub Head : Dismantling and Demolition
Clause : 15.2.7.4



15.3A : R.C. Beams



15.3B : R.C. Columns



15.3C : R.C. Walls

Fig. 15.3 : Hand Demolition of In-Situ Concrete Structure

SUB HEAD : 17.0

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LIST OF BUREAU OF INDIAN STANDARDS (BIS) CODES

S. No.	*BIS. No.*	*Subject*
1.	IS 771 (Pt.1)	Specification for glazed fire clay sanitary appliances: Part 1: General requirements.
2.	IS 771 (Pt.-2)	Specification for glazed fire clay sanitary appliances: Part 2: Specific requirements of kitchen and laboratory sink.
3.	IS 772	Specific action for general requirements for enameled cast iron sanitary appliances.
4.	IS 774	Flushing cisterns for water closets and urinals (Other than plastic cistern)-Specifications.
5.	IS 1300	Phenolic moulding materials.- Specifications
6.	IS 13983	Providing and fixing stainless steel sink
7.	IS 1570 (Part-5)	Schedule for Wrought steel (Stainless Steel and heat resisting steels)
8.	IS 1703	Water fittings- copper alloy float valves (horizontal plunger type) - Specification.
9.	IS 1729	Cast iron /Ductile Iron Drainage Pipes and pipe fittings for Over ground non-pressure pipe line Socket and Spigot Series.
10.	IS 1795	Specification for pillar taps for water supply purposes.
11.	IS 1865	Iron casting with spheroidal or nodular graphite
12.	IS 2267	Polystyrene moulding and extrusion materials - Specifications
13.	IS 2326	Specification for Automatic Flushing Cisterns for Urinals (Other than plastic cisterns)
14.	IS 2548 (Part-1)	Plastic seats and covers for water closets Part 1: Thermo set seats and covers - Specifications
15.	IS 2548 (Part-2)	Plastic seats and covers for water closets Part 2: Thermoplastic seats and covers.- Specifications
16.	IS 2556	Vitreous sanitary appliances (vitreous china) -Specifications
17.	IS 2556 (Part-1)	Part-1: General requirements.
18.	IS 2556 (Part-2)	Part-2: Specific requirements of wash-down water closets.
19.	IS 2556 (Part-3)	Part-3: Specific squatting pans.
20.	IS 2556 (Part-4)	Part-4: Specific requirements of wash basins.
21.	IS 2556 (Part-5)	Part-5: Specific requirements of laboratory sinks.
22.	IS 2556 (Part-6)	Part-6: Specific requirements of Urinals & Partition plates
23.	IS 2556 (Part-7)	Part-7: Specific requirements of accessories for sanitary appliances
24.	IS 2556 (Part -14)	Part-14: Specific requirements of integrated squatting pans.

25.	IS 2556 (Part -15)	Part-15: Specific requirements of universal water closets.
26.	IS 2556 (Part -16)	Part-16: Specific requirements of wash down wall mounted water closets
27.	IS 2963	Specification for Copper alloy waste fittings for wash basins and sinks.
28.	IS 3076	Specification for low density polyethylene pipes for potable water supplies.
29.	IS 3389	Urea formaldehyde moulding materials. - Specifications
30.	IS 3989	Specification for centrifugally cast (spun) iron spigot and socket soil, waste and ventilating pipes fittings and accessories.
31.	IS 4827	Specification for electroplated coating of nickel and chromium on copper and copper alloys.
32.	IS 4984	Specification for high density polyethylene pipes for potable water supplies.
33.	IS 4985	Unplasticised P.V.C. pipes for potable water supply - Specifications.
34.	IS 7231	Plastic flushing cisterns for water closets and urinals - Specifications.
35.	IS 13983	Stainless steel sinks for domestic purposes -Specifications.
36.	IS 15905	Centrifugally Cast Iron Hubless pipes & fittings

17.0 SANITARY INSTALLATIONS

17.0 TERMINOLOGY

Antisiphon Pipe (Fig. 17.1)
A ventilating pipe connected to or close to the outlet side of a trap seal.

Automatic Flushing Cistern (Fig. 17.3)
A flushing cistern arranged to discharge its content by siphonage at regular intervals, determined by the rate at which water is fed into the cistern.

Ball Cock (Fig. 17.3)
A faucet opened or closed by the fall or rise of a ball floating in the surface of water.

Ball Valve (Fig. 17.3)
A simple non return valve consisting of a ball resting on a cylindrical seat within a fluid passageway.

Bell Mouth (Fig. 17.3)
An expanded rounded entrance to a pipe or orifice.

Bend
Length of pipe bent or cast into an angle shape.

Bib Tap
A tap with a horizontal inlet and nozzle bent to discharge in a downward direction.

Blister
A raised portion of the surface protruding not more than one millimeter above the surface and not greater than 3 mm in its greatest dimension.

Box Union
A device for joining two threaded pipes.

Branch (Fig. 17.1)
(a) A special form of vitrified sewer and cast iron pipe used for making connections to a sewer or water main. The various types are called T, Y, T-Y, double Y, and V branches, according to their respective shapes.

(b) Any part of piping system other than a main.

Caulking
(a) The process of driving, pouring or forcing lead, oakum, plastic or other material into a joint to make it leak proof.

(b) The material used in the caulking process.

Caulked Joint
A spigot and socket joint in which the jointing material is compacted by means of caulking tool and hammer.

Chase

A continuous recess in wall, floor or ceiling for the purpose of holding pipes and conduits.

Cistern (Fig. 17.3)

A fixed container for water in which the water is at atmospheric pressure. The water is usually supplied through a ball valve.

Collar

A pipe-fitting in the form of sleeve for jointing the spigot ends of two pipes in the same alignment.

Cowl (Fig. 17.1)

A hood on the top of a vent pipe or soil stack.

Craze or Crazing

Fine cracks in the glaze.

Cross

A pipe fitting used for connecting four pipes at right angles.

Fittings

Coupling, flange, branch, bend, tee, elbow, union, waste with plug, P or S trap with vent, ferrule, stop tap, bib tap, pillar tap, globe tap, ball valve, cistern, storage tank, baths, water closets, boiler geyser, pumping set with motor and accessories, metre, hydrant valve and any other article used in connection with water supply, drainage and sanitation.

Float Valve (Fig. 17.3)

A valve in which the closure to an opening such as a plug or gate, is actuated by a float to control the flow in to a tank.

Flush Bend

A bend located at the bottom of low level flushing cistern for the purpose of flushing pedestal type water closet and similar fixture.

Flushing Cistern (Fig. 17.3)

A cistern provided with a device for rapidly discharging the contained water and used in connection with a sanitary appliance for the purpose of cleaning the appliance and carrying away its contents into a drain.

Gasket

A piece of compressible material used to make a joint between two flat surfaces.

Oakum

Hemp or old hemp rope soaked in oil to make it water proof.

One Pipe System (Fig. 17.1)

In this a single soil waste pipe conveys both soil and waste directly to the building drain.

Pinhole

A hole in the body, less than 1.5 mm, in its maximum dimension.

Reducer

A pipe-fitting with inside threads larger at one end than at the other. All such fittings having more than one size are reducers because of the custom of stating the larger size first.

Single Stack System (Fig. 17.1)

This is the name given to a simplified one pipe system wherein all ventilation pipes are omitted. The stack itself is made to cater (or provide) for all the vent requirements by restricting the flow into the stack to certain predetermined limits.

Sink (Fig. 17.7)

A shallow fixture, ordinarily with a flat bottom, that is usually used in kitchen or in connection with the preparation of food, laboratory purposes and for certain industrial processes.

Socket

The female part of spigot and socket joint.

Soil Pipe

A pipe which conveys to drain the discharge from a water closet or urinals. In 'One pipe' and 'single stack' system the soil pipe also conveys to a drain the discharges from bath, wash basins, sinks and similar appliances.

Speck

Area of the finished surface with contrasting colour less than one millimeter maximum dimension.

Spigot

The male part of a spigot and socket joint.

Spigot and Socket Joint

Joint in which the end of the one pipe enters the enlarged end of the next pipe.

Stack

A main vertical discharge or ventilating pipe.

Trap

A fitting or device so designed and constructed as to provide, when properly vented, a liquid seal which will prevent the back passage of air without materially affecting the flow of sewage or waste water through it.

Two Pipe System (Fig. 17.1)

In this, the soil pipe conveys discharges from water closets, urinals, and similar soil appliances directly to the drainage system and the waste pipe conveys waste from ablutionary and culinary appliances to the drainage system directly or through a trapped gully where desired.

Union

A pipe fitting used for joining the ends of two pipes neither of which can be turned.

Valve

A device used for controlling the flow of liquid in a line of pipe.

Ventilating Pipe (Vent Pipe)

The pipe which provides a safe outlet into the atmosphere for the foul gases in the drain or sewer.

Warpage

Distortion of original shape during manufacturing process.

Water Seal

The depth of water which should be removed from a fully charged trap before air can pass through the trap.

Waste Pipe

A pipe used to convey liquid waste not containing human excreta.

Waste Stack

A vertical pipe used to convey liquid waste not containing human excreta.

17.1 APPLIANCES AND FITTINGS

17.1.0 All vitreous sanitary appliances (Vitreous China) shall conform to IS 2556 (Part-I) general requirements.

17.1.1 Flushing Cisterns (Fig. 17.3)

The flushing cisterns shall be automatic or manually operated high level or low level as specified, for water closets and urinals. A high level cistern is intended to operate with minimum height of 125 cm and a low level cistern with a maximum height of 30 cm between the top of the pan and the under side of the cistern.

Cisterns shall be of following type (i) Vitreous China (IS 774) for Flushing type (ii) Automatic Flushing Cistern (IS 2326) and (iii) Plastic cisterns (IS 7231).

17.1.1.1 ***Vitreous Chine Cisterns :*** The thickness of the body including cover shall be not less than 6 mm for vitreous China cisterns. The outlet of each syphon or stand pipe shall be securely connected to the cistern by means of lock nut. The cistern shall be free from manufacturing faults and other defects affecting their utility. All working parts shall be designed to operate smoothly and efficiently. Cistern shall be mosquito proof. A cistern shall be considered mosquito proof only if there is no clearance any where which would permit a 1.6 mm wire to pass through in the permanent position of the cistern i.e. in the flushing position or filling position.

The breadth of a low level cistern, from front to back shall be such that the cover or seat, or both, of water closet pan shall come to rest in a stable position when raised.

The cistern shall be supported on two cast iron brackets of size as approved by the Engineer-in-Charge and embedded in cement concrete 1:2:4 block 100 x 75 x 150 mm. These shall be properly protected by suitable impervious paint. Alternatively the cisterns shall have two holes in the back side above the overflow level for screwing into the wall, supplemented by two cast iron wall supports. A 5 litres cistern, however, may be supported by larger brackets cast on the body of the cistern.

The cistern shall have a removable cover which shall fit closely on it and be secured against displacement. In designs where the operating mechanism is attached to the cover this may be made in two sections, but the section supporting the mechanism shall be securely bolted or screwed to the body. The outlet fitting of each cistern shall be securely connected to the cistern. The nominal internal diameter of cistern outlet shall be not less than 38 ± 1mm for low level cisterns respectively. The length of the outlet of the cistern shall be 37 ± 2 mm.

Ball valve shall be of screwed type 15 mm in diameter and shall conform to IS 1703. The float shall be made of polyethylene as specified in IS 9762. (The design shall permit the cistern to fill in rapidly and close effectively when the level of water reaches the working water level.)

In the case of manually operated cisterns the siphonic action of the flushing cistern shall be capable of being rapidly brought into action by the operating lever, but shall not self siphon or leak. When tested according to IS 774 the discharge rate shall be 10 ± 0.5 litre in 6 seconds and 5 ± 0.5 litre in 3 seconds for cisterns of capacities 10 litre and 5 litre respectively. The cisterns shall be so designed that there is not appreciable variation in the force of flush during the discharge of the required quantity of water. The cistern shall have a discharge capacity of 5 & 10 litres as specified. When required to give a full flush, they shall respectively discharge 5 litres and 10 litres with variation of ± 0.5 litres.

The flush pipe shall be of (a) medium quality galvanised iron having internal diameter of 38 ± 1 mm for low level cistern. The flush pipe shall be of suitable length with bends etc. as required for fixing it with front or back inlet W.C. Pan. (b) Polyethylene pipes low density conforming to IS 3076 or high density (c) Unplasticised PVC pipes. For high density polyethylene and unplasticised PVC pipes, the outside diameter of the pipes shall be 40 mm. When PVC plumbing pipes are used the outside diameter of the pipe shall be 40 mm for high level cisterns and 50 mm for low level cisterns.

In case of low level cistern the flush pipe shall be a vertical pipe 30 cm long and having a nominal internal dia 38 ± 1 mm (except plastic flush pipes).

Over Flow Pipe

(a) GI overflow pipe shall be of not less than 20 mm nominal bore and shall incorporate a non-corrodible mosquito proof brass cover having 1.25 mm dia perforation, screwed in a manner which will permit it to be readily cleaned or renewed when necessary. No provision shall be made whereby the overflow from the cistern shall discharge directly into the water closet or soil pipe without being detected.

The invert of the overflow pipe in the case of high level and low level cisterns shall be 19 mm minimum above the working water level. In case of overflow due to any reason water should drain out through the over flow pipe and not through the siphon pipe.

(b) The plastic overflow pipes shall be manufactured from high density polyethylene conforming to IS 4984 or unplasticised P.V.C. conforming to IS 4985.

Inlet and Overflow Holes: The cistern shall be provided with inlet and overflow holes, situated one at each end which shall be capable of accommodating an overflow pipe of not less than 20 mm nominal bore and a 15 mm size ball valve. The holes shall be cleanly cast or drilled and the adjacent surfaces shall be smooth.

17.1.1.2 ***PVC Cisterns :*** Plastic flushing cisterns for WC and Urinals shall be as per IS 7231.

The materials for manufacturing various components of the flushing cisterns shall conform to the requirements given in Table 17.1 below:

TABLE 17.1
Materials for Various Components of Flushing Cisterns

Sl. No.	*Component(s)*	*Material*	*Conforming to*
(1)	*(2)*	*(3)*	*(4)*
1.	Cisterns	High density polyethylene (HDPE) Or Polystryene, high impact Or Polypropylene[1)] Or Acrylonitrile-butadiene-styrene (ABS) Or Glass Fibre reinforced plastic (GRP)	IS 7328 IS 2267 - - -
2.	Flush pipe	Steel tube, seamless or welded, medium or light, completely protected inside and outside by hot-dip galvanizing, electroplating or vitreous enamelling Or Lead pipe Or Copper alloy tube Or High density polyethylene pipe Or Unplasticised PVC plumbing pipe	 IS 1239 ((Part 1) IS 404 (Part 1) IS 407 IS 2501
3.	Cover	Same material as that of the body	
4.	Chain	Hot-dip galvanized steel wires Or Inter-locked non-ferrous metal Or Any other corrosion resistant material	-
5.	Overflow pipe	High density polyethylene Or Unplasticised PVC Or Any other corrosion-resistant material	IS 4984 IS 4985
6.	Siphon/Valve	High density polyethylene Or Polystyrene, high impact Or Polypropylene Or Acrylonitrile- butadiene-styrene Or Glass fibre reinforced plastic (GRP)	IS 7328 IS 2267 - -
7.	Operating Mechanism/ Lever	Non-ferrous metal or any other corrosion resistant material	-
8.	Float valve	Water fittings-Copper Alloy Float Valves (Horizontal Plunger type) Plastic equilibrium float valve for cold water services Diaphragm type (plastic body) float operated valves for cold water services	IS 1703 IS 12234 IS 13049
9.	Polyethylene float for float valve	As specified in IS 9762	
10.	Coupling nut and lock-nut	Non-ferrous metal, Or Hot-dip galvanised steel Or Hot-dip galvanised malleable iron Or	

(1) Talc as filler, if used shall not exceed 20%

Note: Where the requirements for the material of any component or the relevant Indian Standard designation for any material are not specified, these shall be as directed by the Engineer-in-Charge.

The thickness of the body including cover at any point shall not be less than 2 mm for GRP, and not less than 3 mm for other plastic materials. The cistern shall be free from manufacturing faults and other defects affecting its utility. All working parts shall be designed so as to operate smoothly and efficiently. The cistern shall be mosquito-proof. It shall be deemed to be mosquito proof only when there is no clearance anywhere in it which would permit a 1.6 mm diameter wire to pass through. The outlet of each siphon or stand pipe or flush valve shall be securely connected to the cistern by means of a lock nut. In the case of plastic siphon, it shall be provided with suitable means of ensuring and maintaining watertight and airtight joint to the cistern.

The cistern shall be provided with a removable cover which shall fit closely and shall be secured against displacement. In designs, where the operating mechanism is attached to the cover, the cover may be made in two sections, the section supporting the mechanism being securely fixed or booked to the body.

The flush pipe (except plastic flush pipe) shall have an internal diameter of 32 $\pm$ 1 mm for high level cistern and 38 + 1 mm for low level cistern. The steel flush pipe shall be not less than 1 mm thick whereas the lead flush pipe shall have a minimum thickness of 3.5 mm. For high density polyethylene pipes, the outside diameter of the pipes shall be 40 mm. For unplasticised PVC plumbing pipes the outside diameter of the pipe shall be 40 mm for high level cisterns, and 50 mm for low level cisterns. In the case of high level flushing cisterns, a pipe clip fitted with a rubber buffer shall be fixed to the flush pipe to prevent damage either to the pipe or to the seat when the seat is raised. No flush pipe is required for coupled cisterns.

Note: The minimum thickness specified is for normal conditions of service. Where highly corrosive atmospheres are expected, greater thicknesses are required to be provided as per nomenclature of the item.

Flush Pipe Connection to Cistern

The flush pipe shall be securely connected to cistern outlet and made airtight by means of a coupling nut. The nuts made of injection-molded HDPE/Polyacetal may be used only if the end pipe is also made of plastic. The nominal internal diameter of the cistern outset shall be not less than 32 mm and 38 mm for high-level and low-level cisterns respectively.

The screw threads for connection to the flush pipe shall not be less than size 1½ of IS 2643 (Part 3). In the case of polyethylene and unplasticised PVC flush pipes, the upper end of the flush pipe shall be provided with suitable means of ensuring and maintaining a watertight and airtight joint to the flushing cistern. When ordered for use with a flush pipe, the outlet connection may be supplied with coupling nut made of copper based alloy or other non-corrodible material and a plain tail piece having a minimum length of 60 mm. The centre of the outlet hole shall be generally central to the length of the cistern. The length of the outlet shall be 37±2 mm in case of interchangeable siphon; however, where integral siphon is provided, the outlet length shall be 20±2 mm.

Note: The length of the cistern outlet shall be the dimension from the bottom surface of the cistern to the end of the outlet after the cistern with siphon/stand pipe has been duly fitted with all washers, lock-nuts, etc.

Inlet and Overflow Holes

The cistern shall be provided with inlet and overflow holes, situated one at each end, which shall be capable of accommodating overflow pipe of not less than 20 mm nominal bore and a 15 mm size float valve. The holes shall be cleanly moulded or drilled and the adjacent surfaces shall be smooth.

Float Valve

The float valve shall be 15 mm nominal size and shall conform to IS 1703 or IS 12234 or IS 13049.

Operating Mechanism Lever

The operating mechanism/lever shall not project beyond the side of the cistern for a distance greater than 350 mm measured from the centre of the cistern to the end of the lever arm. The lever arm shall be provided with a suitable hole near the end through which a split ring or S-hook can be inserted. A string (chain) shall be attached to the ring or hook. When S-hook is employed, it shall be effectively closed after assembly to prevent accidental disconnection.

In the case of low- level cisterns, where the mechanism is handle operated, the handle, whether situated on the front or at the end of the cistern, shall be within the projection limit. Particular attention shall be given to the case of operation of the handle.

String (Chain)

The string (chain) shall be of such strength as to sustain a dead load of 500 N without any apparent or permanent deformation.

The string (chain) shall terminate in a suitable handle or pull made of a moulding in any heat-resisting and non-absorbent plastic or any other equally suitable material. The finish shall be smooth and all burrs which are liable to cause injury to the hand when gripped shall be removed.

Overflow Pipe

The overflow pipe shall be of not less than 20 mm nominal bore and shall incorporate a non-corrodible mosquito-proof device secured in a manner which will permit it to be readily cleaned or renewed when necessary. No provision shall be made whereby the overflow from the cistern shall discharge directly into the water-closet or soil pipe without being detected.

The invert of the overflow pipe in the case of high-level and low level cisterns and the top edge of the overflow pipe in the case of coupled cistern shall be 19 mm (Min) above the working water level. In case of overflow due to any reason, water should drain out through the overflow pipe and not through the siphon pipe.

Finish

The surface of the cistern including cover shall be free from blisters and delamination, and reasonably free from flow lines, streaking or colour variations. The cistern and cover shall be opaque to light.

Operational and Performance Requirements

Flushing Arrangement

The cistern under working conditions and with the float valve in closed position shall operate on a single operation of the operating mechanism/lever without calling for a sudden jerk in pulling. If a valve is used instead of siphon for flushing purposes, the valve shall be completely leak proof.

Working Water Level

The working water-level shall be a minimum of 6.5 cm. below the effective top edge of the cistern and shall be legibly and permanently marked on the inside of the cistern. Effective top edge shall be taken on edge after top of the body without considering bead.

Freedom from Self Siphonage

The siphonic system shall be capable of being rapidly brought into action when the water is at the working water level, but shall not self siphon or leak into the flush pipe when the water is up to 1 cm above the invert of the overflow pipe.

Reduced Water Level

The discharge shall operate satisfactorily when the cistern is filled to a level up to 1 cm. below the working water level.

Discharge Capacity

When tested in accordance with IS 7231, cistern of 5 litres and 10 litres capacities, when required to give a full flush, shall respectively discharge 5 litres and 10 litres with variation of ± 0.5 litres. Dual-flush cistern of 10 litres capacity shall discharge alternatively a short flush of 5 ± 0.5 litres. Dual flush cistern of 6/3 litres capacity shall discharge 6 ± 0.5 litres and alternatively a half flush of 3 ± 0.5 litres.

Discharge Rate

When tested in accordance with IS 7231, the discharge rate shall be 10 ± 0.5 litres within 6 seconds and 5 ± 0.5 litres within 3 seconds for cistern of capacities 10 litres and 5 litres and 6 ± 0.5 litres within 6 second and 3 ± 0.5 litres within 3 second for cistern of 6/3 litres capacity respectively. The cistern shall be so designed that there is no appreciable variation in the force of the flush during the discharge of the required quantity of water. For coupled cisterns, this test shall not be applicable.

Special Requirements

Distortion Resistance Test

The cisterns, complete with its fittings, shall be installed and filled with water to the marked water line and observed for any distortion. The cistern shall not budge more than 6 mm and the cover shall not be dislodged.

Dead Load Test

When the flushing mechanism incorporates chain pull or hand operated lever, the cistern, complete with its fittings, when installed and filled with water to the marked water line and tested by the application of a dead load of 230 N applied 6 mm from the end of the operating lever arm for 30 seconds, shall not distort to such an extent that any part becomes detached. In the case of other operating mechanism, the dead load applied shall be a mass equivalent to the operating force required to overcome the normal hydrostatic head; Thirty seconds after the load is removed, the function and appearance of the cistern shall not be impaired.

Front Thrust Test

The front thrust test shall be applied only to cisterns intended for low level use. The cistern complete with its fittings, when installed and filled with water to the marked water line and tested by the method described in IS 7231, shall not distort to such an extent as to be inoperable or unsightly when the load is removed.

Impact Test

The cistern, complete with its fittings, when installed and filled as described in IS 7231 shall show no defect after one impact. Repeat the test but with the cistern empty. The cistern shall show no defect after the further impact.

17.1.2 Draining Board

Draining board made of Glazed fireclay conforming to C.P.W.D. Specifications and as per directions of Engineer-in-Charge, shall be provided. The size of the board shall be as specified. The entire surface including bottom of the board shall be finished smooth.

17.1.3 Foot Rests (Fig. 17.4)

Foot rests shall be of Vitreous China conforming to IS 2556 (Part- X). Foot rests which are rectangular shall meet the minimum requirements and dimensions shown in Fig. 17.4 and may be of different designs where so specified. Foot rests of different shapes and sizes shall also be allowed subject to approval of Engineer-in-Charge.

17.1.4 Glass Shelf/PVC Shelf

Glass shelf shall consist of an assembly of glass shelf, with anodised aluminium angle frame to support the glass shelf. The shelf shall be of glass of best quality with edges rounded off, and shall be free from flaws specks or bubbles. The size of the shelf shall be 60 x 12 cm unless otherwise specified and thickness not less than 5.5 mm. The shelf shall have C.P. brass brackets which shall be fixed with C.P. brass screws to rawl plugs firmly embedded in the walls.

PVC shelf as per manufacturer's specifications and size as specified shall be provided.

17.1.5 Mirror

The mirror shall be of superior glass with edges rounded off or beveled, as specified. It shall be free from flaws, specks or bubbles. The size of the mirror shall be 60 x 45 cm unless specified otherwise and its thickness shall not be less than 5.5 mm. It shall be uniformly silver plated at the back and shall be free from silvering defects. Silvering shall have a protective uniform covering of red lead paint. Where beveled edge mirrors of 5.5 mm thickness are not available, fancy looking mirrors with PVC beading/border or aluminium beading or stainless steel beading/border based on manufacture's specifications be provided nothing extra shall be paid on this account. Backing of mirrors shall be provided with environmentally friendly material other than asbestos cement sheet.

17.1.6 M.S. Stays and Clamps (Fig. 17.5)

The clamps shall be made from 1.5 mm thick M.S. flat of 32 mm width, bent to the required shape and size to fit tightly on the socket, when tightened with nuts & bolts. It shall be formed of two semicircular pieces with flanged ends on both sides with holes to fit in the screws, bolts and nuts 40 mm long. The stay shall be minimum one metre long of 10 mm dia M.S. bar. One end of the stay shall be bent for embedding in the wall in cement concrete block of size 20 x 10 x 10 cm in 1:2:4 mix (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size). The concrete shall be finished to match with the surrounding surface.

17.1.7 Pillar Taps

Pillar taps shall be chromium plated brass and shall conform to IS 1795. The nominal sizes of the pillar tap shall be 15 mm or 20 mm as specified. The nominal size shall be designated by the nominal bore of the pipe outlet to which the tap is to be fitted. Finished weights of 15 mm and 20 mm pillar taps shall be as prescribed in Table 17.2.

TABLE 17.2
Minimum Finished Weights of Pillar Taps

Particulars	*Weights in gms*	
	15 mm size	*20 mm size*
Body	255	505
Washer plate loose valve	15	28
Back nut	40	50
Tap	650	1175

Casting shall be sound and free from laps, blow hole and pitting. External and internal surfaces shall be clean, smooth and free from sand and be neatly dressed. The body, bonnet and other parts shall be machined true so that when assembled, the parts shall be axial, parallel and cylindrical with surfaces smoothly finished.

The area of waterway through the body shall not be less than the area of the circle of diameter equal to the bore of the seating of the tap. The seating of pillar tap shall be integral with the body and edges rounded to avoid cutting of washer. Pillar taps shall be nickel chromium plated and thickness of coating shall not be less than service grade No. 2 of IS 4827 and plating shall be capable of taking high polish which shall not easily tarnish or scale.

Every pillar tap, complete with its component parts shall withstand an internally applied hydraulic pressure of 20 Kg/sq. cm maintained for a period of 2 minutes during which period it shall neither leak nor sweat.

17.1.8 Sand Cast Iron or Centrifugally Cast (Spun) Iron Pipes and Fittings

Sand cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories shall conform to IS 1729. Centrifugally cast (Spun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories shall conform to IS 3989.

The fittings shall conform to the same I.S. specifications to which the pipe itself conforms in which they are connected.

The pipes shall have spigot and socket ends, with head on spigot end in case of sand cast iron pipes and without head on spigot end in case of cast iron (Spun) pipes. The pipes and fittings shall be true to shape, smooth and cylindrical, their inner and outer surface being as nearly as practicable concentric. They shall be sound and shall be free from cracks, taps, pinholes and other imperfections and shall be neatly dressed and carefully fettled. All pipes and fittings shall ring clearly when struck with a light hand hammer.

The ends of pipes and fittings shall be reasonably square to their axis. The sand cast iron pipes shall be 1.5/1.8/2.0 metre in length including socket ends, cast iron (Spun) pipes shall be 1.5/1.75/ 2.0/2.5/3.0 metre in length excluding socket ends, unless shorter lengths are either specified or required at junctions etc. The pipe and fittings shall be supplied without ears, unless specified or directed otherwise.

All pipes and fittings shall be coated internally and externally with the same material at the factory, the fitting being preheated prior to total immersion in a bath containing a uniformly heated composition having a tar or other suitable base. The coating material shall have good adherence and shall not scale off. In all instances where the coating material has tar or similar base it shall be smooth and tenacious and hard enough not to flow when exposed to a temperature of 77 degree centigrade but not so brittle at a temperature of 0 degree centigrade as to chip off when scribed lightly with a pen knife.

The standard weights and thicknesses of pipes and their tolerances shall be as prescribed in Appendix A.

The thickness of fittings and their socket and spigot dimensions shall conform to the thickness and dimensions specified for the corresponding sizes of straight pipes. The tolerance in weights & thicknesses shall be the same as for straight pipes.

The access door fittings shall be designed so as to avoid dead spaces in which filth may accumulate. Doors shall be provided with 3 mm rubber insertion packing and when closed and bolted, these shall be water tight.

Sand Cast Iron Floor Trap or Nahani Trap

Sand cast Iron Floor trap or Nahani trap shall be 'P' or 'S' type with minimum 50 mm seal. However, if the plumbing is in two pipe system and with a gully trap at the ground level the minimum water seal shall be 35 mm. The traps shall be of self cleansing design and shall have exit of same size as that of waste pipe. These shall conform to IS 1729.

17.1.8A HUBLESS CENTRIFUGALLY CAST (SPUN) IRON PIPES AND FITTINGS

Hubless Centrifugally Cast (Spun) Iron Pipes and Fittings soil, waste and ventilating pipes, fittings and accessories shall conform to IS 15905.

The hubless centrifugally cast (spun) iron pipes shall have plain both ends (spigot type), without sockets. The pipes and fittings shall be true to shape, smooth and cylindrical, their inner and outer surface being as nearly as practicable concentric. They shall be sound and shall be free from cracks, taps, pinholes and other imperfections and shall be neatly dressed and carefully fettled. All pipes and fittings shall emit a clear ringing sound when struck with a light hand hammer.

The ends of pipes and fittings shall be reasonably square to their axis. The hubless centrifugally cast iron pipes shall be 3.0 metre or more in length.

All pipes and fittings shall be coated internally and externally with the epoxy coating material at the factory, the fitting being preheated prior to total immersion in a bath containing a uniformly heated composition. The coating material shall have good adherence and shall not scale off.

The tolerance in diameter of pipes shall be as prescribed in Table-17.2A below :

Table-17.2A
External Diameters and Tolerances

Sl. No.	**Nominal size** *DN (in mm)*	**External Diameter** *DE (in mm)*	**Tolerance on External diameter DE** *(in mm)*
(1)	(2)	(3)	(4)
1	50	58	+2 -1
2	75	83	+2 -1
3	100	110	+2 -2
4	150	160	+2 -2
5	200	210	+2.5 -2.5

The thickness of fittings and spigot dimensions shall conform to the thickness and dimensions specified for the corresponding sizes of straight pipes. The nominal & minimum thicknesses of pipes & fittings shall be as per Table-2 below:

Table-2
Nominal & Minimum Thickness of Pipes & Fittings

Sl. No.	Nominal size (DN)	Thickness 'e' mm			
		Pipe		Fittings	
		Nominal	Minimum	Nominal	Minimum
(1)	(2)	(3)	(4)	(5)	(6)
i)	50	3.5	3.0	4.2	3.0
ii)	75	3.5	3.0	4.2	3.0
iii)	100	3.5	3.0	4.2	3.0
iv)	150	4.0	3.5	5.3	3.5
v)	200	5.0	4.0	6.0	4.0

The access door fittings shall have no dead spaces in which filth may accumulate. Doors shall be provided with 3 mm rubber insertion packing and when closed and bolted, these shall be water tight.

Joints:

The pipes and fittings may assembled using various types of joints, The joints are intrinsic components of the drainage, whose characteristics and tolerances shall be specified in the manufactures catalogues.

Taking into account the different applications of cast iron pipe work systems, various joint designs are permitted provided that they satisfy the requirement to this standard. The joints shall incorporate one or more EPDM rubber gasket(s) to ensure leak tightness and prevent direct contact between the ends of pipes, fittings and accessories.

Materials for coupling of clamping components shall usually be made from:

(a) Ductile iron of grade 500/7 as per IS 1865,
or

(b) Stainless steels in accordance with IS 1570 (Part 5) in order to ensure resistance to corrosion and a stabilization against the austenitic stainless steel with at least 17 percent chrome and 9 percent nickel of equivalent, or from material of comparable resistance.

(c) Ductile iron couplings of clamping components shall be coated internally and externally.

(d) All parts of the joints shall free from defects likely to compromise their suitability for use.

17.1.9 Plastic Seat and Covers for Water Closet (Fig. 17.6)

The seat and cover shall be of thermosetting or thermoplastic conforming to IS 2548 (Part-1) or of thermoplastic confirming to IS 2548 (Part-2) as specified. Unless otherwise specified these shall be of closed pattern.

17.1.9.1 Thermosetting plastic used shall conform to grade 2 or 3 of IS 1300 when it is phenolic plastic or IS 3389 when of urea formaldehyde.

Thermo plastic materials used may be of Polystyrene conforming to type 2 or 3 of IS 2267 or of polypropylene, Appendix A of IS 2548. In public buildings where rough and heavy use of seats and covers are common, plastic seats shall be moulded out of thermosetting materials, phenolic or urea formaldehyde only and the underside of the seat shall be flat with solid moulding.

17.1.9.2 The hinging device shall be bronze or brass with nickel chromium plating confirming to IS 1068 and the seat shall have not less than three rubber or plastic buffers of size 25 mm x 40 mm x 10 mm for closed front seats and not less than four for open front seats, which shall be securely fixed to the underside of the seat unless otherwise specified. The cover shall be fitted with the same number of buffers as provided for the seat.

17.1.9.3 Seats shall have a smooth finish and shall be non absorptive and free from cracks and crevices. They shall be capable of being easily cleaned and shall not be adversely affected by common solvents or household cleanser.

17.1.9.4 ***Strength:*** The seats shall withstand without permanent distortion of the seat or hinge fittings or damage to any finish, a load of 1150 N for 30 minutes applied in the manner prescribed in IS 2548.

17.1.10 Sinks (Fig. 17.7)

Laboratory sinks and Kitchen sinks shall be of white glazed fire clay confirming to IS 771 (Part-2) with up to date amendments. The kitchen sink shall be of one piece construction with or without rim but without overflow.

17.1.10.1 Stainless steel kitchen sink shall be of sizes as specified and shall be conforming to IS 13983 (Fig. 17.7).

17.1.11 Towel Rail

The towel rail shall be of PTMT as specified and as per direction of Engineer-in-charge.

17.1.12 Toilet Paper Holder

The toilet paper holder shall be of CP brass or vitreous china as specified and of size and design as approved by the Engineer-in-Charge. It shall be fixed in position by means of C.P. brass screws and rawl plugs embedded in the wall.

17.1.13 Urinals

17.1.13.1 ***Bowl Type Urinals (Fig. 17.9 & 17.10) :*** Urinal basins shall be of flat back or corner wall type lipped in front. These shall be of white vitreous china conforming to IS 2556-(Part 6). The urinals shall of one piece construction. Each urinal shall be provided with not less than two fixing holes of minimum dia 6.5 mm on each side. Each urinal shall have an integral flushing rim of suitable type and inlet or supply horn for connecting the flush pipe. The flushing rim and inlet shall be of the self draining type. It shall have a weep hole at the flushing inlet of the urinals.

At the bottom of the urinal an outlet horn for connecting to an outlet pipe shall be provided. The exterior of the outlet horn shall not be glazed and the surface shall be provided with grooves at right angles to the axis of the outlet to facilitate fixing to the outlet pipe. The inside surface of the urinal shall be uniform and smooth throughout to ensure efficient flushing. The bottom of pan shall have sufficient slope from the front towards the outlet such that there is efficient draining.

17.1.13.2 ***Half Stall Urinals (Fig. 17.11) :*** They shall be of white vitreous China conforming to IS 2556 (Part 6). They shall be of one piece construction with or without an integral flushing box rim and provided with slots or alternative fixing arrangement at the flat back end. They shall be provided with ridges where integral flushing rim is not provided in the sides of the interior of the bowl, to divert the water towards the front line of the urinal where integral flushing box rim is specified, water spreaders provided shall conform to IS 2556 Part-6 (Fig. 17.13) . These shall be vitreous China of one piece construction with integral flush inlet. The tolerance of ± 4 per cent may be allowed on the dimensions specified.

17.1.13.3 ***Urinal Partition Slabs :*** Urinal Partition slabs shall be provided, as specified in the item of work.

17.1.13.4 ***Squatting Plate Urinal (Fig. 17.12) :*** The plates shall be of white vitreous china conforming to IS 2556 (Part-1) and IS 2556 (Part-6) with internal flushing rim with front or side inlet. Squatting Plate shall be of one piece construction. Each urinal shall have integral longitudinal flushing pipe of suitable type which may be connected to flush pipe. These shall be 100 mm dia white glazed vitreous china channel with stop and outlet piece in front.

17.1.14 Wash Basins (Fig. 17.14, 17.15, 17.16, 17.17 & 17.18)

Wash basins shall be of white vitreous china conforming to IS 2556 (Part -I) and IS 2556 (Part-4). Wash basins either of flat back or angle back as specified shall be of one piece construction, including a combined overflow. All internal angles shall be designed so as to facilitate cleaning. Each basin shall have a rim on all sides, except sides in contact with the walls and shall have a skirting at the back. Basins shall be provided with single or double tap holes as specified. The tap holes shall be 28 mm square or 30 mm round or 25 mm round for pop up hole. A suitable tap hole button shall be supplied if one tap hole is not required in installation. Each basin shall have circular waste hole to which the interior of basin shall drain. The waste hole shall be either rebated or beveled internally with dia meter of 65 mm at top. Each basin shall be provided with a non-ferrous 32 mm waste fitting. Stud slots to receive the brackets on the underside of the wash basin shall be suitable for a bracket with stud not exceeding 13 mm diameter, 5 mm high and 305 mm from the back of basin to the centre of the stud. The stud slots shall be of depth sufficient to take 5 mm stud. Every basin shall have an integral soap holder recess or recesses, which shall fully drain into the bowl. A slot type of overflow having an area of not less than 5 sq. cm, shall be provided and shall be so designed as to facilitate cleaning of the overflow.

Where oval shape or round shape wash basins are required to be fixed these shall be fixed preferably in RCC platform with local available stone topping either fully sunk in stone top or top flush with the stone topping as directed by Engineer-in-Charge.

The wash basins shall be one of the following patterns and sizes as specified (Fig. 17.14).

(a) Flat back: 660 x 460 mm (Surgeon's Basin)
630 × 450 mm
550 × 400 mm

450 × 300 mm

(b) Angle back: 600 × 480 mm 400 × 400 mm

White glazed pedestals for wash basins, where specified shall be provided. The quality of the glazing of the pedestal shall be exactly the same as that of the basin along with which it is to be installed. It shall be completely recessed at the back to accommodate supply and waste pipes and fittings. It shall be capable of supporting the basin rigidly and adequately and shall be so designed as to make the height from the floor to top of the rim of basin 75 to 80 cm as shown in Fig. 17.14, 17.15, 17.16, 17.17 & 17.18. All the waste fittings shall be brass chromium plated, or as specified.

17.1.15 Waste Fittings for Wash Basins and Sinks (Fig. 17.8)

The waste fittings shall be of nickel chromium plated brass, with thickness of plating not less than service grade 2 of IS 4827 which is capable of receiving polish and will not easily scale off. The fitting shall conform in all respect to IS 2963 and shall be sound, free from laps, blow holes and fittings and other manufacturing defects. External and internal surfaces shall be clean and smooth. They shall be neatly dressed and be truly machined so that the nut smoothly moves on the body.

Waste fitting for wash basins shall be of nominal size of 32 mm. Waste fittings for sinks shall be of nominal size 50 mm.

17.1.16 Water Closet (Fig. 17.19, 17.20, 17.21, 17.22 & 17.23)

17.1.16.1 ***Squatting Pans (Indian Type W.C.) (Fig. 17.19, 17.20 & 17.21*****) :** Squatting pans shall be of white vitreous china conforming to IS 2556 Part-I for General Requirements and relevant IS codes for each pattern as described below:

(i) Long pattern-conforming to IS 2556 (Part-3).

(ii) Orissa pattern-conforming to IS 2556 (Part-3).

(iii) Integrated type conforming to IS 2556 (Part-14).

Preferably Orissa type pan should be used.

Each pan shall have an integral flushing rim of suitable type. It shall also have an inlet or supply horn for connecting the flush pipes, as shown in Fig. 17.19, 17.20 & 17.21. The flushing rim and inlet shall be of the self draining type. It shall have weep hole at the flushing inlet to the pan. The flushing inlet shall be in the front, unless otherwise specified or ordered by the Engineer-in- Charge. The inside of the bottom of the pan shall have sufficient slope from the front towards the outlet and the surface shall be uniform and smooth to enable easy and quick disposal while flushing. The exterior surface of the outlet below the flange shall be an unglazed surface which shall have grooves at right angles to the axis of the outlet. In all cases a pan shall be provided with a (100 mm) S.C.I. trap 'P' or 'S' type with approximately 50 mm water seal and 50 mm dia vent horn, where required by the Engineer-in-Charge.

17.1.16.2 ***Wash Down Type (European Type W.C.) (Fig. 17.22 & 17.23) :*** Water closets shall be of white vitreous china conforming to IS 2556 (Part-1) and 2556 (Part-2), as specified and shall be of "Wash down type". The closets shall be either of the two patterns (Pattern I & Pattern II) and sizes as shown in Fig. 17.22 & 17.23 as specified. The closets shall be of one piece construction. Each water closet shall have not less than two holes having a minimum diameter of 6.5 mm for fixing to floor and shall have an integral flushing rim of suitable type. It shall also have an inlet or supply horn for connecting the flushing pipe of dimensions as shown in table in Fig. 17.20 & 17.21 the flushing rim may be boxed or open type. In the case of box rims adequate number of holes, on each side together with a slot opposite the inlet shall be provided. The flushing rim and inlet shall be of the self draining type. The water closet shall have a weep hole at the flushing inlet. Each water closet shall have an integral trap with either 'S' or 'P' outlet with at least 50 mm water seal. For P trap, the slope of the outlet shall be 14 deg. below the horizontal. Where required the water closet shall have an antisiphonage 50 mm dia vent horn on the outlet side of the trap with dimension conforming to those given in Fig. 17.22 and on either right or left hand or centre as specified set at an angle of 45 deg. and invert of vent hole not below the central line of the outlet. The inside surface of water closets and traps shall be uniform and smooth in order to enable an efficient flush. The serrated part of the outlet shall not be glazed externally. The water closet, when sealed at the bottom of the trap in line with the back plate, shall be capable of holding not less than 15 litres of water between the normal water level and the highest possible water level of the water closet as installed.

17.2 GENERAL REQUIREMENTS FOR INSTALLATION OF W.C. PAN

17.2.1 The work shall be carried cut, complying in all respects with the requirements of relevant bye-laws of the local body in whose jurisdiction the work is situated.

17.2.2 Any damage caused to the building, or to electric, sanitary, water supply or other, installations etc. therein, either due to negligence on the part of the contractor, or due to actual requirements of the work, shall be made good and the building or the installation shall be restored to its original condition by the contractor. Nothing extra shall be paid for such restoration works except where otherwise specified.

17.2.3 For making good the damage to the under mentioned items of work, the specifications as given in the following paras shall apply, unless directed otherwise.

(a) Masonry Work: The masonry work shall be made good by using the same class of bricks, tiles or stones as was damaged during the execution of the work. The mortar used shall be cement mortar 1:5 (1 cement: 5 fine sand) or as directed by the Engineer-in-Charge.

(b) Plain Concrete Work : Concrete work for sub-grade of the flooring, foundations and other plain concrete works shall be cement concrete 1:5:10 (1 cement : 5 coarse sand : 10 graded stone aggregate 40 mm nominal size). A coat of neat cement slurry shall be applied at the junction with old work, before laying fresh concrete.

(c) Cement Concrete Flooring and R.C.C. Work : Cement concrete 1:2:4 (1 Cement : 2 Coarse sand : 4 graded stone aggregate 20 mm nominal size) shall be used after applying a coat of neat cement slurry at the junction with old work, and the surface finished to match with the surrounding surface.

(d) Plastering: Cement plaster 1:4 (1 cement: 4 sand) shall be used. The sand shall be fine or coarse, as used in the original work. The surface shall be finished with two or more coats of white wash, colour wash, distemper or painting as required, but where the surface is not to be white washed, colour washed, distempered or painted, it shall be finished as required to match with the surrounding surface.

(e) Other Items: Damage to any other item shall be made good as directed by the Engineer-in-Charge.

Note: In all the above operations the damaged portion shall be cut in regular geometric shape and cleaned before making good the same.

17.2.4 All exposed G.I., C.I. or lead pipes and fittings shall be painted with approved quality of paint and shade as specified. The painting work shall conform to specification described under SH: Painting.

17.2.5 All sanitary and plumbing work shall be carried out through licensed plumbers.

17. 2.6 On completion of the work the site shall be cleaned and all rubbish disposed off as directed by the Engineer-in-Charge.

17.2.7 Various sanitary fittings described under 17.1 including fixing shall be enumerated individually or in combination under relevant items of works as described below. When used in combination, specifications as described under relevant paras shall apply but nothing extra shall be paid for making connections required for successful functioning of the combination.

17.3 INSTALLATION OF DRAINING BOARD

17.3.1 Fixing

One end of the board shall rest on sink and the other end shall be supported on C.I. bracket embedded in cement concrete (1:2:4) block 100 × 75 × 150 mm. The brackets used shall be of cantilever type or wall fixed type as for the sink.

17.3.2 Painting

The brackets shall be painted with two or more coats of approved paint.

17.3.3 Measurements

Draining board shall be measured in numbers.

17.3.4 Rate

The rate shall include the cost of all materials and labour involved in all operations.

17.4 INSTALLATIONS OF FLUSHING CISTERN

17.4.1 Fixing

17.4.1.1 ***Low Level Cistern:*** The cistern shall be fixed on C.I. cantilever brackets which shall be firmly embedded in the wall in cement concrete (1:2:4) block 100 x 75 x 150 mm. Connection between cistern and closet shall be made by means of 40 mm dia flush bend with rubber or G.I. inlet connection as specified.

17.4.1.2 ***Automatic Cistern:*** Clause 17.4.1.1 shall apply except that CP Brass stop cock shall be provided for cistern having a capacity of more than 5 liter. The main & distribution flush pipe shall be fixed to the wall by means of standard pattern holder bat clamp shown in Fig. 17.5.

17.4.2 Painting

The brackets shall be painted, if specified, with two or more coats of paint of approved shade and quality.

17.4.3 Measurements

Cistern, including all fittings, shall be measured in numbers.

17.4.4 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above.

17.5 INSTALLATION OF MIRROR

17.5.1 Fixing

The mirror shall be mounted on backing with environmentally friendly material other than asbestos cement sheet shall be fixed in position by means of 4 C.P. brass screws and C.P. brass washers, over rubber washers and wooden plugs firmly embedded in walls. C.P. brass clamps with C.P. brass screws may be an alternative method of fixing, where so directed. Unless specified otherwise the longer side shall be fixed horizontally.

17.5.2 Measurements

Mirror shall be measured in numbers.

17.5.3 Rate

Rate shall include the cost of all the materials and labour involved in all the operations described above.

17.6 FIXING AND JOINTING OF PIPES AND FITTINGS

17.6.0 The specifications described in sub-head 12.0 shall apply, as far as applicable, except that the joint shall be lead caulked. All soil pipes shall be carried up above the roof and shall have sand cast iron terminal guard.

17.6.1 Height of Ventilating Pipes

The ventilating pipe or shaft shall be carried to a height of at least 60 cms above the outer covering of the roof of the building or in the case of a window in a gable wall or a dormer window it shall be carried up to the ridge of the roof or at least 2 metres above the top of the window. In the case of a flat roof to which access for use is provided it shall be carried up to a height of 2 metres above the roof and shall not terminate within 2 metres, measured vertically from the top of any window opening which may exist up to a horizontal distance of 3 meters from the vent pipe into such building and in no case shall be carried to a height less than 3 metres above plinth level. In case the adjoining building is taller, the ventilating pipe shall be carried higher than the roof of the adjoining building, wherever it is possible.

The pipes above the parapet shall be secured to the wall by means of M.S. stay and clamps as specified in 17.1.6.

The connections between the main pipe and branch pipes shall be made by using branches and bends with access doors for cleaning. The waste from lavatories, kitchen, basins, sinks, baths and other floor traps shall be separately connected to respective waste stack of upper floors. The waste stack of lavatories shall be connected directly to manhole while the waste stack of others shall separately discharge over gully trap. Where single stack system is provided, the connection shall be made direct to the manhole.

17.6.2 Jointing

The interior of the socket and exterior of the spigots shall be thoroughly cleaned and dried. The spigot end shall be inserted into the socket right up to the back of the socket and carefully centered by two or three laps of treated spun yarn, twisted into ropes of uniform thickness, well caulked into the back of the socket. No piece of yarn shall be shorter than the circumference of the pipe. The jointed pipe line shall be at required levels and alignment.

The leading of pipes shall be made by means of ropes covered with clay or by using special leading rings. The lead shall be melted so as to be thoroughly fluid and each joint shall be filled in one pouring.

The following precautions shall be taken for melting lead:

(a) The pot and the ladle in which lead shall be put shall be clean and dry.

(b) Sufficient quantity of lead shall be melted.

(c) Any scum or dross which may appear on the surface of the lead during melting shall be skimmed off.

(d) Lead shall not be overheated.

After the lead has been run into the joint the lead shall be thoroughly caulked. Caulking of joints shall be done after a convenient length of the pipes has been laid and leaded.

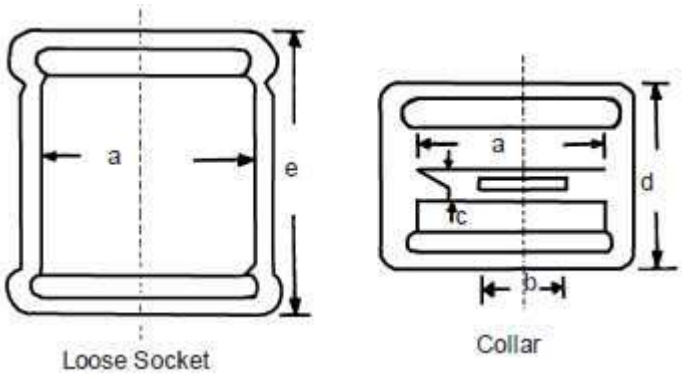
The leading ring shall first be removed and any lead outside the socket shall be removed with a flat chisel and then the joint caulked round three times with caulking tools of increasing thickness and hammer 2 to 3 kg. weight. The joints shall not be covered till the pipe line has been tested under pressure.

Use of collars for jointing is not permitted in any concealed or embedded location. However, in exposed locations where full length pipes cannot be fixed due to site constraints, collars (and not loose sockets) may be used subject to the following:

(a) No two consecutive joint shall be with the use of collars.

(b) The joint of collar with the cut/spigot end of the pipe shall be made on the ground in advance and tested against leakage before fixing.

(c) Cut/spigot end of the pipes shall be inserted in the collars up to the projection inside the collar and jointing shall be done as in the case of socket and spigot joint. The jointed pipe line shall be at required level/slope and alignment.



As marked in fig	*Pipe dia (size in mm)*			
	50	75	100	150
a	76	101	129	181
b	50	75	100	150
c	10	10	10	10
d	79	89	95	108
e	89	101	114	140

Note: The dimensions of loose sockets shall correspond to those of appropriate nominal size of pipe.

17.6.3 Testing

In order to ensure that adequate lead is poured properly into the joints and to control waste in use of lead, at the beginning of work three or four sample joints shall be made and the quantum of lead per joint approved by the Engineer-in-Charge. All sand cast iron/cast iron (Spun) pipes and fittings including joint shall be tested by smoke test to the satisfaction of the Engineer-in-Charge and left in working order after completion. The smoke test shall be carried out as under:

Smoke shall be pumped into the pipes at the lowest end from a smoke machine which consists of a bellow and burner. The material usually burnt is greasy cotton waste which gives out a clear pungent smoke which is easily detectable by sight as well as by smell, if there is leak at any point of the drain.

17.6.4 Painting

All sand cast iron/cast iron (Spun) pipes and fittings shall be painted with shade to match the colour of the background as directed by the Engineer-in-Charge.

17.6.5 Measurements

17.6.5.1 The pipes shall be measured net when fixed in position excluding all fittings along its length, correct to a cm.

17.6.5.2 When collars are used for jointing SCI pipes these shall be measured as fittings and shall be paid for separately.

17.6.5.3 No allowance shall be made for the portions of the pipe lengths entering the sockets of the adjacent pipes or fittings. The above shall apply to both cases i.e. whether the pipes are fixed on wall face or embedded in masonry.

17.6.5.4 No deduction shall be made in the former case from the masonry measurement for the volume of concrete blocks embedded therein. Similarly no deduction shall be made for the volume occupied by the pipes from the masonry when the former are embedded in the later.

17.6.6 Rates

The rate shall include the cost of all labour and materials involved in all the operations described above, excluding fittings, lead caulk jointing, the supply and fixing M.S. holder bat clamps and M.S. stays and clamps, floor trap and painting, which shall be paid for separately.

17.7 INSTALLATION OF SEAT AND COVER TO WATER CLOSET

17.7.1 Fixing

The seat shall be fixed to the pan by means of two corrosion resistant hinge bolts with a minimum length of shank of 65 mm and threaded to within 25 mm of the flange supplied by the manufacturer along with the seat. Each bolt shall be provided with two suitably shaped washers of rubber or other similar materials for adjusting the level of the seat while fixing it to the pans. In addition, one non-ferrous or stainless steel washer shall be provided with each bolt. The maximum external diameter of the washer fixed on the underside of the pan shall not be greater than 25 mm. Alternative hinging devices as supplied by the manufacturer of the seat can also be used for fixing with the approval of Engineer-in-Charge.

17.7.2 Measurements

Seat with cover shall be measured in numbers.

17.7.3 Rate

Rate shall include the cost of all the materials and labour involved in all the operations described above.

17.8 INSTALLATION OF SINK

17.8.0 The installation shall consist of assembly of sink C.I. brackets, union and G.I. or P.V.C. waste pipe.

17.8.1 Fixing

The sink shall be supported on C.I. cantilever brackets, embedded in cement concrete (1:2:4) block of size 100 x 75 x 150 mm. Brackets shall be fixed in position before the dado work is done. The C.P. brass or P.V.C. union shall be connected to 40 mm nominal bore G.I. or PVC waste pipe which shall be suitably bent towards the wall and shall discharge into a floor trap. C.P. brass trap and union and waste shall be paid separately. The height of front edge of sink from the floor level shall be 80 cm.

17.8.2 Measurements

The sinks shall be measured in numbers.

17.8.3 Rate

Rate shall include the cost of all materials and labour involved in all the operations described above but shall not included the cost of waste fitting and brackets which shall be paid for separately.

17.9 INSTALLATION OF URINAL LIPPED, HALF STALL (SINGLE OR RANGE) (FIG. 17.9 & 17.11)

17.9.0 Urinal installation shall consist of a lipped urinal (Single or range), an automatic flushing cistern, G.I. flush and waste pipe. The capacity of flushing cistern and relevant size of flush pipe for urinals in a range shall be as prescribed in Table 17.3.

Waste pipe shall be of 32 mm nominal bore G.I. pipe and shall be paid separately.

17.9.1 Fixing

Urinals shall be fixed in position by using wooden plugs and screws. It shall be at a height of 65 cm from the standing level to the top of the lip of the urinal, unless otherwise directed by the Engineer -in-Charge. The size of wooden plugs shall be 50 mm × 50 mm at base tapering to 38 mm × 38 mm at top and of length 5.0 cms. These shall be fixed in the wall in cement mortar 1:3 (1 cement: 3 fine sand). After the plug fixed in the wall, the mortar shall be cured till it is set.

TABLE 17.3

No. of Urinals	Capacity of Flushing Cistern	Size of Flush Pipe (Galvanised Iron)	
		Main	Distribution
One	5 Litres	15 mm	15 mm
Two	10 Litres	20 mm	15 mm
Three	10 Litres	25 mm	15 mm
Four	15 Litres	25 mm	15 mm

Each urinal shall be connected to 32 mm dia waste pipe which shall discharge into the channel or a floor trap. The connection between the urinal and flush or waste pipe shall be made by means of putty or white lead mixed with chopped hemp.

17.9.2 Measurements

Urinals shall be measured in numbers.

17.9.3 Rate

Rate shall include the cost of all the materials and labour involved in all the operations described above.

17.10 INSTALLATION OF STALL URINAL (SINGLE OR RANGE)

17.10.0 The installation shall consist of stall urinal (single or range), automatic flushing cistern, C.P. brass standard flush pipes, C.P. brass spreader and C.I. trap with tail piece and outlet grating of C.P. brass. Capacity of flushing cistern and relevant size of flush pipe, C.I. trap shall be as prescribed in Table 17.4.

TABLE 17.4

No. of Urinals in range	*Capacity of Flushing cistern*	*Size of Flush Pipe (Chromium Plated)*		*Diameter of C.I. Traps*
		Main	*Distribution*	
One	05 Litres	15 mm	15 mm	50 mm
Two	10 Liters	20 mm	15 mm	50 mm
Three	15 Litres	25 mm	15 mm	80 mm
Four	15 Litres	25 mm	15 mm	80 mm

17.10.1 Fixing

The floor slab shall be suitably sunk to receive the stall urinal. Where the floor slab is not sunk, the stall urinal shall be provided over a platform. The lip of the stall urinal shall be flush with the finished floor level adjacent to it. The stall urinal shall be laid over a fine sand cushion of average 25 mm thickness. A space of not less than 3 mm shall be provided all -round, in front, sides and filled with water proofing plastic compound. Care shall be taken that after the sub-grade for the floor is cast, one week should lapse before urinals are installed. The trap and fittings shall be fixed as directed by the Engineer-in-Charge. Payment for the floor and its sub-grade shall be made separately.

17.10.2 Measurements

Stall urinals shall be measured in numbers.

17.10.3 Rate

The rate shall include the cost of all the materials and labour involved in all the operations described above.

17.11 INSTALLATION OF WASH BASIN (FIG. 17.14, 17.15, 17.16, 17.17 & 17.18)

17.11.0 The installation shall consist of an assembly of wash basin, pillar taps, C.I. brackets, C.P. brass or P.V.C. union, as specified. The wash basin shall be provided with one or two 15 mm C.P. brass pillar taps, as specified. The height of top of the rim of wash basin from the floor level shall be within 750 mm to 800 mm.

17.11.1 Fixing

The basin shall be supported on a pair of C.I. cantilever brackets conforming to IS 775 and be embedded in cement concrete (1:2:4) block 100 x 75 x 150 mm. Use of M.S. angle or Tee section as bracket is not permitted. Brackets shall be fixed in position before dado work is done. The brackets have been shown in Fig. 17.15. The wall plaster on the rear shall be cut to rest over the top edge of the basin so as not to leave any gap for water to seep through between wall plaster & skirting of basin. After fixing the basin, plaster shall be made good and surface finished matching with the existing one. S.C.I. floor traps conforming to IS 1729 having 50 mm water seal (minimum 35 mm in two pipe systems with gully trap) should be used. Waste pipes laid horizontally should have gradient not flatter than 1 in 50 and not steeper than 1 in 10.

The waste water from wash basin shall be discharged directly to vitreous semi-circular open drain, discharging to a floor trap and finally to the vertical stack (Fig.17.15) on upper floors and in case of ground floor, the waste water shall be discharged either directly to the gully trap or through the floor trap (Fig. 17.16). C.P. brass trap and union are not to be used in such situations.

If waste pipe is concealed or crosses the wall, waste water shall be discharged through non ferrous trap like PVC Engineering plastic or C.P. brass and union (Fig. 17.17) to vertical stack. The C.P. brass trap and union shall be paid for separately.

Where so specified a 20 mm G.I. puff pipe terminating with a perforated brass cap screwed on it on the outside of the wall or connected to the antisyphon stack shall be provided.

17.11.2 Measurements

Wash basins shall be measured in numbers.

17.11.3 Rate

The rate shall include the cost of all the materials and labour involved in all the operations described above.

17.12 INSTALLATION OF SQUATTING PAN

17.12.0 The installation shall consist of squatting pan, flushing cistern, flush pipe and a pair of foot rests.

17.12.1 Fixing

The pan shall be sunk into the floor and embedded in a cushion of average 15 cm thick cement concrete 1:5:10 (1 Cement : 5 fine sand : 10 graded brick ballast 40 mm nominal size). The concrete shall be left 115 mm below the top level of the pan so as to allow flooring and its bed concrete. The pan shall be provided with a 100 mm S.C.I., P or S type trap with an approximately 50 mm seal and 50 mm dia vent horn, where required by the Engineer-in-Charge. The joint between the pan and the trap shall be made leak proof with cement mortar 1:1 (1 cement : 1 fine sand).

17.12.2 Measurements

The squatting pans shall be measured in numbers.

17.12.3 Rate

Rate shall include the cost of all the materials and labour involved in all the operations described above. Cost of concrete shall be paid separately.

17.13 INSTALLATION OF WATER CLOSET

17.13.0 Installation shall consist of water closet with seat and cover, flushing cistern and flush bend.

17.13.1 Fixing

The closet shall be fixed to the floor by means of 75 mm long 6.5 mm diameter counter-sunk bolts and nuts embedded in floor concrete.

17.13.2 Measurements

Water closets shall be measured in numbers.

17.13.3 Rate

Rate shall include the cost of all the materials and labour involved in all the operations described above.

17.14 INSTALLATION OF FOOT RESTS

17.14.1 After laying the floor around squatting pan as specified a pair of foot rests shall be fixed in cement mortar 1 : 3 (1 cement : 3 coarse sand). The position of foot rests with respect to pan shall be as per Fig. 17.4.

17.14.2 Measurements

Pair of foot rests shall be measured in numbers.

17.14.3 Rate

Rate shall include the cost of all the materials and labour involved in all the operations described above.

17.15 INSTALLATION OF SQUATTING PLATE (SINGLE OR RANGE) (FIG. 17.12)

17.15.0 The installation shall consist of an assembly of squatting plates (single or range), vitreous China channel, automatic flushing cistern, flush pipe with fittings spreader and C.I. trap. The capacity of flushing cistern and relevant size of flush pipes shall be as specified in Table 17.5.

TABLE 17.5

No. of Squatting Plates in range	Capacity of Flushing Cistern	Size of Flush Pipe (Galvanised Iron)	
		Main	*Distribution*
One	5 liters	—	20 mm
Two	10 liters	25 mm	20 mm
Three	15 liters	32 mm	20 mm
Four	15 liters	32 mm	20 mm

17.15.1 Fixing

The floor slab shall be suitably sunk to receive the squatting plate. Where the floor slab is not sunk, the plates shall be provided over a platform. The top edge of the squatting plate shall be flush with the finished floor level adjacent to it. It shall be embedded on a layer of 25 mm thick cement mortar 1:8 (1 cement: 8 fine sand) laid over a bed of cement concrete 1:5:10 (1 cement: 5 fine sand: 10 graded brick aggregate 20 mm nominal size).

There shall be 100 mm dia, white glazed vitreous China channels with stop and outlet pieces suitably fixed in the floor in cement mortar 1:3 (1 cement :3 coarse sand) and joint finished with white cement. The squatting plate shall have 1200 high and half brick thick wall in front and on either side of the squatting plate. The brick work for the walls shall be paid separately. The exposed surface of walls shall be lined with white glazed tiles with proper corners and angles set in neat cement mortar, the face of the joints shall be gone over with whiting so as to match with the colour of the tiles. The tiles shall be 15 mm square. Space if any, left between the side walls and squatting plate shall be finished white to match the colour of the squatting plate. The trap and fittings shall be fixed as directed by the Engineer-in-Charge. The vitreous China channel shall discharge into 65 mm diameter standard urinals, C.I. trap with vent arm having 65 mm C.P. brass outlet grating.

17.15.2 Measurements

Squatting plates shall be measured in numbers.

17.15.3 Rate

The rate shall include the cost of all the materials and labour involved in all the operations described above.

17.16 INSTALLATION OF TOWEL RAIL

It shall be fixed in position by means of C.P. brass screws on wall surface by PVC dash fasteners, firmly embedded in wall.

17.16.1 Measurements

Tower rails shall be measured in numbers.

17.16.2 Rate

Rate shall include the cost of all the materials and labour involved in all the operations described above.

17.17 INSTALLATION OF STAINLESS STEEL SINK:- Stainless steel A ISI 304 (18/8) kitchen sink.

The installation shall consist of assembly of sink C.I. brackets, union and G.I. or P.V.C. waste pipe.

17.17.1 Fixing

The stainless steel sink shall be fixing as per IS:13983 and shall be supported on C.I. cantilever brackets, embedded in cement concrete (1:2:4) block of size 100 x 75 x 150 mm. Brackets shall be fixed in position before the dado work is done. The C.P. brass or P.V.C. union shall be connected to 40 mm nominal bore G.I. or PVC waste pipe which shall be suitably bent towards the wall and shall discharge into a floor trap. C.P. brass trap and union and waste shall be paid separately. The height of front edge of sink from the floor level shall be 80 cm.

17.17.2 DIMENSIONS AND TOLERANCES

17.17.2.1 Thickness of Sheet/Strip

17.17.2.2 Nominal thickness of stainless steel sheet/ strip used in the construction of sink shall be not less than 1.00 mm before forming.

17.17.2.3 Thickness at any point of sink, after forming, shall not be less than 0.75 mm.

17.17.3 Depth of Bowls

The depth of the sink bowl shall be 150 mm minimum, when measured from the top edge of the bowl to the base of the sink.

NOTE - Depth of smaller bowl shown in Fig. 1 for Type E2 and E3 may be reduced up to 100 mm.

17.17.4 Internal Dimensions of Bowls

The minimum internal dimensions, when measured on the bowl centre lines across the top of the bowl. shall be 380 mm x 340 mm for rectangular bowls and 360 mm for round bowls.

NOTES I. There is no restriction on bowl shape provided the minimum dimensions given in this clause are complied with.

1. Internal width of smaller bowl shown in FIg. 1 for Type E2 and E3 may be reduced as per the manufacturers design.

17.17.5 Bowl Locating Limits

17.17.5.1 The distance between the edge of the sink bowl and the end of the sink shall be 15 mm minimum for sit-on type sinks and 30 mm minimum for inset type sinks. Depth of the collar provided for inset sinks shall be 10 ± 2 mm,

17.17.5.2 For sinks designed for use with a 600 mm wide work top, the distance between the edge of the sink bowl and the front of the sink shall be 50 mm minimum and in the case of sinks designed for use with 500 mm wide worktop, the distance shall be 45 mm minimum.

17.17.5.3 Both single and double bowl sink shall be set a minimum of 10 mm from gridline.

17.17.6 Measurements

The sinks shall be measured in numbers.

17.17.7 Rate

Rate shall include the cost of all materials and labour involved in all the operations described above but shall not included the cost of waste fitting and brackets which shall be paid for separately.

17.18 CUTTING CHASE IN MASONRY WALL

17.18.1 Cutting chasing in brick masonry wall shall be has specified in item no. 18.22.

17.18.2 Filling chases

After sand cast iron/ centrifugally cast/spun iron pipe etc. are fixed in chases, the chases shall be filled with cement concrete 1:3:6 (1 cement: 3 coarse sand: 6 graded stone aggregate 12.50 mm nominal size) or cement mortar 1:4 (1 cement: 4 coarse sand) as may be specified or otherwise directed by the Engineer-in-Charge and made flush with the masonry surface. The concrete surface shall be roughened with wire brushes to provide a key for plastering.

17.18.3 Measurements

Chases shall be measured in running meter correct to a cm.

17.18.4 Rates

The rate shall include the cost of labour the materials involved in all the operations described above excluding the cost of providing pipes etc. which shall be paid separately.

17.19 PAINTING SYNTHETIC ENAMEL PAINT ON SCI/CENTRIFUGALLY CAST (SPUN) IRON SOIL, WASTE AND VENT PIPES.

17.19.1 The primer and paint of approved brand and manufacturer shall be used as specified. Paint shall be synthetic enamel paint of any color such as chocolate, grey or buff etc.

17.19.2 Painting new surface

17.19.2.1 Preparation of surface:- The surface of pipe and fittings shall be thoroughly cleaned. All unevenness shall be rubbed down and made them smooth with sand paper and dust shall be removed properly. After obtaining approval of Engineer-in-Charge, for SCI/CI pipe, the priming coat shall be applied before the pipe is fixed in position.

17.19.2.2 Application:- The primer shall be applied with brushes properly on the pipe surface and spread even and smooth. The application of synthetic enamel paint over priming coat shall be carried out after drying of primer surfaces. Additional finishing coat shall be applied if found necessary, to ensure proper uniform surface. The two coats of synthetic enamel paint shall be applied . The second coat shall be applied when the previous coat has dried up.

17.19.3 Measurement:- Measurement shall be taken over the finished line of pipe including specials and fittings such as socket, tee, bend, cowl, holder bat clamp etc. in running meter correct to a centimeter. Pipe of different diameter shall be measured and paid for separately.

17.19.4 Rate:- The rate shall be inclusive of cost of all materials and labours involved in all the operations described above including painting all specials and fittings etc.

17.20 REPAINTING SCI / CENTRIFUGALLY CAST (SPUN) IRON SOIL, WASTE AND VENT PIPE
17.20.1 The synthetic enamel paint of approved brand and manufacturer shall be used as specified .

17.20.2 Painting old surface.
17.20.2.1 Preparation of surface:- The old surface shall be cleaned off by removing grease, smoke etc. The surface of pipe shall then be thoroughly cleaned, rubbed down with sand paper and dusted. Rusted patches shall be cleared up and touched with synthetic enamel paint. If the old paint is blistered and flaked, it shall be completely removed as described in 13.41. Such removal shall be paid for separately and painting shall be treated as on new work.

17.20.2.2 Application:- The paint shall be applied with brushes properly on the pipe surface and spread even and smooth. The one coat of paint to be applied . Additional finishing coat shall be applied if found necessary to ensure proper uniform surface.

17.20.3 Measurement:- Same as described in the 17.19.3.

17.20.4 Rate:- The rate shall be inclusive of cost of all materials and labours involved in all the operations described above, including painting all specials and fittings etc.

17.21 INSTALLATION OF WALL MOUNTING WATER CLOSET (WC)
17.21.1 Installation

It shall consist of white vitreous china extended wall mounting WC of size 780x370x690 mm of approved shape, brand and manufacture with duel flush fitting of flushing capacity 3 Ltr / 6 Ltr (adjustable to 4 Ltr/8 Ltr) including seat cover and cistern fittings, nuts, bolts and gasket etc. complete in all respect as per direction of Engineer-in-Charge. Wall mounting water closet shall be of white vitreous China confirming to IS 2556 (Part 16) : 2002. For general requirement relating to terminology, materials, manufacture, glazing, defects, minimum thickness, tolerances, performance and methods of tests shall confirm to IS 2556 (Part 1). Wall mounted water closet shall be of one piece construction. Each wall mounted water closet shall be provided with fixing arrangement and shall have an integral flushing rim of suitable type. It shall have an inlet for connecting the flushing pipe of dimension confirming to IS 2556 and mentioned in Table No.2. The flushing rim may be box or open rim type or a combination of both. In case of box rim, adequate number of holes and slot be provided. The flushing rim and the inlet shall be of the self draining type and weep hole shall be provided at the flushing inlet of the wall mounted water closet.

The WC shall be provided with not less than two fixing holes to enable the WC to be securely installed to the wall using metallic corrosion resistant bolts and nuts and an independent concealed support frame. The support frame (metal hanger or carrier), depending on the design shall be securely attached to the building structural members so that no strain is transmitted to WC connector or any part of the plumbing system.

Each wall mounted water closet shall have an integral trap and P type outlet confirming to IS 2556 (Part 16): 2002 and mentioned in Fig. 25 & Fig. 26. Inside surface of water closet and trap shall be uniform and smooth in order to ensure an efficient flushing. The outlet if without serration, shall be glazed and if same is with serration, may not be glazed.

17.21.2 Marking

Each piece of wall mounted water closet shall be cleary and indelibly marked at a suitable place with the following:-

(a) Name of trade mark of the manufacturer and
(b) Batch/lot numbers.

17.21.3 BIS certification marking

Wall mounted water closet shall be marked with the standard mark. The use of Standard Mark is governed by the provisions of the Bureau of Indian Standards Act, 1986 and the Rules and Regulations made .

17.21.4 General requirement for installation of WC

The specification described in 17.2 shall be hold good so far as it is applicable.

17.21.4.1 All sanitary and plumbing work shall be carried out through licensed plumbers.

17.21.4.2 On completion of the work the site shall be cleaned and all rubbish disposed off as directed by the Engineer-in-Charge.

17.21.5 Measurement

Wall mounted water closet shall be measured in numbers.

17.22 INSTALLATION OF FLOOR MOUNTED SINGLE PIECE WATER CLOSET (WC)

17.22.1 Installation

It shall consist of white vitreous China single piece, double traps syphonic water closet of approved shape, brand, size, pattern and manufacturer with integrated white vitreous china cistern of capacity 10 ltr. with dual flushing system, including all fitting and fixtures with seat cover, cistern fittings, nuts, bolts and gasket etc. including making connection with the existing P/S trap, complete in all respect as per direction of the Engineer-in-Charge.

The general requirement relating to terminology, materials, manufacture, glazing, defects, minimum thickness, tolerances, performance and methods of tests shall confirm to IS 2556 (Part-1).
Single piece floor mounted WC generally smaller than a two piece floor mounted WC. The flushing tank is connected and sits lower on the bowl than on a two piece. Due to the smaller size, single piece WC are able to be installed in toilet/bathroom with less square footage.

17.22.2 Fixing

The water closet shall be fixed to the floor by means of 75mm long and 6.5mm dia counter sunk bolts and nuts embedded in the floor concrete.

17.22.2.3 Marking

Each piece of wall mounted water closet shall be cleary and indelibly marked at a suitable place with the following:-

(a) Name of trade mark of the manufacturer and
(b) Batch/lot numbers.

17.22.3 General requirement for installation of WC

The specification described in 17.2 shall be hold good so far as they are applicable.

17.22.3.1 All sanitary and plumbing work shall be carried out through licensed plumbers.

17.22.3.2 On completion of the work the site shall be cleaned and all rubbish disposed off as directed by the Engineer-in-Charge.

17.22.4 Measurement

Single piece floor mounted water closet shall be measured in numbers.

APPENDIX A

STANDARD WEIGHTS AND THICKNESS OF C.I. PIPES

(Clause 17.1.8)

For Sand Cast Iron Pipes IS 1729

Nominal dia of bore (mm)	*Thickness (mm)*	*Over all weight of pipe*		
		1.5 m long (Kg)	*1.80 m long (Kg)*	*2.0 m long (Kg)*
50	5.0	9.56	11.41	12.65
75	5.0	13.83	16.52	18.37
100	5.0	18.14	21.67	24.15
150	5.0	26.70	31.92	35.66

For Cast Iron (Spun Pipes IS 3989).

Nominal dia (mm)	*Thickness (mm)*	*Overall Weight in Kg. for an effective length in metres of*				
		3.000	*2.500*	*2.000*	*1.800*	*1.500*
50	3.5	13.40	11.3	9.2	8.4	7.1
75	3.5	20.0	16.8	13.8	12.5	10.6
100	4.0	30.0	25.5	21.0	18.8	16.0
150	5.0	56.0	47.0	38.5	34.9	29.5

Tolerances

(a) Tolerances on the external diameter of the barrel, the internal diameter of the socket and the depth of socket shall be as follows:—

Dimensions (mm)	*Nominal Diameter (mm)*	*Tolerance*
External diameter of barrel	50, 75	± 3.0
	100	± 3.5
	150	± 4.0
Internal diameter of socket	All diameters	± 3.0
Depth of socket	All diameters	10.0

The maximum and minimum jointing space resulting from these tolerances shall be such that the jointing of the pipes and fittings is not adversely affected.

The tolerance on length of pipes shall be ± 20 mm.

(b) The tolerances on dimensions of fittings shall be as given below:

Type of Casting	*Dimension*	*Tolerance mm*
Bend pipes	a	+25 -10
	b	+20 -10
Branches with equal branch pipes	a	+25 -10
	b	+25 -10
Branches with unequal branch pipes	L	+30 -20
S. Shape casting	L	+50 -10
Taper collars	L	+25 -10
Other	L	+20 -10

Note:

(1) Tolerance on wall-thickness shall be limited to –15 per cent. No limits for plus tolerance is specified.

(2) Tolerance for dimensions other than those specified above shall be as specified in IS 5519.

(3) Tolerance on mass shall be limited to –10 per cent. No limit for plus tolerance specified.

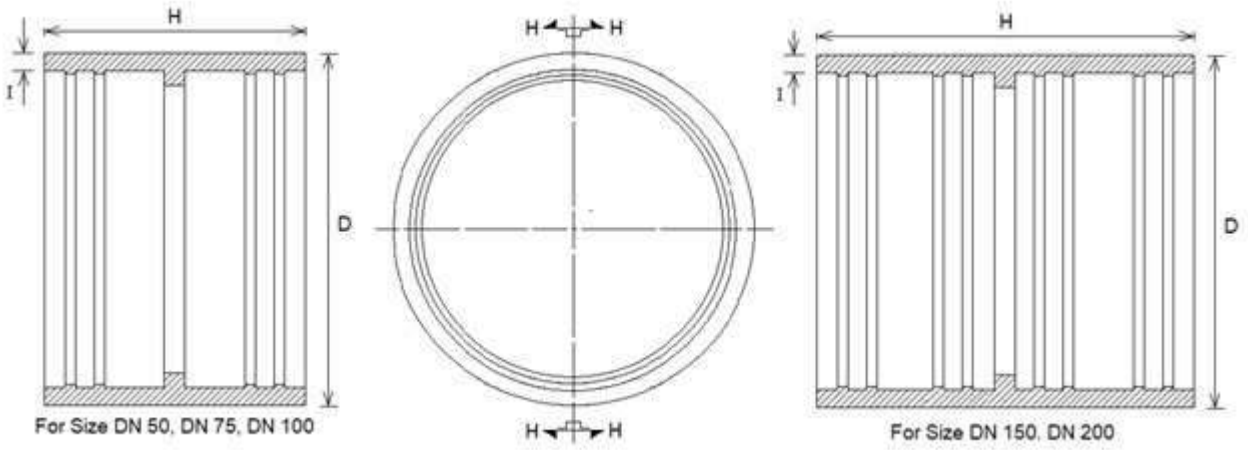
APPENDIX B
(Clause 17.1.8A)

DRAWING AND DIMENSIONS FOR STAINLESS STEEL SHIELDED COUPLING

A-1 Profile of EPDM rubber gasket as given inTable-6.

A-2 Design of stainless steel shield and clamp as given in Table-7.

Table- 6 EPDM Rubber Gasket
(Clause A-1)



Sl No. (1)	DN mm (2)	Outside Dia (D) Mm (3)	Thickness (I) Mm (4)	Height (H) mm (5)
i)	50	59.8	2.4	54
ii)	75	84.8	2.4	54
iii)	100	111.0	2.5	54
iv)	150	162.0	3.0	76
v)	200	211.0	3.0	101

A-3.2 Firmly seat the pipe or fitting ends against the integrally moulded center stop inside the EPDM rubbergasket.

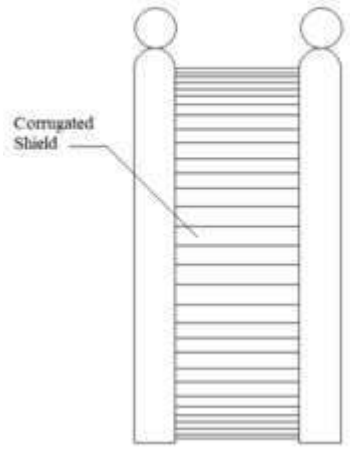
A-3.3 Slide the stainless steel shield and clampassembly over the EPDM rubber gasket and tightenthe bands. For larger diameters couplings which havefour bands, the inner bands should be tightened first and then the outer bands.

A-3.4 In all the cases, when tightening bands theyshould be tightened alternately to insure that thecoupling shield is drawn up uniformly.

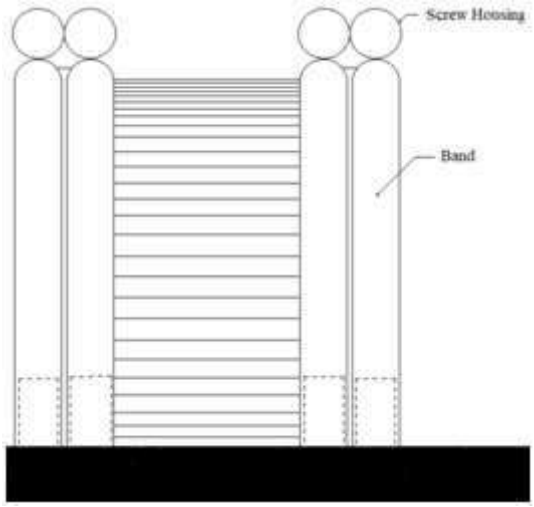
NOTE — Other types of joints can also be used at the discretion ofthe customer. The details given in this Annex is for guidance only

Table-7 Stainless Steel Shield

(Clause A-2)

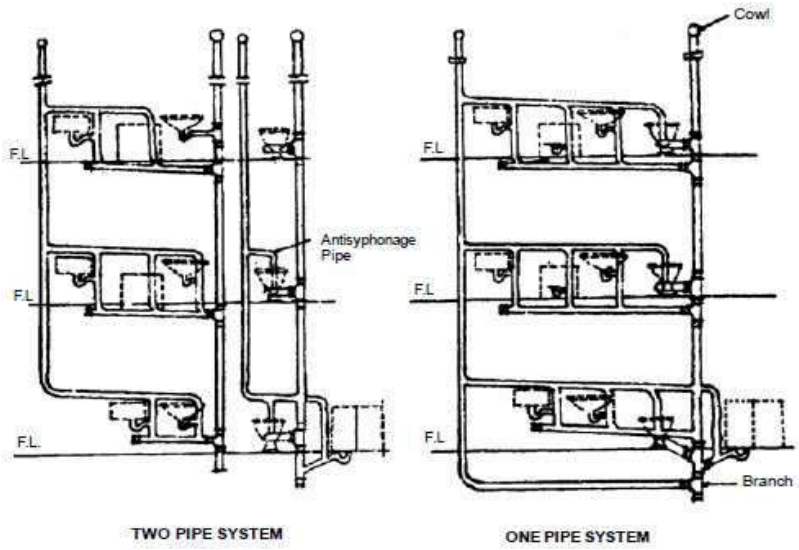


For Size DN50, DN75, DN100



For Size DN50, DN75, DN100

Sl. No.	DN mm	Height (H) mm
(1)	(2)	(3)
i)	50	54
ii)	75	54
iii)	100	54
iv)	150	76
v)	200	101

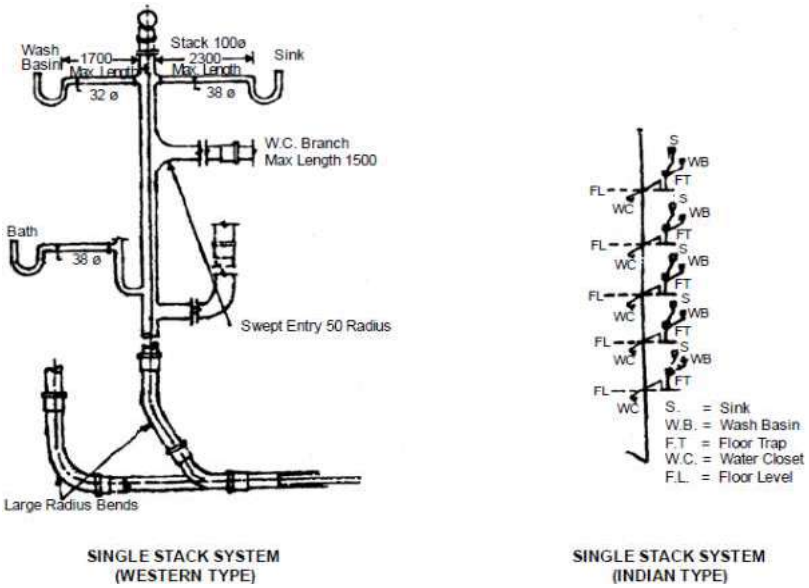


Drawing Not to Scale
All Dimensions are in mm

Fig. 17.1 : Pipe Systems and Parts

PIPE SYSTEMS AND PARTS

Sub Head : Sanitary Installations
Clause : 17.1

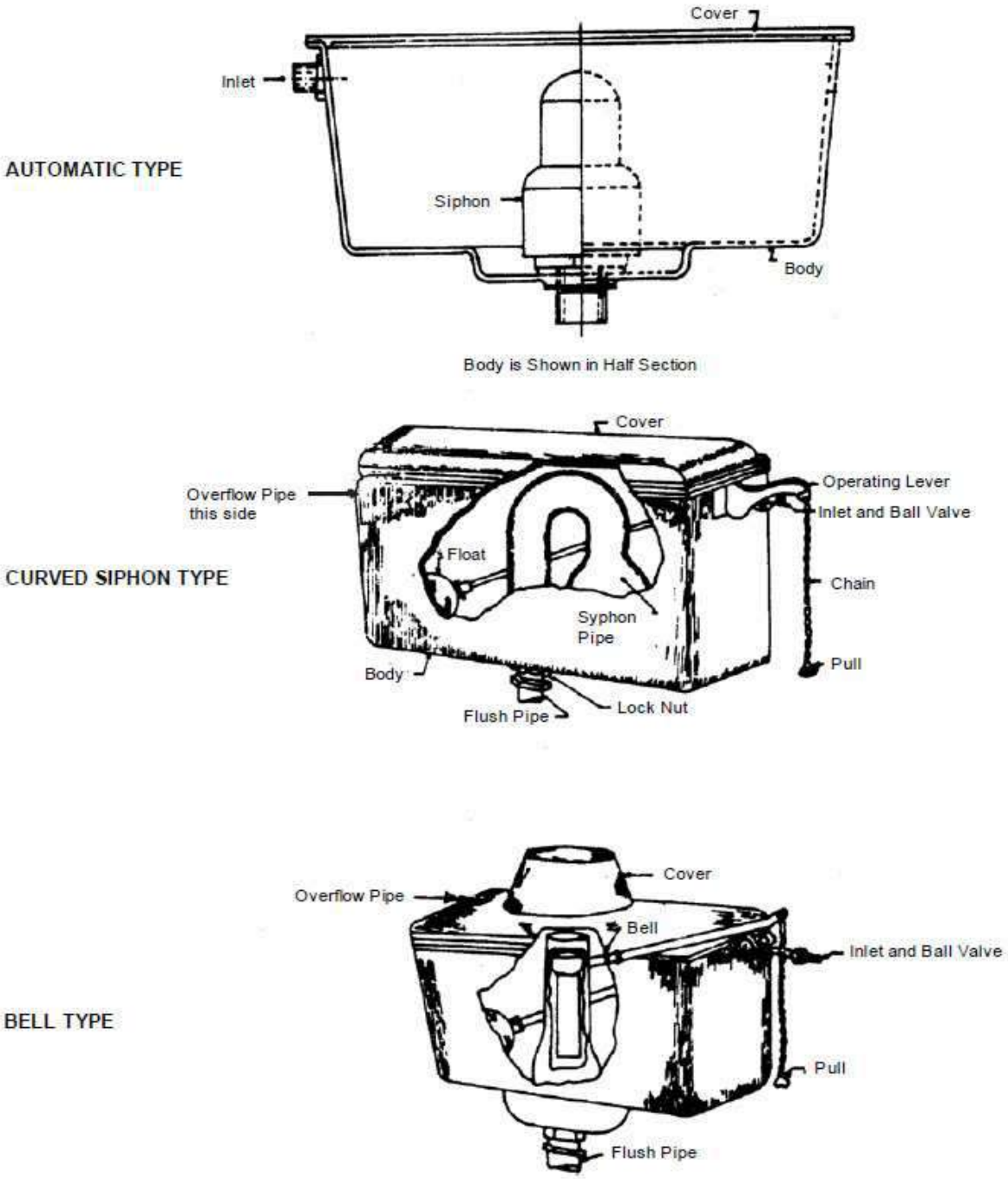


Drawing Not to Scale
All Dimensions are in mm

Fig. 17.2 : Pipe Systems and Parts

FLUSHING CISTERNS

Sub Head : Sanitary Installations
Clause : 17.1.1

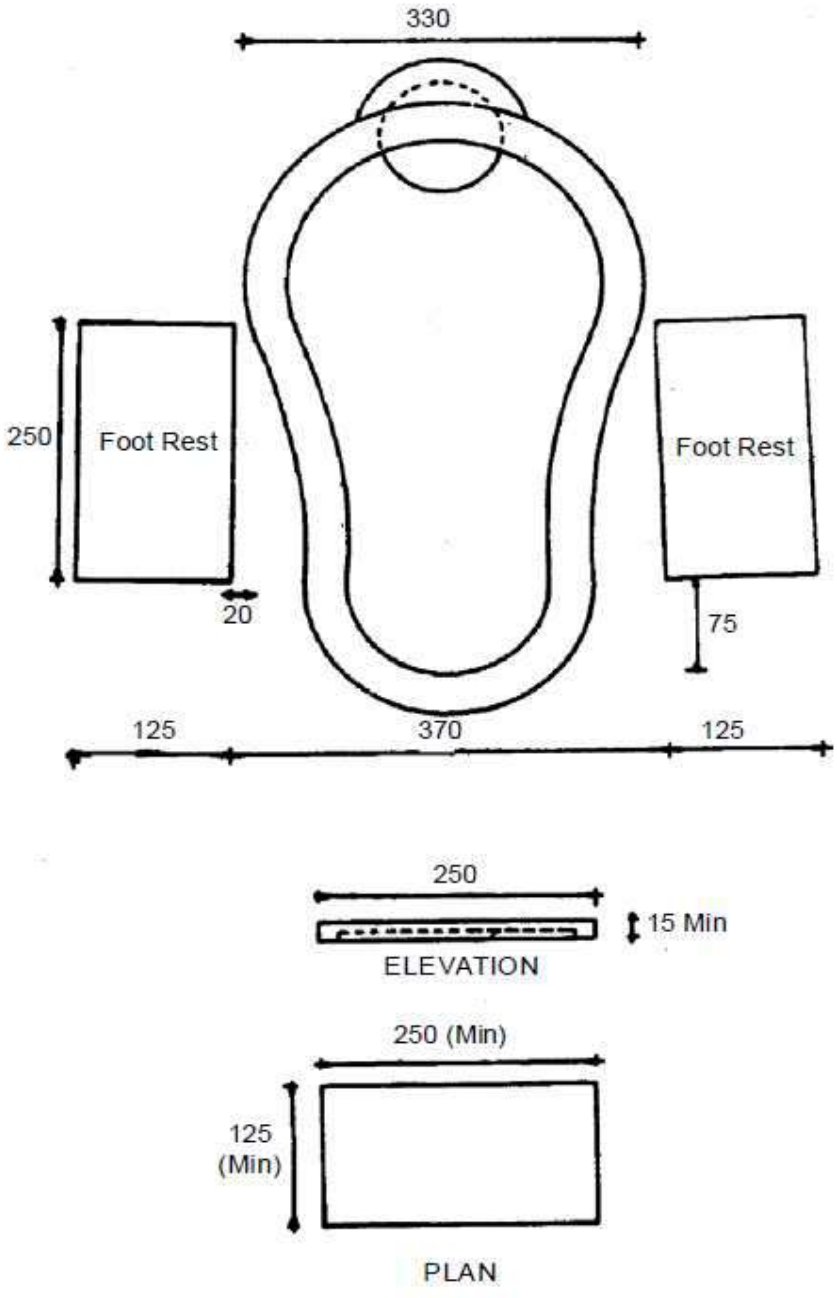


Drawing Not to Scale
All Dimensions are in mm

Fig. 17.3 : Flushing Cisterns

FOOT REST

Sub Head : Sanitary Installations
Clause : 17.1.3

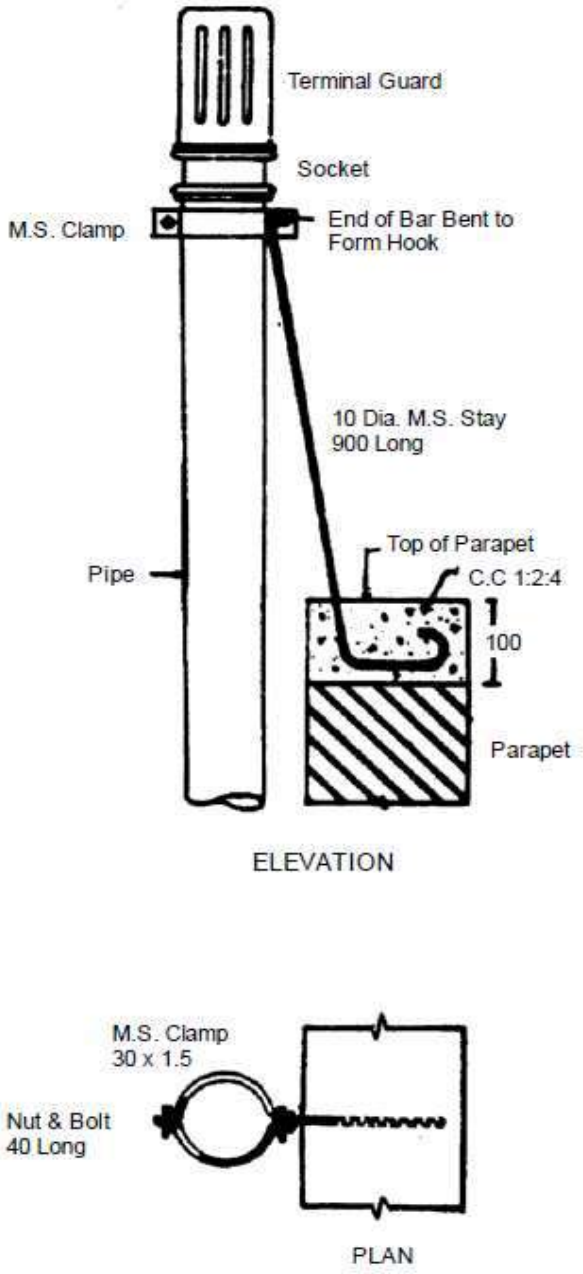


Drawing Not to Scale
All Dimensions are in mm

Fig. 17.4 : Foot Rest

M.S. STAYS AND CLAMP

Sub Head : Sanitary Installations
Clause : 17.1.6



Drawing Not to Scale
All Dimensions are in mm

Fig. 17.5 : M.S. Stays and Clamp

PLASTIC SEAT AND COVER

Sub Head : Sanitary Installations
Clause : 17.1.9

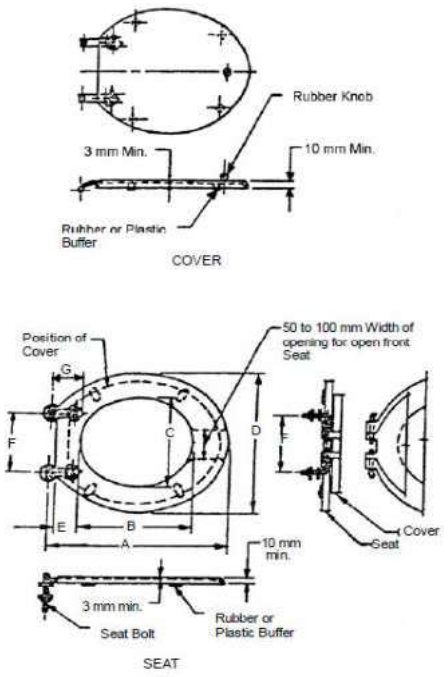


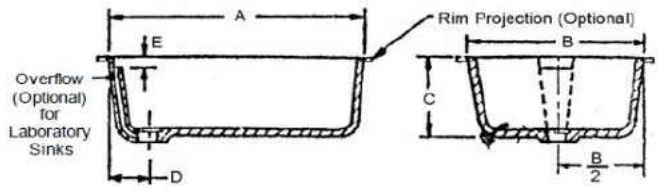
Table 1 Dimensions of Seats and Covers
All dimensions in millimeters

Sl.No	Description	Dimensions	
		Min	Max
(1)	(2)	(3)	(4)
(i)	Distance from centre line of hinge bolts to extreme edge of rim at front, *A*	445	475
(ii)	Length of opening at longest point, *B*	250	290
(iii)	Width of opening at widest point, *C*	215	240
(iv)	Overall width at widest point, *D*	380	-
(v)	Distance between inner and outer rims, *E*	55	-
(vi)	Centre-to-centre distance of seat bolt holes, *F*	145	175
(vii)	Distance from centre line of hinge bolts to inner rim of seat at the back, *G*	85	-
(viii)	Thickness of seat at thinnest point	3	-
(ix)	Thickness of cover at thinnest point	3	1
Note : Some hinging devices are made so as to provide adjustment in the longitudinal direction. This is not precluded by these figures.			

Fig. 17.6 : Plastic Seat and Cover

KITCHEN & LABORATORY SINKS

Sub Head : Sanitary Installations
Clause : 17.1.10

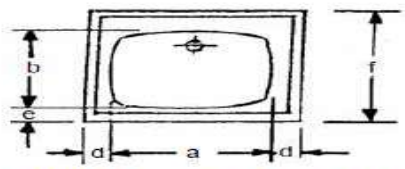


KITCHEN AND LABORATORY SINKS (WHITE GLAZED FIRE CLAY)

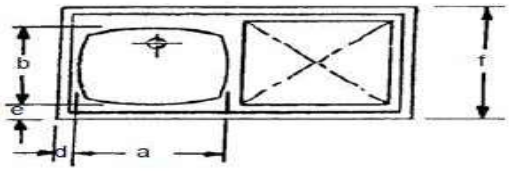
DIMENSIONS OF KITCHEN AND LABORATORY SINKS
(White Glazed Fire Clay)

All dimensions in millimeters

Pattern	*Size*	*A*	*B*	*C*	*D*
(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
(a) Kitchen sinks (White glazed fire clay)	750 x 450 x 250	750	450	250	150
	600 x 450 x 250	600	450	250	150
	600 x 450 x 200	600	450	200	150
(b) Kitchen sink with drain board stainless steel	510x1040x250	510	1040	250	150
	510x1040x225	510	1040	225	150
	510x1040x200	510	1040	200	150
	510x1040x178	510	1040	178	150
(c)Kitchen sink without drain board stainless steel	610x510x200	610	510	200	150
	610x460x200	610	460	200	150
	470x420x178	470	420	178	150
(d) Laboratory sinks	600 x 400 x 200	600	450	200	90
	500 x 350 x 150	600	350	150	90
	450 x 300 x 150	450	300	150	90
	400 x 250 x 150	400	250	150	90



WITHOUT DRAINING BOARD



WITH DRAINING BOARD

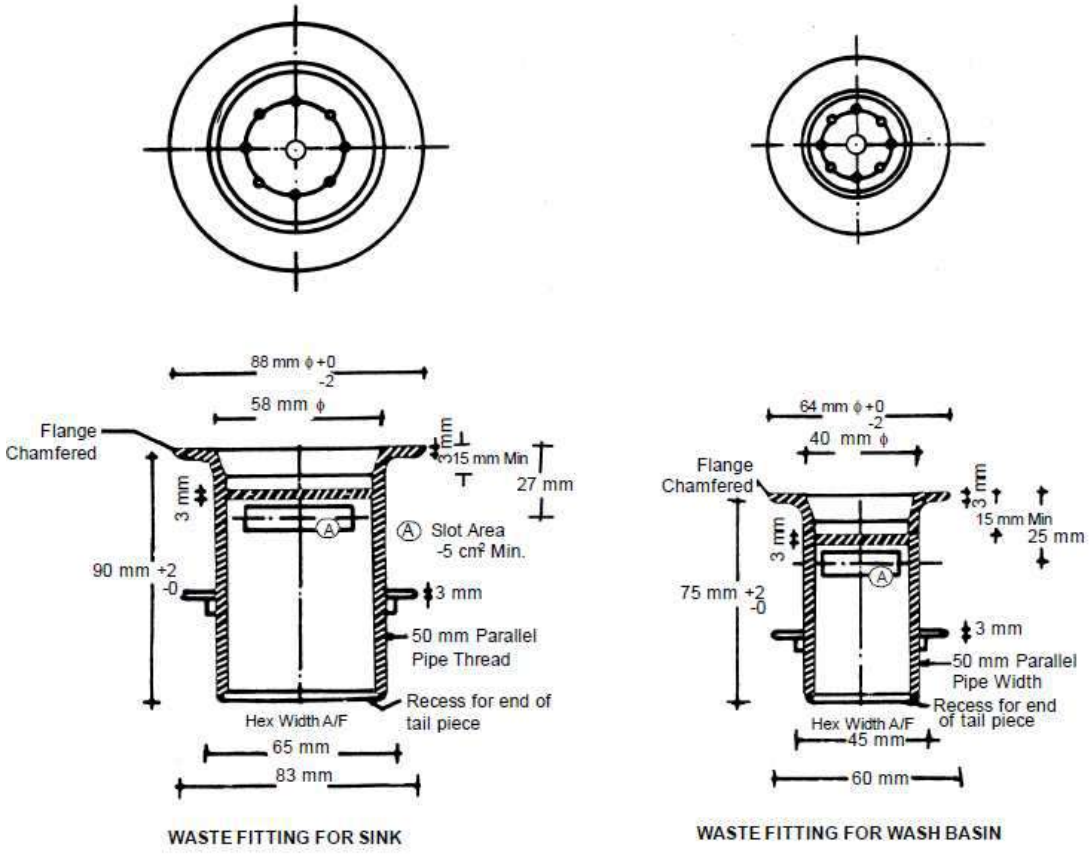
Reference to Fig. above	*Dimensions in mm (Minimum Unless Specified)*
a	380 (for rectangular bowl) 360 (for round bowl)
b	340
c	20
d	30
e	45
f	440 mm Max for 500 mm worktop 515 mm Max for 600 mm worktop

STAINLESS STEEL SINK

Fig. 17.7 : Kitchen & Laboratory Sinks

WASTE FITTINGS FOR W.B. & SINKS

Sub Head : Sanitary Installations
Clause : 17.1.15

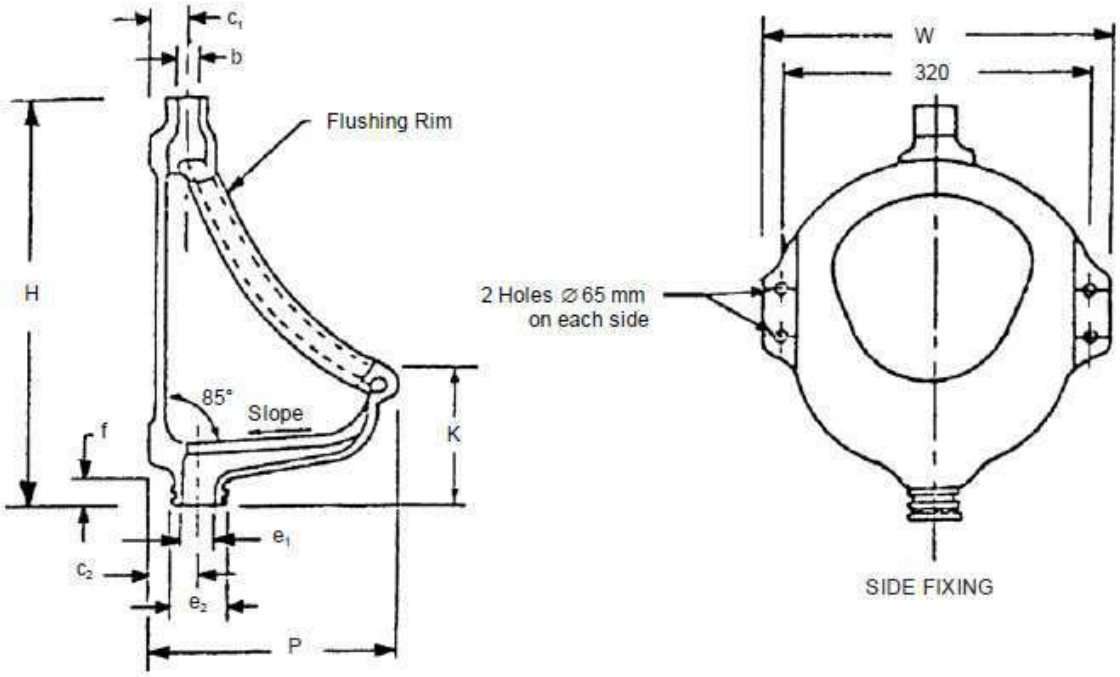


Drawing Not to Scale
No. and Sizes of Holes Indicative

Fig. 17.8 : Waste Fittings for W.B. & Sinks

URINAL BOWL TYPE

Sub Head : Sanitary Installations
Clause : 17.1.13



Note : Where a closed channel with overflow is not provided a domed grating with perforating starting from the base and the crown of which shall be 25 mm, minimum above surface shall be provided which may be integral or otherwise.

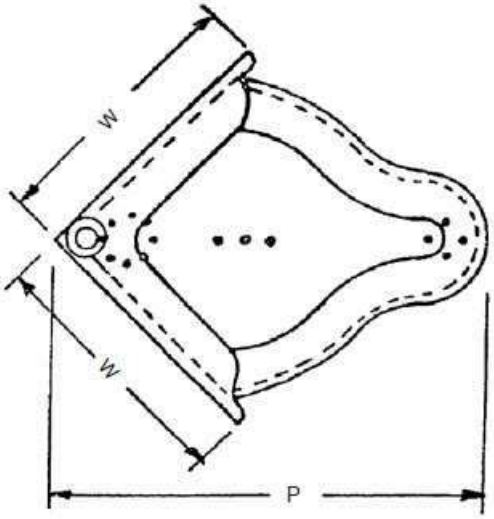
BOWL PATTERN URINAL (FLAT BACK)

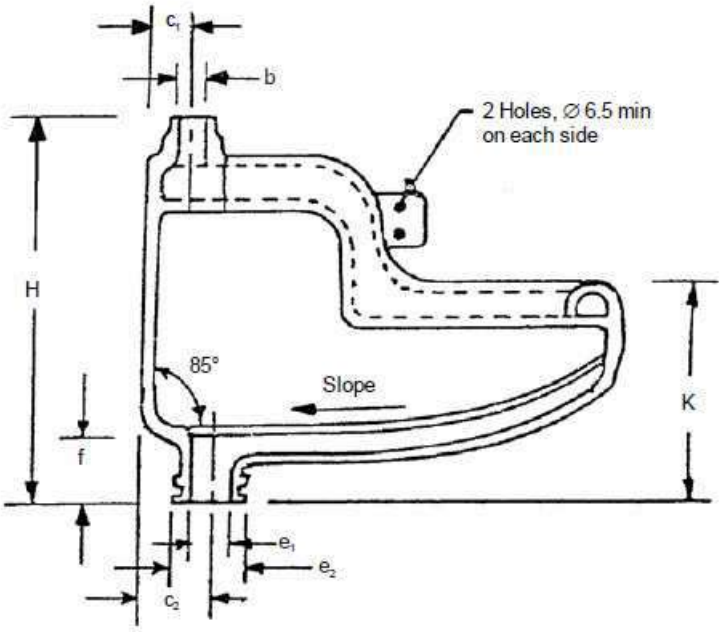
All dimensions in millimetres

Fig. 17.9 : Urinal Bowl Type

URINAL BOWL TYPE (Contd.)

Sub Head : Sanitary Installations
Clause : 17.1.13





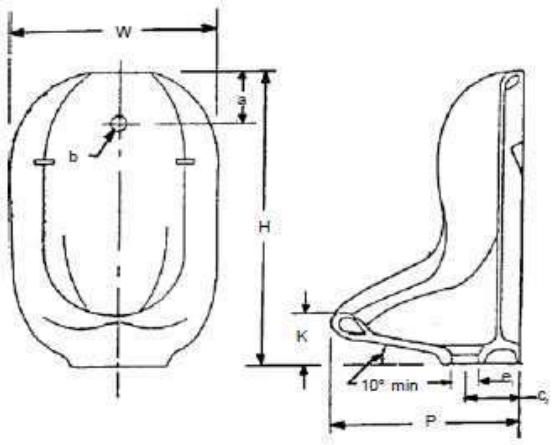
Note : Ovality of 5 percent is permissible on inlet and outlet diameters.

All Dimensions in Millimetres

Fig. 17.10 : Urinal Bowl Type (Corner Wall Type)

URINAL – HALF STALL

Chapter : Sanitary Installations
Clause : 17.1.13.2



BOWL TYPE FLAT BACK URINAL WITHOUT RIM

FUNCTIONAL DIMENSIONS OF BOWL PATTERN URINALS
All dimensions in millimetres

Sl. No.	*Pattern*	*Dimension*			
		Height	*Projection*	*Width*	*Distance*
		H	*P*	*W*	*K, Min*
1.	Flat back with flushing rim				
	Size 1	440	265	355	140
	Size 2	440	265	315	140
2.	Flat back without flushing rim				
	Size 1	410	265	305	100
	Size 2	590	375	390	100
3.	Angle back with flushing rim	345	420	270	190
4.	Angle back without flushing rim				
	Size 1	450	350	275	100
	Size 2	580	500	300	100

CONNECTING DIMENSIONS OF BOWL PATTERN URINALS
All dimensions in millimetres

Sl.No.	*Pattern*	*Dimension in mm*							
		a	*b* [1]	c_1	c_2	*d*	e_1	e_2	*f, Min*
1.	Flat back, with flushing rim	—	20 ± 3	40 ± 5	50 ± 5	—	35 ± 2	55	20
2.	Flat back, without flushing rim	75 Max	20 ± 3	—	100 Min	65 ± 5	45 ± 2	60 Min	20
3.	Angle back, with flushing rim	—	20 ± 3	35 ± 5	65 ± 5	—	35 ± 2	55	20
4.	Angle back, without flushing rim	75 max	20 ± 3	—	150 (for size 1) 225 (for size 2)	65 ± 5	45 ± 2	60	20

Explanation for Legends Used

a = Dimension from top of bowl to centre of water supply hole or spreade
b = Diameter of water supply hole
c_1 = Distance from centre of water supply hole to back of bowl
c_2 = Distance from centre of waste outlet to back of bowl
d = Dimension of outlet of the waste flange
e_1 = Internal diameter of waste outlet
e_2 = Outside diameter of the outlet hole
f = Depth of waste outlet

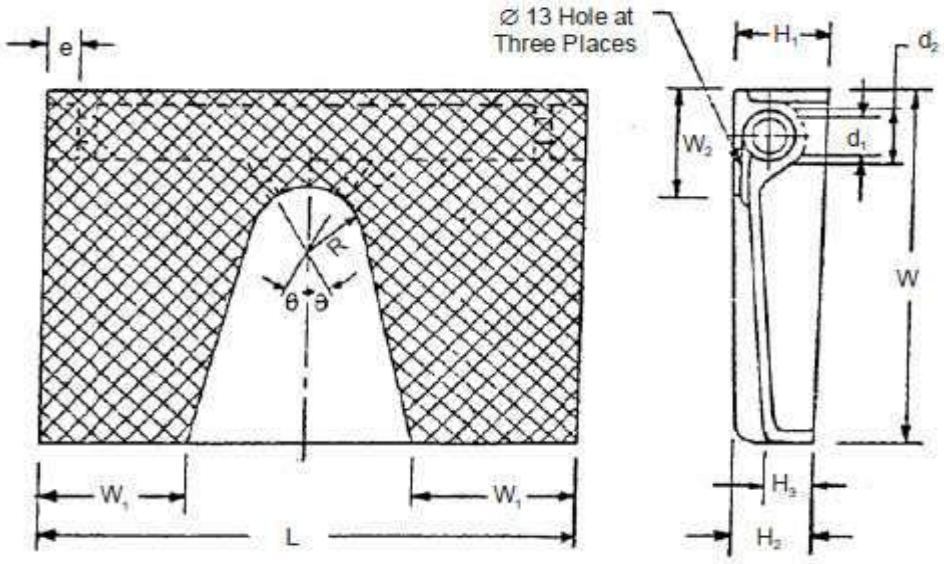
Note : Distance between pairs of screw holes for flat back with flushing rim bowl urinal shall be 395 mm for top/bottom fixing arrangement and 320 mm for side fixing arrangement.

(1) Ovality is permissible within the variation allowed for the dimensions
(2) Ovality is permissible within ± 2 mm of the dimensions.

Fig. 17.11 : Urinal – Half Stall

URINAL SQUATTING PLATE

Sub Head : Sanitary Installations
Clause : 17.1.13.4



SQUATTING PLATE URINAL

FUNCTIONAL DIMENSIONS OF SQUATTING PLATES (IN MM)

Sl.No.	*Description*	*Ref. in Fig. above*	*Size 1*	*Size 2*
1.	Size	—	450 x 350	600 x 350
2.	Length	*L*	450	600
3.	Minimum foot rest width	W_1	125	165
4.	Width	*W*	350	350
5.	Height at back end	H_1	100	100
6.	Height at front end	H_2	85	85
7.	Minimum height at bowl draining surface	H_3	50	50
8.	Width at flat top	W_2	100	100
9.	Radius of curvature of the bowl	*R*	65	65
10.	Angle of direction of the two end spray hole with that of the central one	Ø	30°	30°

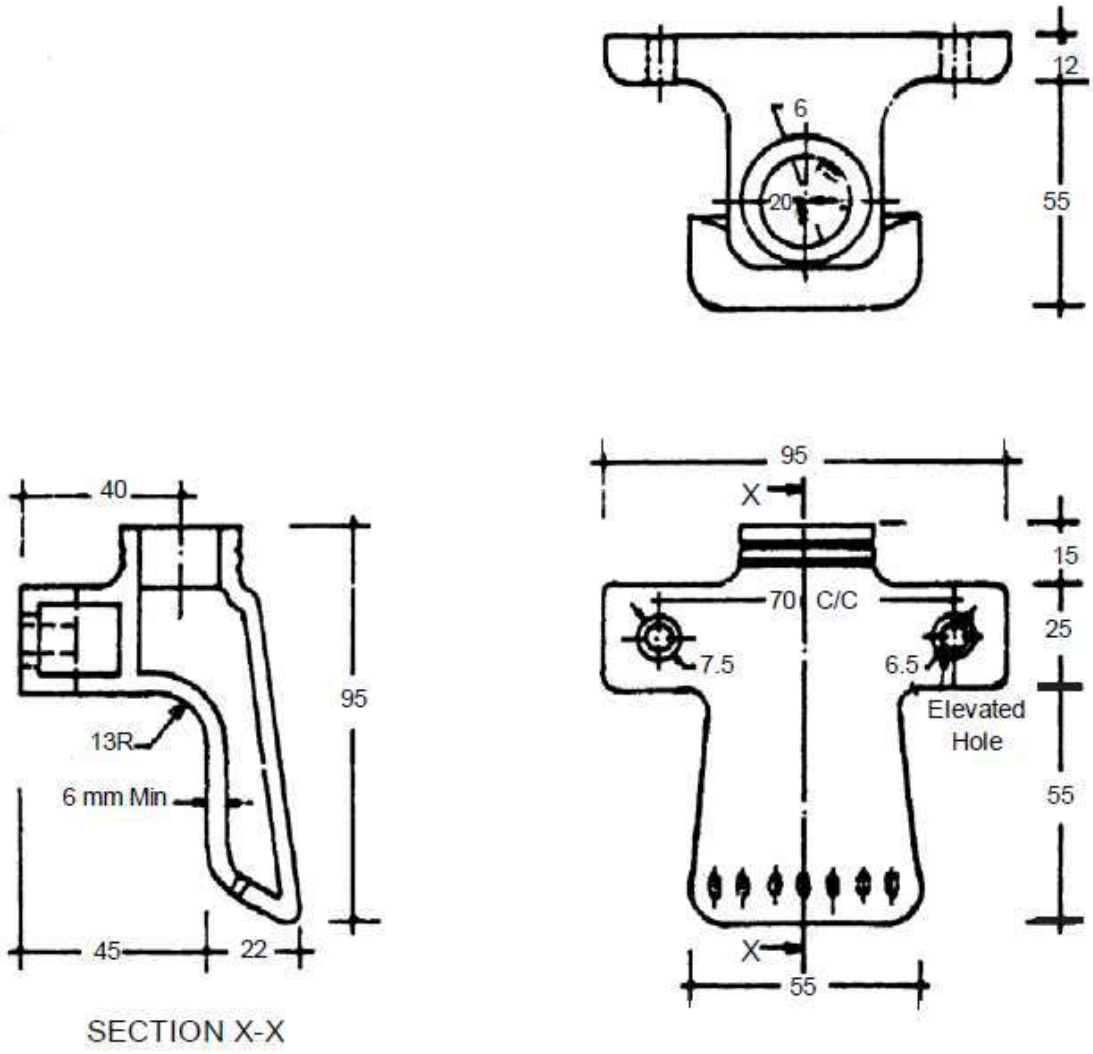
CONNECTING DIMENSIONS OF SQUATTING PLATES, MM

Description	*Ref. in Fig. above*	*Size 1/Size 2*
Diameter of inlet hole	d_1	40
Diameter of the inlet socket	d_2	50
Depth of the inlet socket, *Min*	*e*	25
1) Ovality is permissible within the variation allowed for the dimensions.		

Fig. 17.12 : Urinal Squatting Plate

SPREADER FOR URINAL

Sub Head : Sanitary Installations
Clause : 17.1.13

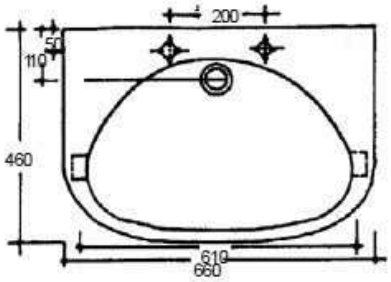


Drawing Not to Scale
All dimensions are in mm

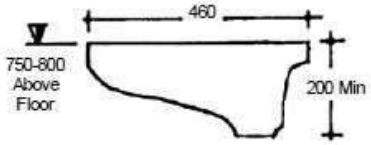
Fig. 17.13 : Spreader for Urinal

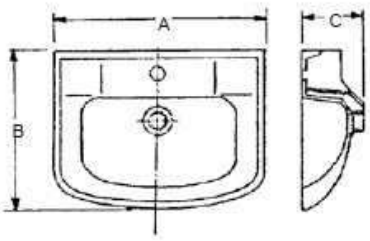
WASH BASINS

Sub Head : Sanitary Installations
Clause : 17.1.14

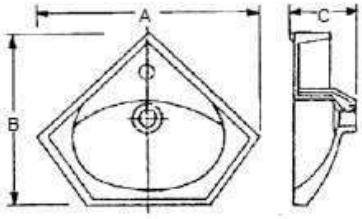


SURGEONS BASIN





FLAT BACK

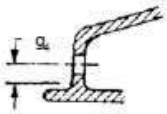


ANGLE BACK

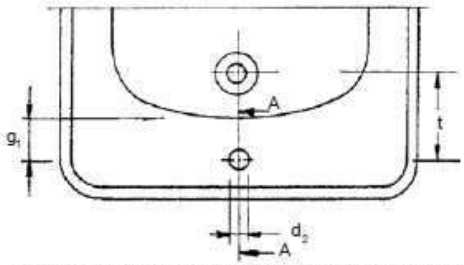
FUNCTIONAL DIMENSIONS OF WASH BASINS

All dimensions in millimetres

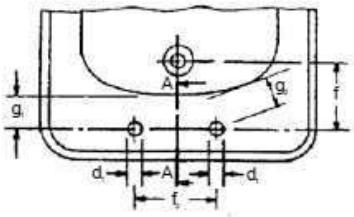
S. No.	Pattern	Size	Length A	Breadth B	Height C
(1)	(2)	(3)	(4)	(5)	(6)
(i)	Flat Back	660 x 460 (Surgeon's basin)	660	460	200, *Min*
		630 x 450	630	450	290, *Max*
		550 x 400	550	400	290, *Max*
		450 x 300	450	300	225, *Max*
(ii)	Angle back	600 x 480	600	480	290, *Max*
		400 x 400	400	400	290, *Max*

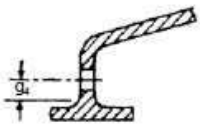


SECTION A-A



CONNECTING DIMENSIONS FOR SINGLE TAP HOLE WASH BASINS





SECTION A-A

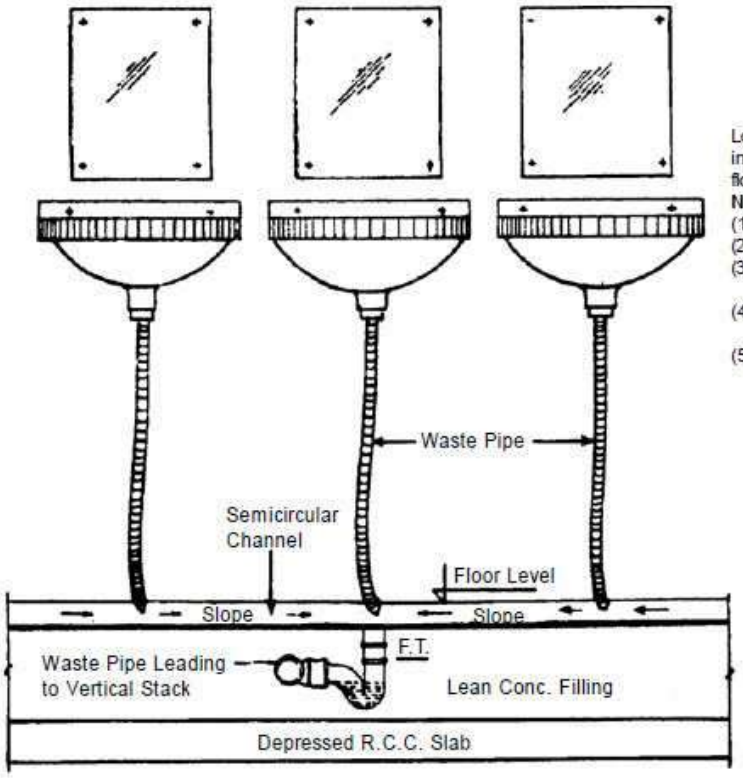
CONNECTING DIMENSIONS OF WASH BASINS AND TWO TAP

Drawing Not to Scale
All dimensions are in mm

Fig. 17.14 : Wash Basins

FIXING ARRANGEMENT OF WASH BASIN
(ELEVATION OF WASH BASIN)

Sub Head : Sanitary Installations
Clause : 17.1.14

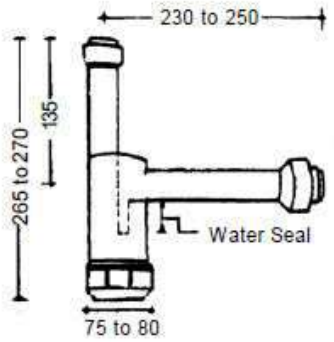


Location : General Offices Waste discharging in Semicircular open channel and collected in floor trap.

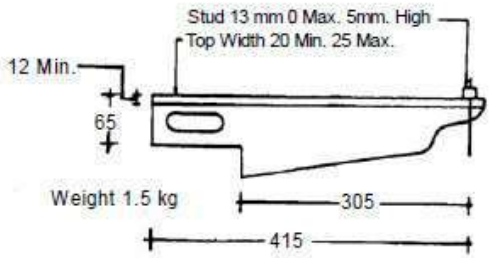
Notes:

(1) Slope : 1 in 10 to 1 in 50.
(2) F.T.: Ref. Q.C.T.A Circular No. 2 of 1992.
(3) Waste Pipe : P.V.C. flexible Type (32 mmø)
(4) F.T. Location preferred in Centre to Achieve Max. Slope.
(5) Water supply connection not shown.

TYPICAL ELEVATION OF 3 WASH BASINS IN A ROW



TYPICAL DETAIL OF BOTTLE TRAP



C.I. BRACKET

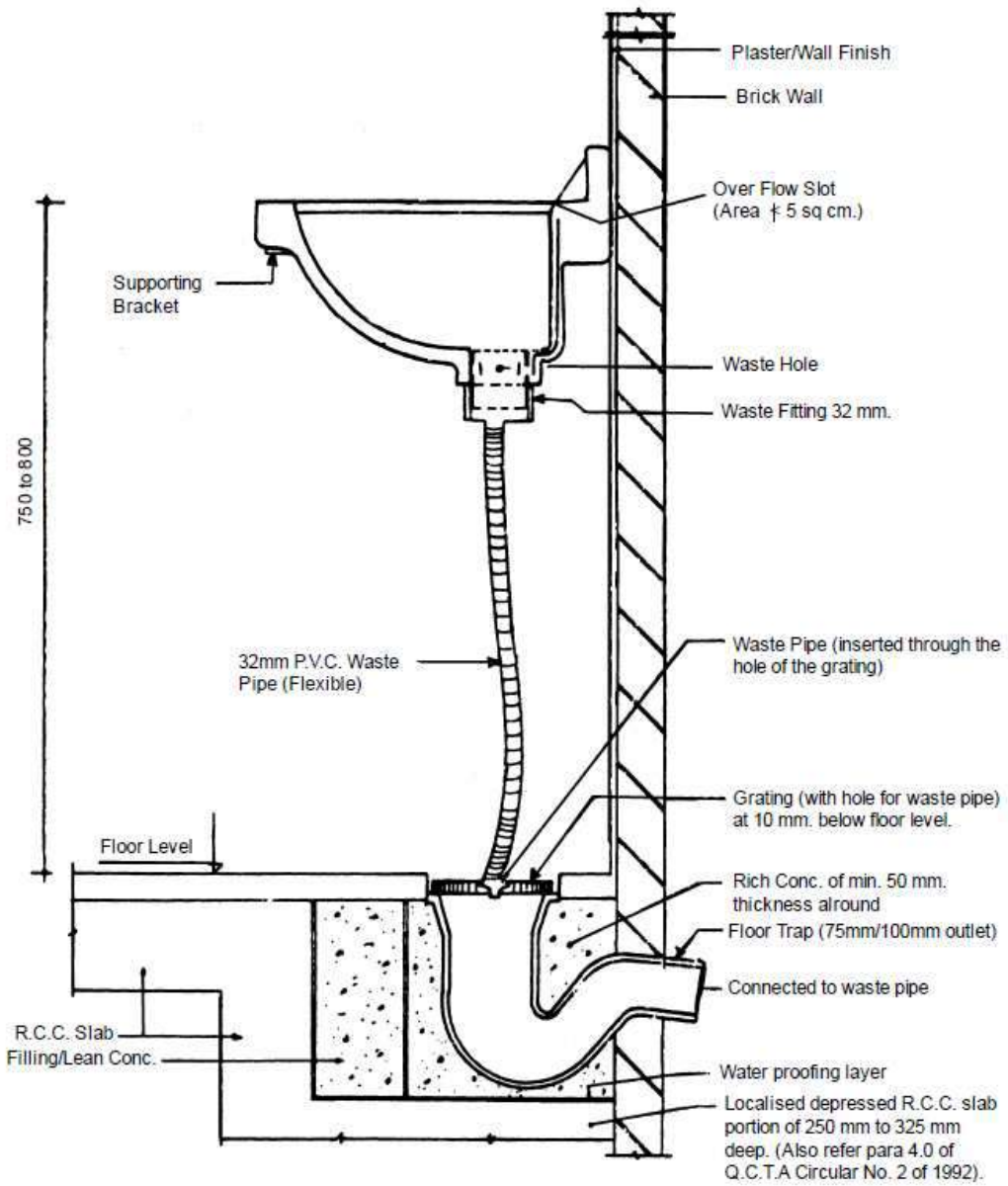
Note : Stud shall be provided for supports intended for glazed earthenware, vitreoware wash basins only.

Drawing Not to Scale
All dimensions are in mm

Fig. 17.15 : Fixing Arrangement of Wash Basin

TYPICAL VERTICAL SECTION OF WASH BASIN
(WASTE PIPE OPEN TO VIEW)

Sub Head : Sanitary Installations
Clause : 17.1.14

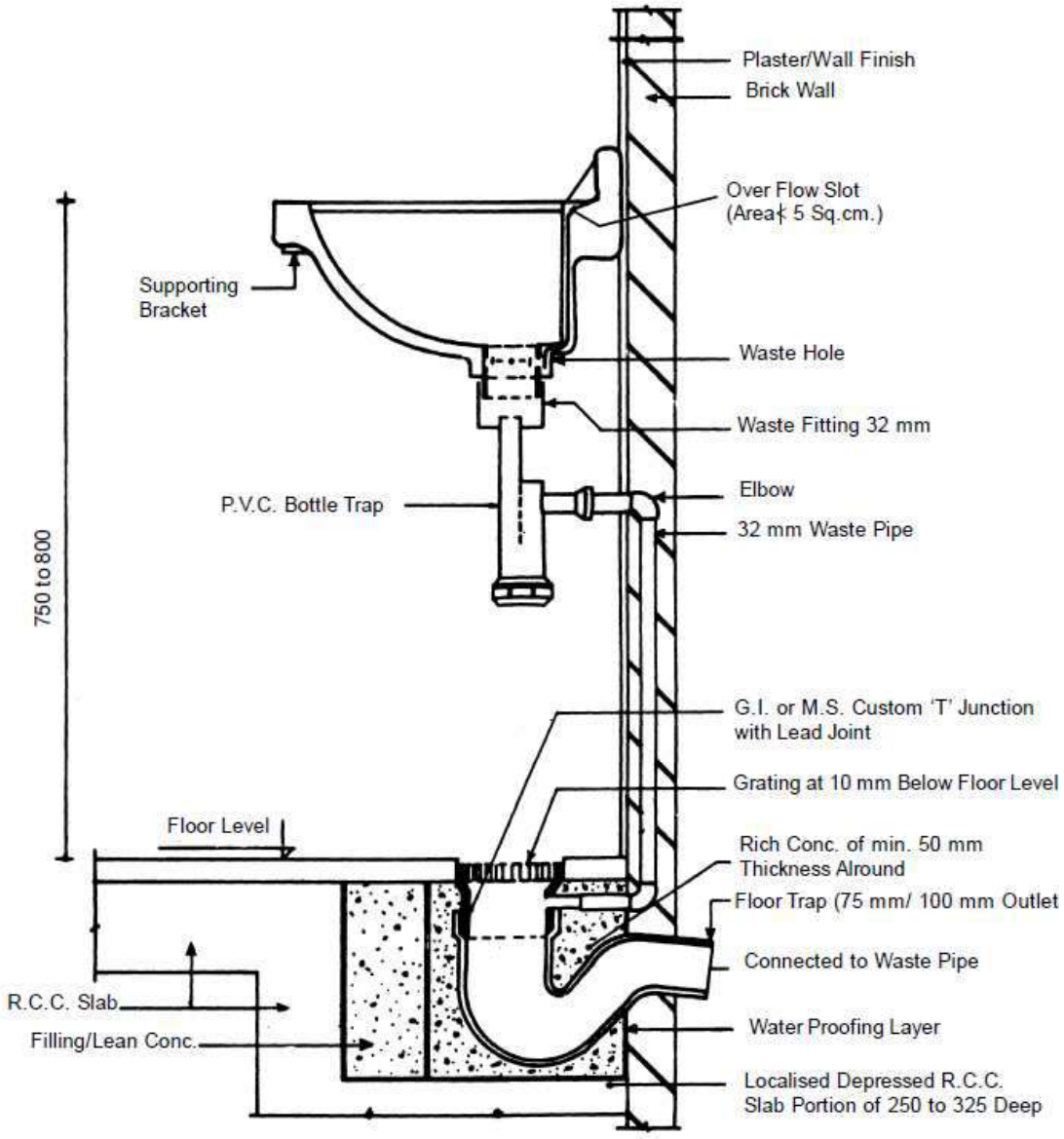


Drawing Not to Scale
All dimensions are in mm

Fig. 17.16 : Typical Vertical Section of Wash Basin (Waste Pipe Open to View)

TYPICAL VERTICAL SECTION OF WASH BASIN
(WASTE PIPE CONCEALED FROM VIEW)

Sub Head : Sanitary Installations
Clause : 17.1.14

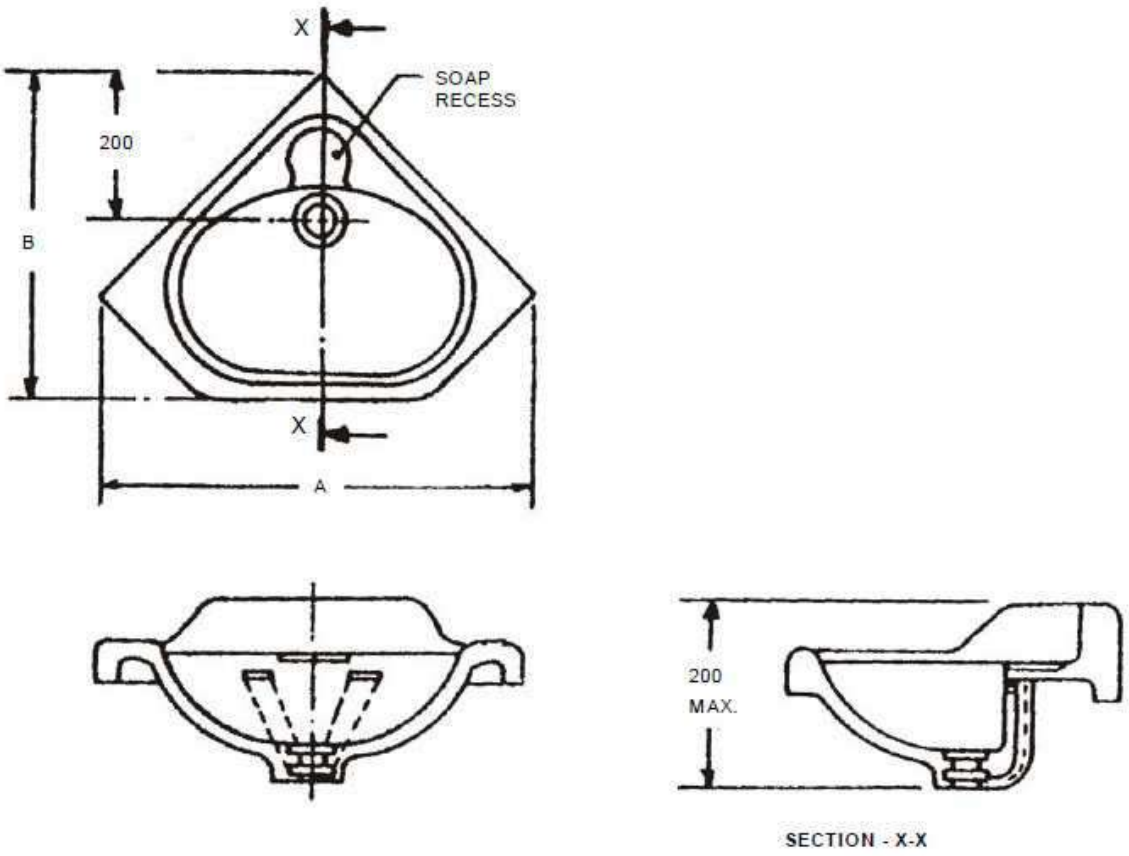


Drawing Not to Scale
All dimensions are in mm

Fig. 17.17 : Typical Vertical Section of Wash Basin (Waste Pipe Concealed from View)

ANGLE BACK WASH BASIN
(PATTERN-2)

Sub Head : Sanitary Installations
Clause : 17.1.14

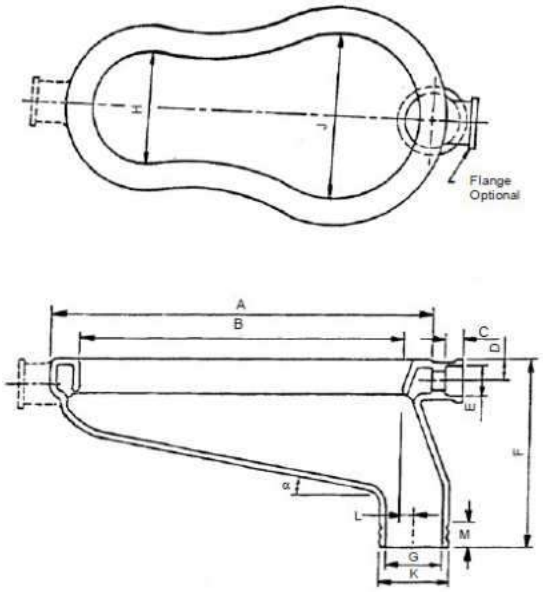


Notes :
(1) Tap hole provisions are not shown. However provision shall be made for 1 or 2 Tap holes in any suitable position.
(2) Stud provisions are not shown but suitable provision shall be made for fixing purposes.
(3) Provision of soap recess need not be central in the case of single tap hole.
(4) Drawing not to scale.
(5) All dimensions are in mm.

Fig. 17.18 : Angle Back Wash Basin (Pattern-2)

LONG PATTERN SQUATTING PAN, TYPE I

Sub Head : Sanitary Installations
Clause : 17.1.16.1



Functional Dimensions of Long and Orissa Pattern
All Dimensions in millimetres

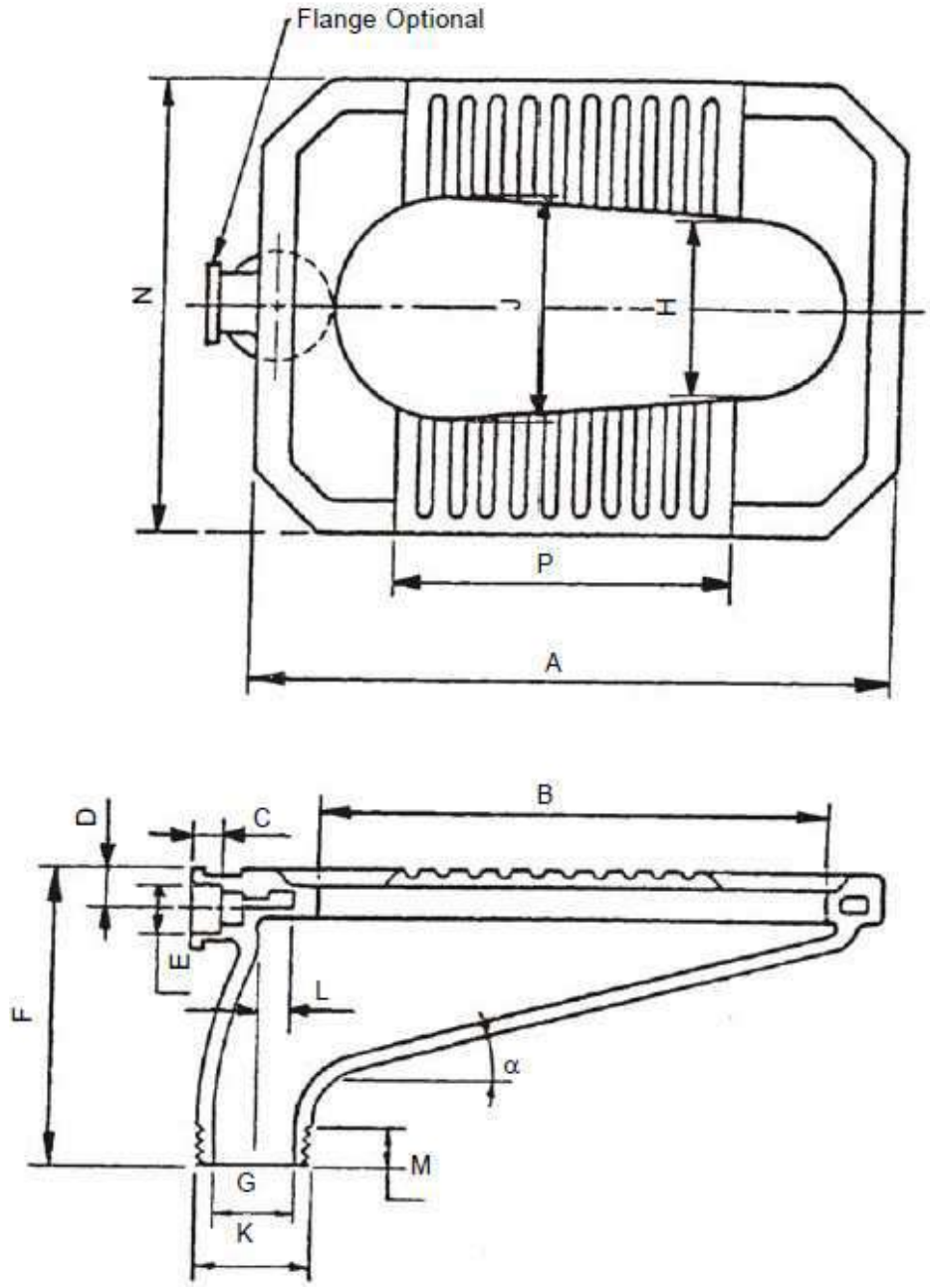
Sl. No.	Description	Ref. in Fig. 19 and 20	Long Pattern of Size		Orissa Pattern of Size	
			580	630	580 x440	630 x 450
(1)	(2)	(3)	(4)	(5)	(6)	(7)
(i)	Length	*A*	580	630	580	630
(ii)	Length of opening, *Min*	*B*	480	530	470	500
(iii)	Height	*F*	300 ± 10	320 ± 10	300 ± 10	320 ± 10
(iv)	Width of opening, small end	*H*	170 ± 10	170 ± 10	180 ± 10	180 ± 10
(v)	Width of opening, wide end	*j*	260 ± 10	260 ± 10	210 ± 10	220 ± 10
(vi)	Slope of bottom of Pan	α	15°	15°	15°	15°
(vii)	Distance between the centre of outlet to the inside face of flushing rim at the back, *Max*	*L*	70	70	70	70
(viii)	Width	*N*	—	—	440	450
(ix)	Length of foot rest	*P*	—	—	310 ± 10	310 ± 10

Note : Tolerances where not specified shall conform to Part I of IS-2556

Fig. 17.19 : Long Pattern Squatting Pan, Type I

ORISSA PATTERN SQUATTING PAN

Sub Head : Sanitary Installations
Clause : 17.1.16.1



Note : Footrest may be flushed or raised, clearance permissible between raised footrest and rim opening.

All Dimensions in Milliletres.

Fig. 17.20 : Orissa Pattern Squatting Pan

INTEGRATED SQUATTING PAN

Sub Head : Sanitary Installations
Clause : 17.1.16.1

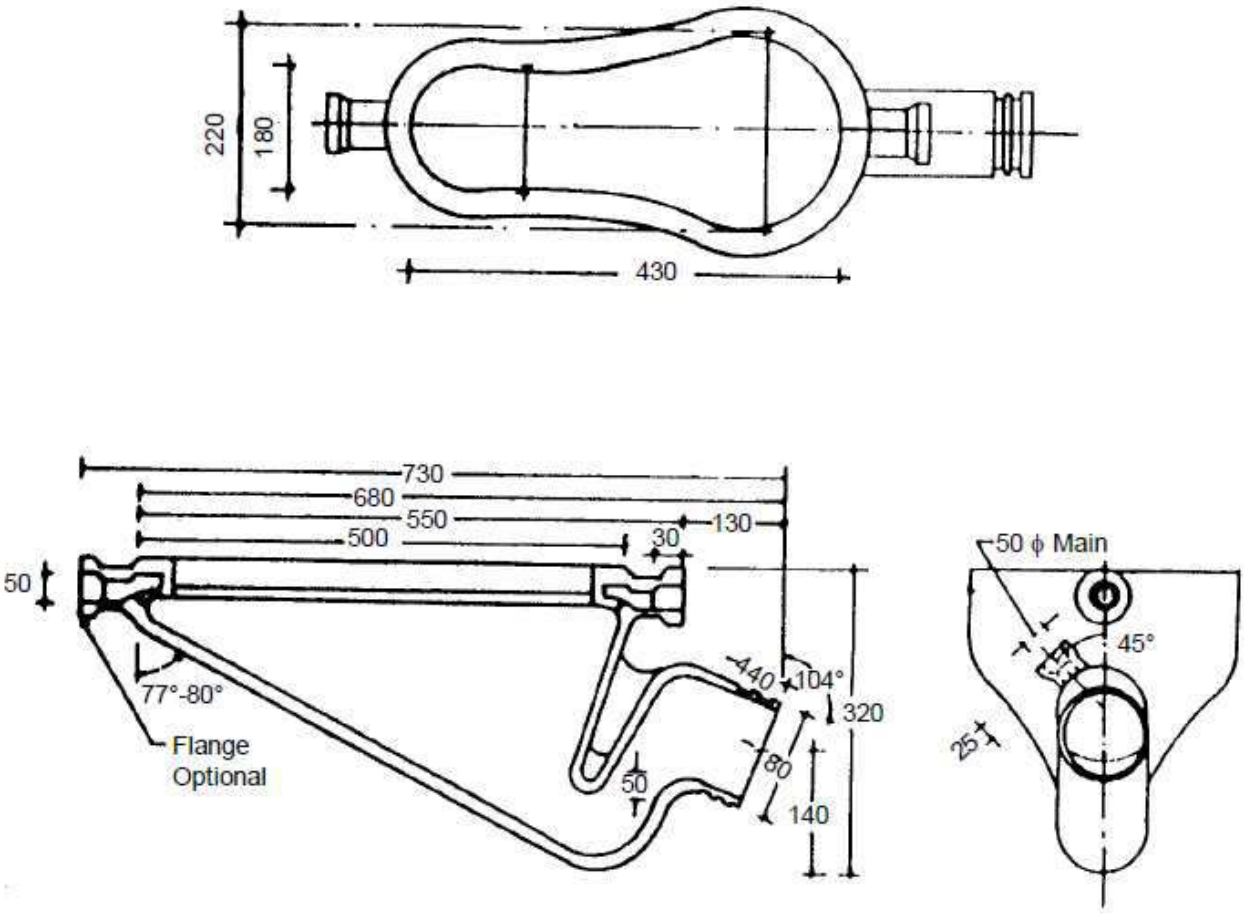
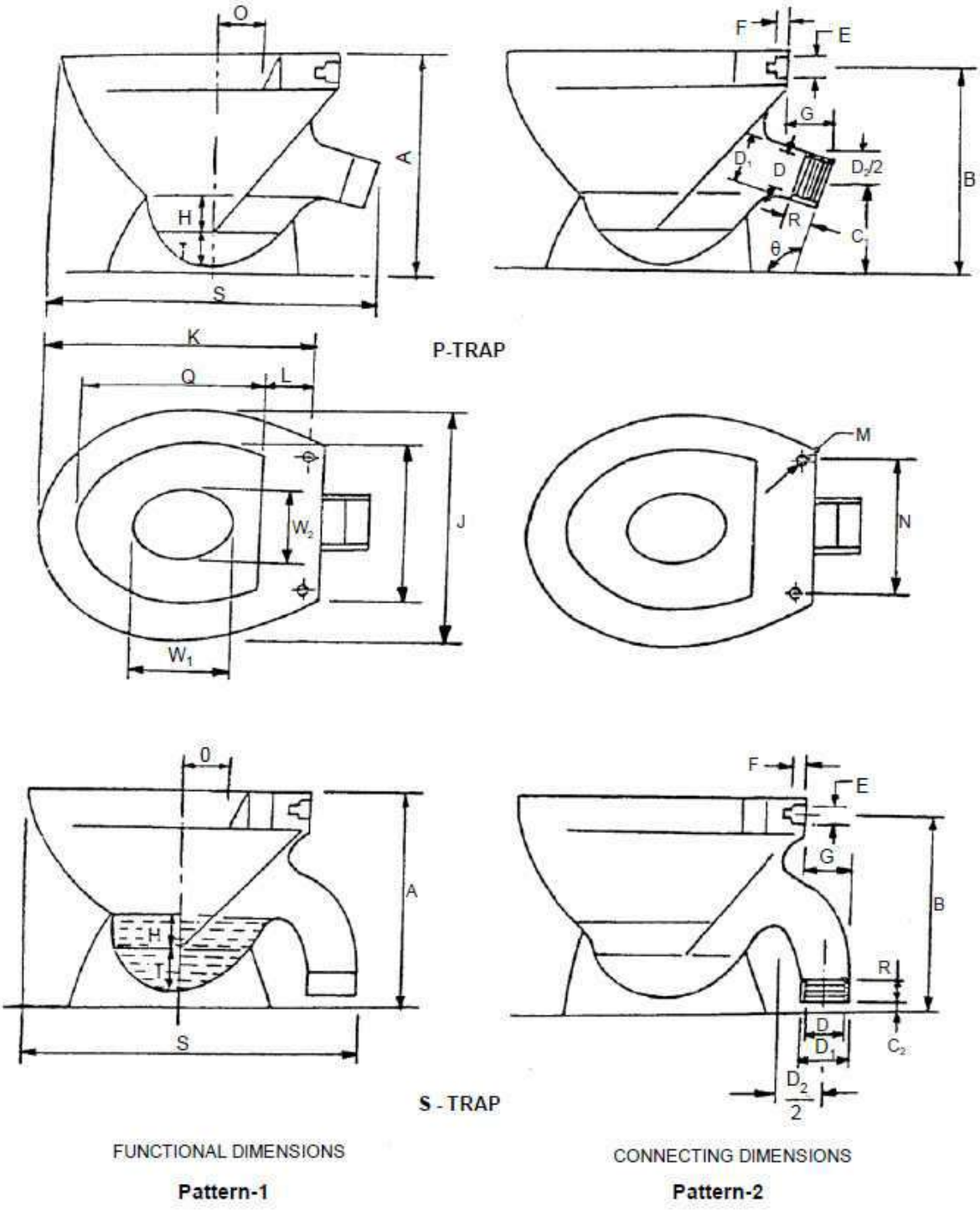


Fig. 17.21 : Integrated Squatting Pan

PATTERN 1 AND PATTERN 2 WATER CLOSETS

Sub Head : Sanitary Installations
Clause : 17.1.16.2



All dimensions in millimetres

Fig. 17.22 : Pattern 1 and Pattern 2 Water Closets

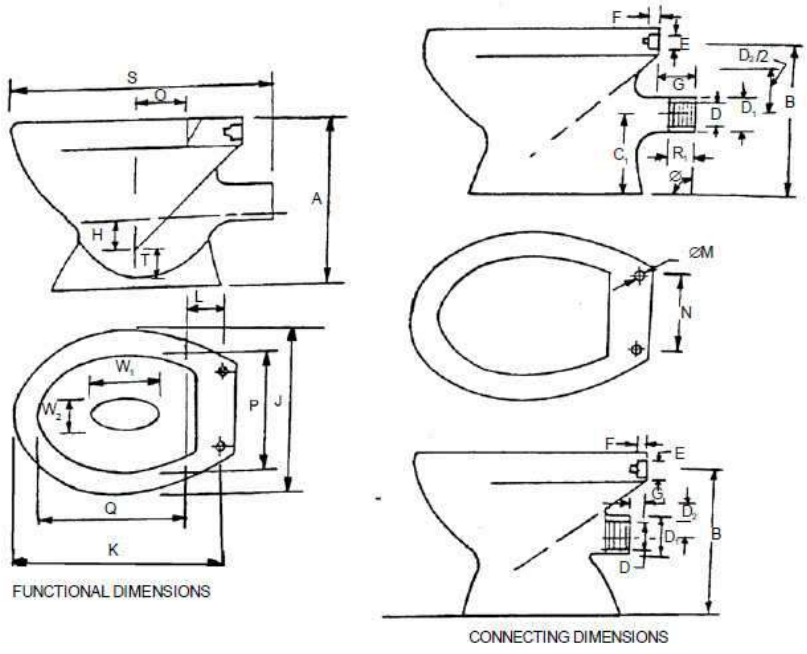
PATTERN 3 WATER CLOSET WITH HORIZONTAL P-TRAP

Sub Head : Sanitary Installations
Clause : 17.1.16.2

FUNCTIONAL DIMENSIONS
All dimensions in millimetres

Sl.No.	Description	Ref. in Fig.	Pattern 1	Pattern 2	Pattern 3
(1)	(2)	(3)	(4)	(5)	(6)
(i)	Height	A	390 ± 10	390 ± 10	390 ± 10
(ii)	Depth of water seal, *Min*	H	50	50	50
(iii)	Width of water closet	J	360 ± 10	360 ± 10	360 ± 10
(iv)	Distance from centre of seat bolt hole to front of water closet	K	415 to 445	415 to 445	415 to 445
(v)	Distance from centre of seat bolt hole to inside face of flush rim at back, *Max*	L	80	80	80
(vi)	Distance between a vertical line from tip of back plate to inside face of flush rim at back, *Max*	O	70	70	70
(vii)	Width of opening, *Min*	P	240	240	240
(viii)	Length of opening, *Min*	Q	290	290	290
(ix)	Overall length	S	500-575	500-575	500 *Max*
(x)	Trap inlet depth, *Min*	T	75	75	75
(xi)	Water surface				
	Back to front	W_1	150 *Min*	100 *Min*	150 *Min*
	Side to side	W_2	110 *Min*	75 *Min*	110 *Min*

Note : In case of centre vent in S Trap, overall length should be taken as S + 75.



FUNCTIONAL DIMENSIONS

CONNECTING DIMENSIONS

All dimensions in millimetres

Fig. 17.23 : Pattern-3 Water Closet with Horizontal P-Trap

TYPICAL COUPLING JOINT INSTALLATON

Sub Head : Sanitary Installations
Clause : 17.1.8A

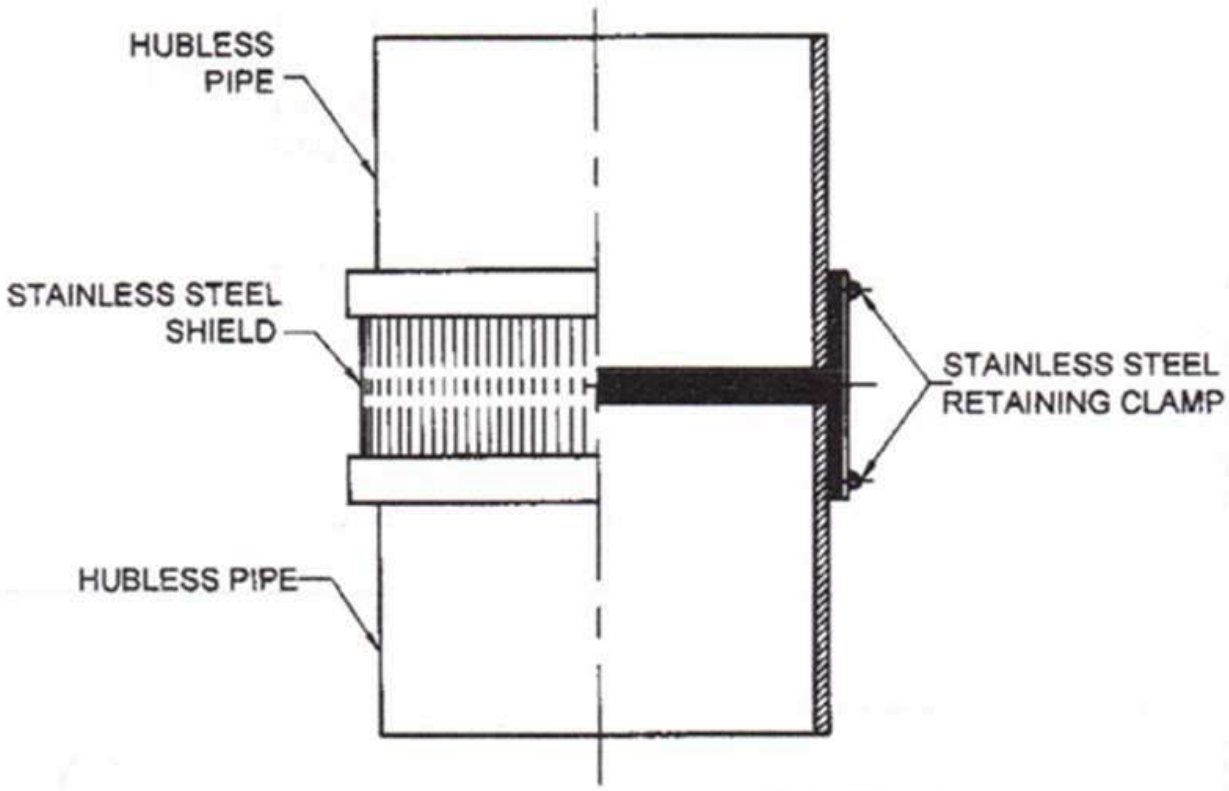


Fig. 17.24 Typical coupling joint-installation

TYPICAL ILLUSTRATION OF WALL MOUNTED WATER CLOSET WITH CONCEALED OUTLET (PATTERN 1)

Sub Head : 17.0 Sanitary Installations

Clause : 17.21.1

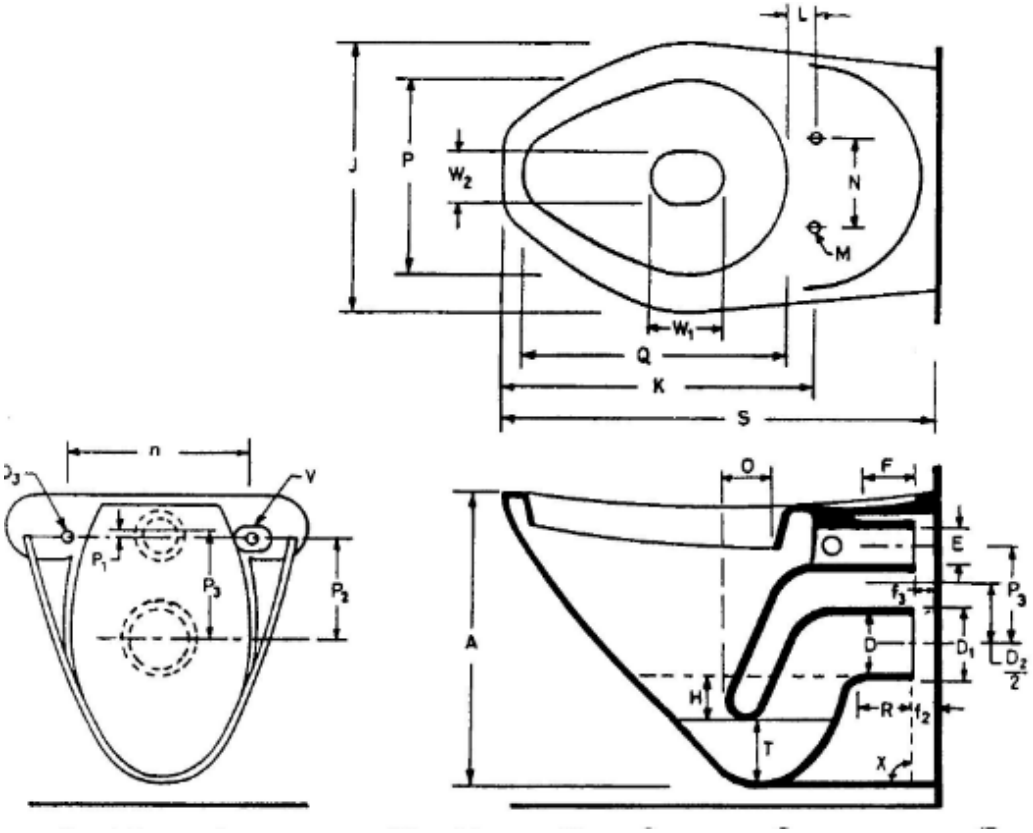


Fig **17.25** Typical illustration of wall mounted Water Closet with concealed outlet (Pattern 1)

TABLE-2

Connecting dimensions:

SL.No	Description	Reference to Fig 25 & Fig 26	Pattern 1	Pattern 2
1	Internal Dia of Inlet	E	55+3 -1	55±3

TYPICAL ILLUSTRATION OF WATER CLOSET WITH FIXING ARRANGEMENT ON TOP OF BRACKET (PATTERN 2)

Sub Head : 17.0 Sanitary Installations

Clause : 17.21.1

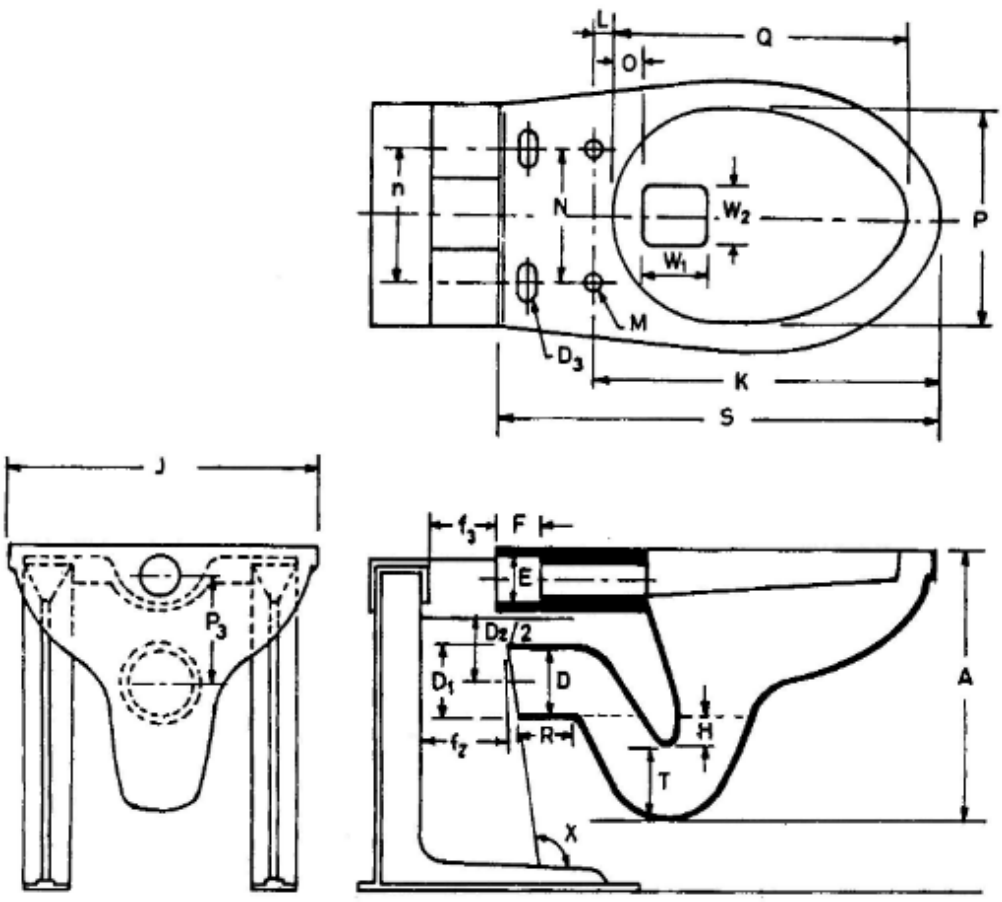


Fig 17.26 Typical illustration of water closet with fixing arrangement on top of bracket (pattern 2)

SUB HEAD : 18.0

WATER SUPPLY

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LIST OF BUREAU OF INDIAN STANDARDS (BIS) CODES

S. No.	*BIS. No.*	*Subject*
1	IS 554	Pipe threads where pressure tight joints are required on the threads- Dimensions, tolerances and designation.
2	IS 778	Specification for copper alloy gate, and check valves for water works purposes
3	IS 779	Water meters (domestic type) -Specification
4	IS 14846	Specification for sluice valves for water works purposes (50 to 1200 mm size)
5	IS 781	Specification for cast copper alloy screw down bib taps and stop valves for water services
6	IS 782	Specification for caulking lead
7	IS 909	Underground fire hydrant, sluice valve type-Specification
8	IS 1239 (Part 1)	Steel tubes tubular and other wrought steel fittings, Part 1- Steel tubes- Specification
9	IS 1239 (Part 2)	Specification for mild steel tubes tubular and other wrought steel fittings, Part 2-Mild street tubular and other wrought steel pipe fittings
10	IS 1536	Centrifugally cast (spun) iron pressure pipes for water gas and sewage- Specification
11	IS 1537	Specification for vertically cast iron pressure pipes for water, gas and sewage
12	IS 1538	Cast iron fittings for pressure pipes for water, gas and sewage - Specification
13	IS 1703	Water fittings - copper alloy float valves (horizontal plunger type) - Specification
14	IS 2692	Ferrules for water services- Specification
15	IS 3950	Specification for surface boxes for sluice valves
16	IS 4736	Specification for Hot-dip Zinc Coatings on mild steel tubes
17	IS 5312 (Part 1)	Swing type reflex (non return) valves for water works purposes. Part 1- Single door pattern
18	IS 5312 (Part 2)	Swing type reflex (non return) valves for water works purposes. Part 2- Multi door pattern
19	IS 5382	Rubber sealing rings for gas mains, water mains and sewers
20	IS 9762	Specification for polyethylene floats (spherical) for float valves
21	IS 9763	Plastic Bib taps and stop valves (rising spindle) for cold water services- specifications
22	IS 15450	PE-AL-PE Pipes for hot and cold water supplies-Specifications

23	IS 15778	Chlorinated Polyvinyl Chloride (CPVC) pipes for potable hot and cold water distribution supplies-specifications.
24	IS 15801	Polypropylene- Random Copolymer Pipes for hot and cold water supplies-Specifications
25	IS 2685	Code for selection/Installation and Maintenance of Sluice Valve

18.0 WATER SUPPLY

18.1 TERMINOLOGY

Air Gap: The unobstructed vertical distance through the free atmosphere between the lowest opening from any pipe or fitting supplying water to a tank or other device and the flood level rim of the receptacle in a water supply system.

Air Valve: A valve that releases air from a pipe line automatically without loss of water, or introduces air into a pipe line automatically if the internal pressure becomes less than that of the atmosphere.

Available Head: The head of water available at the point of consideration due to main's pressure or overhead tank or any other source of pressure.

Back Flow: The flow of water into the distributing pipes of water system from any source or sources other than its intended source.

Back Siphonage: The flowing back of used, contaminated or polluted water from a plumbing fitting or vessel into a water supply system due to a lowering of pressure in such system.

Ball Cock (Fig. 18.1): A faucet opened or closed by the fall or rise of a ball floating on the surface of water.

Branch (Fig. 18.2): (i) A special form of cast iron pipe used for making connections to water mains. The various types are called T, Y, T-Y, double Y, and V branches, according to their respective shapes.

(ii) Any part of a piping system other than a main.

Capacity: The storage capacity of storage or flushing cistern or a tank when filled up to the water line.

Non Return Valve (Fig. 18.4): A device provided with a disc hinged on one edge so that it opens in the direction of normal flow and closes with reversal of flow.

Collar: A pipe fitting in the form of a sleeve for jointing the spigot ends of two pipes in the same alignment.

Coupling: A pipe fitting with inside threads only, used for connecting two pieces of pipe.

Cross (Fig. 18.2): A pipe fitting used for connecting four pipes at right angles.

Elbow (Fig. 18.2): A pipe fitting for providing a sharp change of direction in a pipe line.

Ferrule (Fig. 18.2): A pipe fitting for connecting a service pipe to a water main.

Fitting: Anything fitted or fixed in connection with the supply, measurement, control, distribution, utilization or disposal of water.

Fire Hydrant (Fig. 18.5): A device connected to a water main and provided with necessary valve and outlets, to which a fire hose may be attached for discharging water at a high rate for the purpose of extinguishing fires, washing down streets, or flushing out the water main.

Flange (Fig. 18.2): A projecting flat rim on the end of a valve, pipe etc.

Flanged Pipe (Fig. 18.2): A pipe provided with flanges so that the ends can be joined together by means of bolts.

Float Valve: A valve in which the closure to an opening such as a plug or gate is actuated by a float to control the flow into a tank.

Sluice Valve (Gate Valve) (Fig. 18.4) : A valve in which the flow of water is cut off by means of a circular disc., fitting against machine-smoothed faces, at right angles to the direction of flow. The disc is raised or lowered by means of a threaded stem connected to the handle of the valve; the opening in the valve is usually as large as the full bore of the pipe.

Nipple (Fig. 18.2): A tubular pipe fitting usually threaded on both ends and less than 300 mm long used for connecting pipes or fittings.

Offset: A combination of elbows or bends which brings one section of the pipe out of line but into a line parallel with the other section in a piping system.

Reflux Valve (Fig. 18.4): A non return valve used in a pipe line at a rising gradient to prevent water that is ascending the gradient from flowing back in the event of a burst lower down.

Socket (Fig. 18.2): The female part of the spigot and socket joint.

Spigot (Fig. 18.2): The male part of a spigot and socket joint.

Stop Cock (Fig. 18.3): A control valve fixed at the end of a communication pipe which controls the supply from the water main.

Storage Tank: A tank or a cistern for storage of water which is connected to the water main by means of a supply pipe.

Service or Supply Pipe: Pipe through which supply is drawn from water mains.

Union (Fig. 18.2): A pipe fitting used for joining the ends of two pipes neither of which can be turned.

Valve: A device used for controlling the flow of water in a pipe line.

18.2 GENERAL REQUIREMENTS

18.2.1 Any damage caused to the building, or to electric, sanitary water supply or other installations etc. therein either due to negligence on the part of the contractor, or due to actual requirements of the work, shall be made good and the building or the installations shall be restored to its original condition by the contractor. Nothing extra shall be paid for it, except where otherwise specified.

18.2.2 All water supply installation work shall be carried out through licensed plumbers.

18.2.3 It is most important to ensure that wholesome water supply provided for drinking and culinary purposes, is in no way liable to contamination from any less satisfactory water. There shall, therefore, be no cross connection whatsoever between a pipe or fitting for conveying or containing wholesome water and a pipe or fitting for conveying or containing impure water or water liable to contamination or of uncertain quality of water which has been used for any purpose. The provision of reflux or non-return valves or closed and sealed valves shall not be construed a permissible substitute for complete absence of cross-connection.

18.2.4 Where a supply of wholesome water is required as an alternative or standby to supply of less satisfactory water or is required to be mixed with the latter, it shall be delivered only into a cistern, and by a pipe or fitting discharging into the air gap at a height above the top edge of the cistern equal to twice its nominal bore, and in no case less than 15 cm.

18.2.5 No piping shall be laid or fixed so as to pass into, through or adjoining any sewer, scour outlet or drain or any manhole connected therewith nor through any ash pit or manure-pit or any material of such nature that can cause undue deterioration of the pipe.

18.2.6 Where the laying of any pipe through fouled soil or previous material is unavoidable, the piping shall be properly protected from contact with such soil or material by being carried through an exterior cast iron tube or by some other suitable means. Any piping or fitting laid or fixed which does not comply with the above requirements, shall be removed and re-laid in conformity with the above requirements.

18.2.7 The design of the pipe work shall be such that there is no possibility of backflow towards the source of supply from any cistern or appliance whether by siphonage or otherwise, and reflux or non-return valves shall not be relied upon to prevent such back flow.

18.2.8 All pipe work shall be so designed, laid or fixed, and maintained so that it remains completely watertight, thereby avoiding wastage of water, damage to property and the risk of contamination of the water conveyed.

18.2.9 In designing and planning the layout of the pipe work, due attention shall be given to the maximum rate of discharge, required economy in labour and materials, protection against damage and corrosion, protection from frost, if required, and to avoidance of airlocks, noise transmission and unsightly arrangement.

18.2.10 To reduce frictional losses, piping shall be as smooth as possible inside. Methods of jointing shall be such as to avoid internal roughness and projection at the joints, whether of the jointing materials or otherwise.

18.2.11 Change in diameter and in direction shall preferably be gradual rather than abrupt to avoid undue loss of head. No bend or curve in piping shall be made so as to materially reduce or alter the cross-section.

18.2.12 Underground piping shall be laid at such a depth that it is unlikely to be damaged by frost or traffic loads and vibrations. It shall not be laid in ground liable to subsidence, but where such ground cannot be avoided; special precautions shall be taken to avoid damage to the piping. Where piping has to be laid across recently disturbed ground, the ground shall be thoroughly consolidated so as to provide a continuous and even support.

18.2.13 Where the service pipe is of diameter less than 50 mm the stop valves shall be of the screw-down type and shall have loose washer plates to act as non-return valves. Other stop valves in the service line may be of the gate type.

18. 2.14 In flats and tenements supplied by a common service pipe a stop valve shall be fixed to control the each branch separately. In large buildings a sufficient number of stop valves shall be fixed on branch pipes, and to control groups of ball valves and draw off taps, so as to minimize interruption of the supply during repairs, all such stop valves shall be fixed in accessible positions and properly protected from being tampered with, they may be of the gate type to minimize loss of head by friction.

18.2.15 Water for drinking or for culinary purposes as far as possible shall be on branch pipes connected directly to the service pipe.

18.2.16 Pumps shall not be allowed on the service pipe as they cause a drop of pressure on the suction side thereby affecting the supply to the adjoining properties. In cases where pumping is required, a properly protected storage tank of adequate capacity shall be provided to feed the pump.

18.2.17 Service pipes shall be so designed and constructed as to avoid air-locks, so that all piping and fittings above ground can be completely emptied of water to facilitate repairs. There shall be draining taps or draw-off taps (not underground) at the lowest points, from which the piping shall rise continuously to draw-off taps, ball valves, cisterns, or vents (where provided at the high points).

18.2.18 Service pipes shall be designed so as to reduce the production and transmission of noise as much as possible. Appliances which create noise shall be installed as far distant as possible from the living rooms of the house. High velocity of water in piping and fittings shall be avoided.Piping shall be confined, as far as possible, to rooms where appliances are fixed, it shall have easy bends, and where quietness is particularly desired, holder bats or clamps shall be insulated from the piping by suitable pads.

18.2.19 The rising pipe to the storage cistern, if any, or to any feed cistern shall be taken as directly as possible to the cistern and shall be fixed away from windows or ventilators.

18.2.20 All pipe work shall be planned so that the piping is accessible for inspection, replacement and repair. To avoid its being unsightly, it is usually possible to arrange it in or adjacent to cupboards, recesses, etc. provided there is sufficient space to work on the piping with the usual tools. Piping shall not be buried in walls or solid floors. Where unavoidable, piping may be buried for short distances provided that adequate protection is given against damage and that no joints are buried. If piping is laid in ducts or chases, these shall be roomy enough to facilitate repairs and shall be so constructed as to prevent the entry of vermin. To facilitate removal of pipe casing, floor boards covering piping shall be fixed with screws or bolts.

18.2.21 When it is necessary for a pipe to pass through a wall or floor, a sleeve shall be fixed therein for insertion of the pipe and to allow freedom for expansion, contraction and other movement. Piping laid in wood floors shall, where possible, be parallel with the joists.

18.2.22 Where storage tanks are provided to meet overall requirements of water connection of service pipe with any distributing pipe shall not be permitted except one direct connection for culinary or drinking requirements.

18.2.23 No service pipe shall be connected to any water closet or urinal. All such supplies shall be from flushing cisterns which shall have supply from storage tank.

18.2.24 No service or supply pipe shall be connected directly to any hot-water system or to any apparatus used for heating other than through a feed cistern thereof.

18.3 MATERIALS

18.3.0 The standard size of brass or gun metal fittings shall be designated by the nominal bore of the pipe outlet to which the fittings are attached. A sample of each kind of fittings shall be got approved from the Engineer-in-Charge and all supplies made according to the approved samples.

All cast iron fittings shall be sound and free from laps, blow holes and pitting. Both internal and external surfaces shall be clean, smooth and free from sand etc. Burning, plugging, stopping or

patching of the casting shall not be permissible. The bodies, bonnets, spindles and other parts shall be truly machined so that when assembled the parts shall be axial, parallel and cylindrical with surfaces smoothly finished. The area of the water way of the fittings shall not be less than area of the nominal bore, chromium plating wherever specified shall be of 0.3 micron. The chromium shall never be deposited on brass unless a heavy coating of nickel is interposed. In the case of iron a thick coat of copper shall first be applied, then one of nickel and finally the chromium. In finish and appearance the plated articles when inspected shall be free from plating defects such as blisters, pits roughness and unplated areas and shall not be stained or discoloured. Before fitting is plated, the washer plate shall be removed from the fittings, the gland packing shall be protected from the plating solution.

18.3.1 Ball Valve (Brass)

The ball valve shall be of Brass or Gunmetal as specified conforming to IS 1703 (Fig. 18.1). The ball valve shall be of following two classes:—

(a) High Pressure: High pressure float valves are indicated by the abbreviation 'HP' and are designed for use on mains having pressure of 0.175 MPa or above.

(b) Low Pressure: Low Pressure float valves are indicated by the abbreviation 'LP' and are designed for use on mains having a pressure up to. 0.175 MPa.

The ball valves shall be of following nominal sizes 15 mm, 20 mm, 25 mm, 32 mm, 40 mm and 50 mm. The nominal size shall correspond with the nominal bore of the inlet shanks. Polyethylene floats shall conform to IS 9762.

18.3.2 Bib Taps and Stop Valve

Brass (Fig. 18.3): A bib tap is a draw off tap with a horizontal inlet and free outlet and a stop valve is a valve with suitable means of connections for insertion in a pipe line for controlling or stopping the flow. They shall be of specified size and shall be of screw down type and shall conform to IS 781. The closing device shall work by means of disc carrying a renewable non-metallic washer which shuts against water pressure on a seating at right angles to the axis of the threaded spindle which operates it. The handle shall be either crutch or butterfly type securely fixed to the spindle. Valve shall be of the loose leather seated pattern. The cocks (taps) shall open in anti-clock wise direction.

The bib tap and stop valve shall be polished bright. The minimum finished weights of bib tap and stop valve shall be as specified in Table 18.1.

TABLE 18.1
Minimum Finished Mass of Bib Taps and Stop Valves

Size	Minimum Finished Mass			
	Bib Taps	Internally Threaded	Externally Threaded	Mixed End
(1)	(2)	(3)	(4)	(5)
mm	kg	kg	kg	kg
8	0.250	0.220	0.250	0.235
10	0.300	0.300	0.350	0.325
15	0.400	0.330	0.400	0.365
20	0.750	0.675	0.750	0.710
25	1.250	1.180	1.300	1.250
32	--	1.680	1.800	1.750
40	--	2.090	2.250	2.170
50	--	3.700	3.850	3.750

In case these are required to be nickel plated, the plating shall be of the first quality with a good thick deposit of silvery whiteness capable of taking high polish which will not easily tarnish or scale.

18.3.3 Ferrules (Fig. 18.2)

The ferrules for connection with C.I. main shall generally conform to IS 2692. It shall be of non ferrous materials with a C.I. bell mouth cover and shall be of nominal bore as specified. The ferrule shall be fitted with a screw and plug or valve capable of completely shutting off the water supply to the communication pipe, if and when required.

18.3.4 Fire Hydrants (Fig. 18.5)

The hydrant shall conform to IS 909 and shall consist of the following components:

(a)	Body	(d)	Gland	(g)	Valve
(b)	Bonnet	(e)	Spindle Cap	(h)	Screwed Outlet
(c)	Spindle	(f)	Spindle Nut	(i)	Outlet and Chain

The body, bonnet, gland, outlet cap and spindle cap and shall be of good quality cast iron grade FG 200 of IS 210. Outlet, seat for valve, valve, spindle nut, check nut shall be made of copper alloy as per IS 909.

18.3.5 Gate Valve - Gun Metal (Fig. 18.5)

These shall be of the gun metal fitted with wheel and shall be of gate valve type opening full way and of the size as specified. These shall generally conform to IS 778.

18.3.6 Pig Lead

Pig lead shall be of uniform quality, clean and free from foreign materials. It shall be of uniform softness and capable of being easily caulked or driven. It shall conform to IS 782 for caulking lead in all respects.

18.3.7 Lead Wool

Lead wool shall conform to IS 782 in all respects. Lead wool shall consist of fine strands or plated ribbons of lead. The cross-section of the individual strands shall be flat. The dimensions in the sectional plane shall not be less than 0.13 mm and not more than 0.90 mm and the rope shall be supplied in minimum lengths of two metres and the maximum length in any one package shall be such that the package does not weigh more than 50 Kg.

18.3.8 Non-Return Valve (Gun Metal) (Fig. 18.4)

A non- return valve permits water to flow in one direction only and is provided on the ascending part of the main to check return flow. The non-return valve shall be of Gun metal and shall be of horizontal or vertical flow type as specified.

The valve shall be of quality approved by the Engineer-in-Charge and shall generally conform to IS 778.

18.3.9 Pipes and Specials

Pipes and specials may be of any of the following types as specified:

(a) Cast iron centrifugally cast (spun) – IS 1536

(b) Galvanised steel – IS 1239 & IS 4736

(c) PE-AL-PE Pipes – IS 15450

(d) PP-R Pipes – IS 15801

(e) CPVC pipes – IS 15778

In choosing the material for piping and fittings, account shall be taken of the character of the water to be conveyed through it, the nature of the ground in which the pipes are to be laid and the relative economics.

18.3.10 Pipes- Centrifugally Cast (Spun) Iron Pipes

18.3.10.1 The spun iron pipes shall conform to IS 1536. The spun iron pipes shall be of cast iron cast centrifugally and vary in diameters from 80 mm to 750 mm. These shall be of class LA, class A and class B, as specified. Pipes shall be tested hydrostatically at the pressure specified in table 18.2 & 18.3. Tolerances on specified dimensions shall be as prescribed in Appendix A.

18.3.10.2 ***Specials:*** The specials shall conform to IS 1538. The hydraulic test pressure of each class shall be as detailed in Table 18.4. Tolerances on specified dimensions shall be as prescribed in Appendix B of sub head- 18.

TABLE 18.2

Hydrostatic Test pressure for centrifugally cast socket & spigot pipes in MPa		
Hydrostatic Test pressure for works in MPa		
Class	*Up to DN 600*	*DN 700 & above*
LA	3.5	1.5
A	3.5	2.0
B	3.5	2.5

TABLE 18.3

Hydrostatic Test pressure for centrifugally cast pipes with screwed on flanges in MPa		
Class	*Up to DN 600*	*DN 700 & above*
B	2.5	1.6

TABLE 18.4

Hydrostatic Test pressure for fittings in MPa (N/mm^2) (metre head)		
Nominal - Diameter	Fitting without branches or with branches not greater than half the principle diameter.	Fitting with Branches greater than half the Principal Diameter.
Up to and including 300 mm	2.5 (25)	2.5 (25)
Over 300 mm and up to and including 600 mm	2.0 (20)	2.0 (20)
Over 600 mm and up to and including 1500 mm	1.5 (15)	1.0 (10)

18.3.11 Pipes-Galvanised Iron

18.3.11.1 The pipes (tubes) shall be galvanised mild steel hot finished seamless (HFS) or welded (ERW) HRIW or HFW screwed and socketed conforming to the requirements of IS 1239 Part-I for medium grade. They shall be of the diameter (nominal bore) specified in the description of the item, the sockets shall be designated by the respective nominal bores of the pipes for which they are intended.

18.3.11.2 ***Galvanising shall conform to IS 4736 :*** The zinc coating shall be uniform adherent, reasonably smooth and free from such imperfections as flux, ash and dross inclusions, bare batches, black spots, pimples, lumping runs, rust stains, bulky white deposits and blisters. The pipes and sockets shall be cleanly finished, well galvanised in and out and free from cracks, surface flaws laminations and other defects. All screw threads shall be clean and well cut. The ends shall be cut cleanly and square with the axis of the tube.

18.3.11.3 The dimensions and weights of pipes and sockets and tolerances shall be as prescribed in Appendix 'C'.

18.3.11.4 All screwed tubes and sockets shall have pipe threads conforming to the requirements of IS 554. Screwed tubes shall have taper threads while the sockets shall have parallel threads.

18.3.11.5 All tubes shall withstand a test pressure of 50 Kg/sq.cm without showing defects of any kind.

18.3.11.6 ***Fittings :*** The fittings shall be of mild steel tubular or wrought steel fittings conforming to IS 1239 (Part-2) or as specified. The fittings shall be designated by the respective nominal bores of the pipes for which they are intended.

18.3.12 Shower Rose Brass

The shower rose shall be of chromium plated brass of specified diameter. It shall have uniform perforations. The inlet size shall be 15 mm or 20 mm as required.

18.3.13 Sluice Valves-Brass/Gun Metal (Fig. 18.4)

The sluice valves are used in a pipe line for controlling or stopping flow of water. These shall be of specified size and class and shall be of inside non-raising screw type up to 300 mm size and raising or non-raising screw type above 300 mm with either double flange or double socket ends and cap or hand wheel. These shall in all respects comply with the Indian Standard Specification IS 14846. Class I sluice valves are used for maximum working pressure of 10 Kg/sq.cm (100 metre head) and class II sluice valve for 15 Kg/sq.cm (150 metre head).

The body, domes covers, wedge gate and stuffing box shall be of good quality cast iron, the spindle of bronze, and the nut and valve seats of leaded tin bronze. The bodies, spindles and other parts shall be truly machined with surface smoothly finished. The area of the water way of the fittings shall be not less than the area equal to the nominal bore of the pipe.

The valve shall be marked with an arrow to show the direction of turn for closing of the valve.

18.3.14 Surface Box (Fig. 18.6 & 18.7)

This shall be of cast iron, well made and free from casting and other defects. All sharp edges shall be removed and finished smooth. The shape and dimensions for surface boxes for stop cocks, sluice valves, fire hydrants, water meters etc. shall be as specified in Fig. 18.3 & 18.4.

The C.I. surface boxes shall be coated with a black bituminous composition except in case of fire hydrants where the cover of the surface box shall be painted with two coats of rust resisting bright luminous yellow paint for clear visibility during night.

18.3.15 Water Meter (Domestic Type) (Fig. 18.4)

18.3.15.1 Water meters shall be selected according to flow to be measured and not necessarily to suit a certain size of main. The following points shall govern the selection of meters:

(a) The maximum flow shall not exceed the nominal capacity of the meter.

(b) The continuous flow shall be not greater than the continuous running capacity rating.

(c) The minimum flow to be measured shall be within minimum starting flows.

18.3.15.2 Inferential water meter has the same accuracy as the semi -positive type at higher flows; it passes unfiltered water better than a semi-positive meter and is lower in cost.

18.3.15.3 Special care is necessary in selecting the most suitable meter where large rates of flow may exist for short periods. The normal working flow shall be well within the continuous running capacity specified in IS 779, as high rates of flow over short period may cause excessive wear if the meter chosen is too small for the duty.

18.3.15.4 Owing to the fine clearances in the working parts of meters, they are not suitable for measuring water containing sand or similar foreign matter, and in such cases a filter or dirt box of adequate effective area shall be fitted on the upstream side of the meter. See Fig. 18.4. It shall be noted that the normal strainer fitted inside a meter is not a filter and does not prevent the entry of small particles, such as sand.

18.3.15.5 Water meters and their parts, especially parts coming in continuous contact with water shall be made of materials resistant to corrosion and shall be non -toxic and non-training. Use of dissimilar metals in contact under water shall be avoided as for possible in order to minimise electrolytic corrosion.

18.3.15.6 ***Body :*** The body of water meter shall be made either from Type A or Type B materials as specified below:—

Type A : The body of water meters shall be made from bronze, brass or any other corrosion resistant material e.g. Grey iron castings, blackheart malleable iron, pherodial graphite iron casting.

Type B: The body of the water meters shall be made form suitable plastics.

Note: Plastics shall have following qualities:

(i) It shall not affect the potability of water.

(ii) Elongation, 15 per cent, Min. on a specimen of length 150 mm (for procedure of determination of elongation).

(iii) Water absorption on immersion for 24 hours should not exceed 0.6 per cent by weight (for procedure of determination of water absorption).

(iv) It shall be capable of withstanding temperature up to 55°C without undergoing deformation or softening and becoming unsatisfactorily in performance.

18.3.15.*7 Registration Box:* Registration box of water meters of Type A shall be made from bronze, brass, aluminium alloy or suitable plastics. Registration box of water meters of Type B shall be made from suitable plastics or aluminium alloys. The registration box of dry dial water meters shall be provided with one or two escape holes for minimising the accumulation of condensed water.

18.3.15.8 ***Cap:*** Cap of water meters of Type A shall be made from brass, bronze, aluminium alloy or suitable plastics. The cap of water meters of Type B shall be made of plastics or aluminium alloy. Where the cap and registration box are integral, the materials for cap may be the same as used for registration box. The cap shall be so designed and fixed to the registration box as to avoid entry of water and dirt. The transparent window which covers the dial shall be inserted from the inside into the cap. The protective lid shall be secured by a robust hinge or other suitable method of robust construction.

18.3.15.9 ***Locking Arrangement:*** Provision shall also be made to lock the lid. The provision shall be such that the lock is conveniently operated from the top. Where the provision is designed for use in conjunction with padlocks, the hole provided for padlocks shall be of a diameter not less than 4 mm.

18.3.15.10 ***Wiper:*** Where so required for dry-type water meters the transparent window covering the dial shall be provided with a wiper on the inner side for wiping off condensed water.

18.3.15.11 ***Connecting Arrangements:*** The meter casing shall be fitted in the pipe line by means of two conical or cylindrical nipples or tail pieces with connecting nuts which shall be provided with each meter. The nipples of water meters of Type A shall be made of the same materials as specified for body.

Nipples of water meters of Type B shall be made of the same materials as specified for the body where they are integral with the body of the water meters; where they are separate, they shall be made of malleable iron, galvanized steel or suitable plastics. The nuts shall be of the same material as used for nipples. The internal diameter of the nipple where it connects the pipe line shall be equal to that corresponding to the nominal size of the meter. The threads on the connection shall conform to IS 779. The minimum length of the threads shall be as given in Table 18.5.

18.3.15.12 ***Strainers:*** Water meters shall be provided with strainers. Strainers shall be of a material which is not susceptible to electrolytic corrosion. They shall be of plastics or other corrosion-resistant materials for both Type A and Type B meters. They shall be rigid, easy to remove and clean, and shall be fitted on the inlet side of the water meter. It shall be possible to remove and clean the strainer in such a way as not to permit disturbing the registration box or tampering with it. The strainer shall have a total area of holes not less than twice the area of the nominal inlet bore of the pipe to which the meter is connected however, in the case of meters provided with internal strainer involving opening of the registration box for cleaning, an additional external strainer shall be fitted on the inlet side satisfying the above requirements.

Overall dimension of water meters shall be as specified in Table 18.6.

TABLE 18.5
Minimum Length of Thread on Connections

Nominal size of meter	*Minimum length of thread*
15	12
20	14
25	16
40	20
50	25

(All dimensions in millimeters)

Screws & studs shall be of brass or other corrosion resistant material.

TABLE 18.6
Overall Dimensions of Water Meters

Nominal size of Meter	Overall length including nipples	Overall width. (Max.)	Overall height (Max.)
1	*2*	*3*	*4*
15	250	100	180
20	290	130	240
25	380	170	260
40	430	210	300
50	470	270	300

All dimensions are in mm.

Tolerance on the overall length shall be ± 5 mm. for meter with nipples and +0,-2 mm for meters without nipples.

18.3.15.13 ***Capacity on Short Period Rating or Nominal Capacity:*** The nominal capacity of the water meters shall be as specified in Table 18.7. The meters shall be capable of giving minimum discharges as stated in the table without the head loss exceeding 10 m within the meters.

18.3.16 Yarn (Spun)

Spun yarn shall be of clean hemp and of good quality. It shall be soaked in hot coal tar or bitumen and cooled before use.

18.4 LAYING AND JOINTING OF PIPES AND FITTINGS

18.4.1 Unloading

18.4.1.1 The pipes shall be unloaded where they are required.

18.4.1.2 ***Unloading (except where mechanical handling facilities are available) :*** Pipes weighing up to 60 kg shall be handled by two persons by hand passing. Heavier pipes shall be unloaded from the lorry or wagon by holding them in loops, formed with ropes and sliding over planks set not steeper than 45 degree. The planks shall be sufficiently rigid and two ropes shall always be used to roll the pipes down the planks. The ropes should be tied on the side opposite the unloading. Only one pipe shall be unloaded at a time.

TABLE 18.7
Nominal Capacity of Water Meters

Discharge per hour		
Nominal size of meter (mm)	Semi positive Type (liters)	Inferential Type (liters)
15	2000	2500
20	3400	3500
25	5500	5500
40	10000	16000
50	15000	23000

18.4.1.3 Under no circumstances shall the pipes be thrown down from the carriers or be dragged or rolled along hard surfaces.

18.4.1.4 The pipes shall be checked for any visible damage (such as broken edges, cracking or spalling of pipe) while unloading and shall be sorted out for reclamation. Any pipe which shows sufficient damage to preclude it from being used shall be discarded.

18.4.2 Storing

18.4.2.1 The pipes and specials shall be handled with sufficient care to avoid damage to them. These shall be lined up on one side of the alignment of the trench, socket facing upgrade when line runs uphill and upstream when line runs on level ground.

18.4.2.2 Each stack shall contain pipes of same class and size, consignment or batch number and particulars of suppliers, wherever possible, shall be marked on the stack.

18.4.2.3 Storage shall be done on firm, level and clean ground. Wedges shall be provided at the bottom layer to keep the stack stable.

18.4.3 Cutting

18.4.3.1 Cutting of pipes may be necessary when pipes are to be laid in lengths shorter than the lengths supplied, such as while replacing accessories like tees, bends, etc. at fixed position in the pipe lines.

18.4.3.2 A line shall be marked around the pipe with a chalk piece at the point where it is to be cut. The line shall be so marked that the cut is truly at right angle to the longitudinal axis of the pipe. The pipe shall be rigidly held on two parallel rafters nailed to cross beams, taking care that the portion to be cut does not overhang and the cut mark is between the two rafters. The pipe shall be neatly cut at the chalk mark with carpenter's saw or hacksaw having a long blade, by slowly rotating the pipe around its longitudinal axis so as to have the uncut portion on top for cutting. Cutting of the pipe at the overhang should, as far as possible, be avoided, as an overhanging and is liable to tear off due to its weight before the cutting is complete.

18.4.4 Trenches

18.4.4.1 The trenches shall be so dug that the pipes may be laid to the required alignment and at required depth.

18.4.4.2 Cover shall be measured from top of pipe to the surface of the ground.

18.4.4.3 The bed of the trench, if in soft or made up earth, shall be well watered and rammed before laying the pipes and the depressions, if any, shall be properly filled with earth and consolidated in 20 cm layers.

18.4.4.4 If the trench bottom is extremely hard or rocky or loose stony soil, the trench shall be excavated at least 150 mm below the trench grade. Rocks, stone or other hard substances from the bottom of the trench shall be removed and the trench brought back to the required grade by filling with selected fine earth or sand (or fine moorum if fine soil or sand is not available locally) and compacted so as to provide a smooth bedding for the pipe. Where excavation requires blasting operation, it shall be ensured that no pipes have been stacked in the vicinity and completed pipe line in the vicinity has already been covered before starting of blasting operations; this is necessary to prevent damage to the exposed pipes in the vicinity by falling stones as a result of blasting.

18.4.4.5 After the excavation of the trench is completed, hollows shall be cut at the required position to receive the socket of the pipes and these hollows shall be of sufficient depth to ensure that the barrels of the pipes shall rest throughout their entire length on the solid ground and that sufficient spaces left for jointing the underside of the pipe joint. These socket holes shall be refilled with sand after jointing the pipe.

18.4.4.6 Roots of trees within a distance of about 0.5 metre from the side of the pipe line shall be removed or killed.

18.4.4.7 The excavated materials shall not be placed within 1 metre or half of the depth of the trench, whichever is greater, from the edge of the trench. The materials excavated shall be separated and stacked so that in refilling they may be re-laid and compacted in the same order to the satisfaction of the Engineer-in-Charge.

18.4.4.8 The trench shall be kept free from water. Shoring and timbering shall be provided wherever required. Excavation below water table shall be done after dewatering the trenches.

18.4.4.9 Where the pipe line or drain crosses an existing road, the road crossing shall be excavated half at a time, the 2nd half being commenced after the pipes have been laid in the first half and the trench refilled. Necessary safety measures for traffic as directed shall be adopted. All types, water mains cables, etc. met within the course of excavation shall be carefully protected and supported. Care shall be taken not to disturb the electrical and communication cable met with during course of excavation, removal of which, if necessary, shall be arranged by the Engineer-in-Charge.

18.4.5 Laying

18.4.5.1 The pipes shall be lowered into the trench by means of suitable pulley blocks, sheer legs chains ropes etc. In no case the pipes shall be rolled and dropped into the trench. One end of each rope may be tied to a wooden or steel peg driven into the ground and the other end held by men which when slowly released will lower the pipe into the trench. After lowering, the pipes shall be arranged so that the spigot of one pipe is carefully centered into the socket of the next pipe, and pushed to the full distance that it can go. The pipe line shall be laid to the levels required. Specials shall also be laid in their proper position as stated above.

18.4.5.2 Where so directed, the pipes and specials may be laid on masonry or concrete pillars. The pipe laid on the level ground, shall be laid with socket facing the direction of flow of water.

18.4.5.3 The pipes shall rest continuously on the bottom of the trench. The pipes shall not rest on lumps of earth or on the joints. Four metre long wooden templates may be used to check the level of the bed. Clearance of approximately 100 mm in depth and width equal to length of the collar plus 30mm on both sides shall be provided at the joint which shall be refilled from sides after the joint is made.

18.4.5.4 In unstable soils, such as soft soils and dry lumpy soils it shall be checked whether the soils can support the pipe lines and if required suitable special foundation shall be provided.

18.4.5.5 Some clayey soils (for example black cotton soil) are drastically affected by extremes of saturation and dryness. In changing from saturated to a dry condition, these soils are subjected to extraordinary shrinkage which is usually seen in the form of wide and deep cracks in the earth surface and may result in damages to under ground structures, including pipe materials. The clay forms a tight gripping bond with the pipe, subjecting it to excessive stresses as the clay shrinks. It is recommended that in such cases an envelope of a minimum 100 mm of tamped sand shall be made around the pipe line to avoid any bonding.

18.4.5.6 In places where rock is encountered, cushion of fine earth or sand shall be provided for a depth of 150 mm by excavating extra depth of the trench, if necessary, and the pipes laid over the cushion. Where the gradient of the bed slopes is more than 30 degree it may be necessary to anchor a few pipes against sliding downwards (Fig. 18.8).

18.4.6 Thrust Blocks (Fig. 18.8)

18.4.6.0 Thrust blocks are required to transfer the resulting hydraulic thrust from the fitting of pipe on to a larger load bearing soil section.

18.4.6.1 Thrust blocks shall be installed wherever there is a change in the direction/size of the pipe line or the pressure line diagram, or when the pipe line ends at a dead end. If necessary, thrust blocks may be constructed at valves also.

18.4.6.2 Thrust blocks shall be constructed taking into account the pipe size, water pressure, type of fitting, gravity component when laid on slopes and the type of soil. The location of thrust blocks for various types' fittings is given in Fig. 18.8.

18.4.6.3 When a fitting is used to make a vertical bend, it shall be anchored to a concrete thrust block designed to have enough weight to resist the upward and outward thrust. Similarly at joints, deflected in vertical plane, it shall be ensured that the weight of the pipe, the water in the pipe and the weight of the soil over the pipe provide resistance to upward movement. If it is not enough, ballast or concrete shall be placed around the pipe in sufficient weight to counteract the thrust.

18.4.6.4 When the line is under pressure there is an outward thrust at each coupling. Good soil, properly tamped is usually sufficient to hold pipe from side movement. However, if soft soil conditions are encountered, it may be necessary to provide side thrust blocks of other means of anchoring. In such cases only pipe on each side of the deflected coupling shall be anchored without restricting the coupling.

18.4.6.5 Pipes on slopes need be anchored only when there is a possibility of the back fill around the pipe sloping down the hill and carrying the pipe with it. Generally for slopes up to 30 degree good well drained soil carefully tamped in layers of 100 mm under and over the pipe, right up to the top of trench will not require anchoring.

18.4.6.6 For steeper slopes, one out of every three pipes shall be held by straps fastened to vertical supports anchored in concrete.

18.4.7 Back Filling and Tamping

18.4.7.1 Back filling shall follow pipe installation as closely as possible to protect pipe from falling boulders, eliminating possibility of lifting of the pipe due to flooding of open trench and shifting pipe out of line by caved in soil.

18.4.7.2 The soil under the pipe and coupling shall be solidly tamped to provide firm and continuous support for the pipe line. Tamping shall be done either by tamping bars or by using water to consolidate the back fill materials.

18.4.7.3 The initial back fill material used shall be free of large stones and dry lumps. In stony areas the material for initial back fill can be shaved from the sides of the trenches. In bogs and marshes, the excavated material is usually little more than vegetable matter and this should not be used for bedding purposes. In such cases, gravel or crushed stone shall be hauled in.

18.4.7.4 The initial back fill shall be placed evenly in a layer of about 100 mm thick. This shall be properly consolidated and this shall be continued till there is a cushion of at least 300 mm of cover over the pipe.

18.4.7.5 If it is desired to observe the joint or coupling during the testing of mains they shall be left exposed. Sufficient back fill shall be placed on the pipe to resist the movement due to pressure while testing.

18.4.7.6 Balance of the back fill need not be so carefully selected as the initial material. However, care shall be taken to avoid back filling with large stones which might damage the pipe when spaded into the trench.

18.4.7.7 Pipes in trenches on a slope shall have extra attention to make certain that the newly placed back fill will not become a blind drain in effect because until back fill becomes completely consolidated there is a tendency for ground or surface water to move along this looser soil resulting in a loss of support to the pipe. In such cases, the back fill shall be tamped with extra care and the tamping continued in 100 mm layers right up to the ground level.

18.4.8 Hydrostatic Tests (Fig. 18.9)

18.4.8.1 After a new pipe has been laid, jointed and back filled (or any valved section thereof), it shall be subjected to the following two tests:

(a) Pressure test at a pressure of at least double the maximum working pressure-pipe and joints shall be absolutely water tight under the test.

(b) Leakage test (to be conducted after the satisfactory completion of the pressure test) at a pressure to be specified by the authority for duration of two hours.

18.4.8.2 ***Hydrostatic Tests:*** The portions of the line shall be tested by subjecting to pressure test as the laying progresses before the entire line is completed. In this way any error of workmanship will be found immediately and can be corrected at a minimum cost. Usually the length of the section to be tested shall not exceed 500 m.

18.4.8.3 Where any section of a main is provided with concrete thrust blocks or anchorages, the pressure test shall not be made until at least five days have elapsed after the concrete is cast. If rapid hardening cement has been used in these blocks or anchorages, test shall not be made until at least two days have elapsed.

18.4.8.4 Prior to testing, enough back fill as described in 18.4.7 shall be placed over the pipe line to resist upward thrust. All thrust blocks forming part of the finished line shall have been sufficiently cured and no temporary bracing shall be used.

18.4.8.5 The open end of the section shall be sealed temporarily with an end cap having an outlet which can serve as an air relief vent or for filling the line, as may be required. The blind face of the end cap shall be properly braced during testing by screw jacks and wooden planks or steel plate as shown in Fig. 18.6.

18.4.8.6 The section of the line to be tested shall be filled with water manually or by a low pressure pump. Air shall be vented from all high spots in the pipe line before making the pressure strength test because entrapped air gets compressed and causes difficulty in raising the required pressure for the pressure strength test.

18.4.8.7 The test pressure shall be gradually raised at the rate of approximately one Kg./sq. cm./ min. The duration of the test period if not specified shall be sufficient to make a careful check on the pipe line section.

18.5 LAYING AND JOINTING OF CAST IRON PIPES AND FITTINGS (EXTERNAL WORK)

18.5.0 Specifications described in 18.4 shall apply, as far as applicable.

TABLE 18.8
Test Pressure for Pipes

Class of pipe	*Maximum field test pressure kgf./sq.cm*
5	3.75
10	7.50
15	11.25
20	15.00
25	18.75

18.5.1 Trenches

18.5.1.1 The gradient is to be set out by means of boning rods and the required depth to be excavated at any point of the trench shall be regarded as directed by the Engineer -in-Charge. The depth of the trench shall not be less than 1 metre measured from the top of the pipe to the surface of the ground under roads and not less than 0.75 metre elsewhere.

18.5.1.2 The width of the trench shall be the nominal diameter of the pipe plus 40 cm but it shall not be less than 55 cm in case of all kinds of soils excluding rock and not less than 1 metre in case of rock.

18.5.2 Laying

Any deviation either in plan or elevation less than 11.25 degrees shall be effected by laying the straight pipes around a flat curve of such radius that minimum thickness of lead at the face of the socket shall not be reduced below 6 mm or the opening between spigot and socket increased beyond 12 mm at any joint. A deviation of about 2.25 degree can be effected at each joint in this way. At the end of each day's work the last pipe laid shall have its open ends securely closed with a wooden plug to prevent entry of water, soil, rats and any other foreign matter into the pipe.

18.5.3 Lead Caulked Joints with Pig Lead

18.5.3.1 This type of lead caulking is generally done in providing joints in gas water and sewer lines wherever it is practicable to use cast lead caulking, but not in case of wet conditions.

18.5.3.2 The approximate depth and weights of pig lead for various diameters of C.I. pipes and specials shall be as given in Table 18.9.

TABLE 18.9
Lead for Different Sizes of Pipes

Nominal size of pipe (mm)	Lead per joint (Kg.)	Depth of lead joint (mm)
(1)	(2)	(3)
80	1.8	45
100	2.2	45
125	2.6	45
150	3.4	50
200	5.0	50
250	6.1	50
300	7.2	55
350	8.4	55
400	9.5	55
450	14.0	55
500	15.0	60
600	19.0	60
700	22.0	60
750	25.0	60

Note: 1. The quantity of lead given in the table is on average basis and a variation of 10 per cent is permissible.

2. Before pipes are jointed on large scale, three or four sample joints shall be made and the average consumption of lead per joint shall be got approved by the Engineer-in-Charge.

Only required quantity of spun yarn shall be put so as to give the specified depth of lead in the joint.

18.5.4 Lead Caulked Joint with Lead Wool Yarn

18.5.4.1 This type of lead caulking is generally done when it is inconvenient or dangerous to use molten lead for joints, for example in cases such as inverted joints or in wet trenches or in exceptional cases. In such cases the joints shall be made with lead wool or yarn. Caulking with lead wool or yarn shall however be not carried out without the prior permission of Engineer-in-Charge.

18.5.4.2 The approximate weights and depths of lead wool or lead yarn required for each joint of various dia. of C.I. pipes and specials shall be as given in Table 18.10. Just sufficient quantity of spun yarn shall be put so as to give specified depth of lead wool.

18.5.4.3 ***Jointing:*** The spun yarn shall first be inserted and caulked into the socket as described under jointing with pig lead. Lead wool or yarn shall then be introduced in the joint in strings not less than 6 mm thick and the caulking shall be repeated with each turn of lead wool or yarn. The whole of the lead wool or yarn shall be compressed into a dense mass. The joint shall then be finally finished flush with face of the socket.

18.5.5 Flanged joints

18.5.5.1 Cast iron pipes may be jointed by means of flanges cast on. The jointing material used between flanges of pipes shall be compressed fiber board or rubber of thickness between 1.5 mm to 3 mm. The fiber board shall be impregnated with chemically neutral mineral oil and shall have a smooth and hard surface. Its weight per m^2 shall be not less than 112 gm/mm thickness.

TABLE 18.10

Diameter of pipe (mm)	Weight of lead wool or lead yarn (kg)	Depth of lead wool or lead yarn (mm)
80	0.80	19
100	0.90	19
125	1.25	20
150	1.60	23
200	2.05	23
250	2.95	25
300	3.50	25
350	4.65	29
400	5.70	31
450	6.70	32
500	8.30	33
600	10.00	35
700	11.80	36
750	13.60	38
800	15.40	40
900	16.80	40

Note: An allowance of five per cent variation in the specified weights and depths is permissible.

18.5.5.2 Each bolt should be tightened a little at a time taking care to tighten diametrically opposite bolts alternatively. The practice of fully tightening the bolts one after another shall not be allowed.

18.5.5.3 Several proprietary flexible joints are available for jointing cast iron pipes and these may be used with the specific approval of the authority, however, they shall be used strictly in accordance with the manufacturer's instructions.

18.5.5.4 For joints in small diameter cast iron piping, copper-alloy screwed unions or ferrules shall be used, and for large dia. The joints shall be made by flanged connecting pieces.

18.5.6 Hydrostatic

The procedure for testing for leakage under pressure shall be as described in Appendix D of Chapter 18 which is to be read in addition to 18.4.8. The joints of pipes and specials have to be repaired till the leakage in the portion under test is within the specified limit indicated in Appendix-D.

18.5.7 Measurements

18.5.7.1 The net length of pipes as laid or fixed, shall be measured in the running metres correct to a cm. specials shall be excluded and enumerated and paid for separately. The portion of the pipe within the collar at the joints shall not be included in the length of pipe work.

18.5.7.2 Excavation, refilling, shoring and timbering in trenches masonry or concrete pillars and thrust blocks, wherever required, shall be measured and paid for separately, under relevant items of work.

18.5.7.3 Lead caulked joints shall be measured and paid for separately.

18.5.8 Rate

The rate shall include the cost of materials and labour involved in all the operations described above except for the items measured/enumerated separately under Para 18.4.7.1, 18.4.7.2, 18.4.7.3 which shall be paid for separately.

18.6 LAYING AND JOINTING OF G.I. PIPES (EXTERNAL WORK)

18.6.0 The specifications described in 18.4 shall apply, as far as applicable.

18.6.1 Trenches

The galvanised iron pipes and fittings shall be laid in trenches. The widths and depths of the trenches for different diameters of the pipes shall be as in Table 18.11.

TABLE 18.11

Dia of pipe (mm)	Width of trench (cm)	Depth of trench (cm)
15 to 50	30	60
65 to 100	45	75

At joints the trench width shall be widened where necessary. The work of excavation and refilling shall be done true to line and gradient in accordance with general specifications for earth work in trenches.

When excavation is done in rock, it shall be cut deep enough to permit the pipes to be laid on a cushion of sand minimum 7.5 cm deep.

18.6.2 Cutting and Threading

Where the pipes have to be out or rethreaded, the ends shall be carefully filed out so that no obstruction to bore is offered. The end of the pipes shall then be carefully threaded conforming to the requirements of IS 554 with pipe dies and tapes in such a manner as will not result in slackness of joints when the two pieces are screwed together. The taps and dies shall be used only for straightening screw threads which have become bent or damaged and shall not be used for turning of the threads so as to make them slack, as the later procedure may not result in a water tight joint. The screw threads of pipes and fitting shall be protected from damage until they are fitted.

18.6.3 Jointing

The pipes shall be cleaned and cleared of all foreign matter before being laid. In jointing the pipes, the inside of the socket and the screwed end of the pipes shall be oiled and rubbed over. **Teflon Tape** should be used on threads instead of **'Dhaaga/ Safeda'**. The end shall then be screwed in the socket, Tee etc. with the pipe wrench. Care shall be taken that all pipes and fittings are properly jointed so as to make the joints completely water tight and pipes are kept at all times free from dust and dirt during fixing. Burr from the joint shall be removed after screwing. After laying, the open ends of the pipes shall be temporarily plugged to prevent access of water, soil or any other foreign matter.

18.6.4 Thrust Blocks (Fig. 18.8)

In case of bigger diameter pipes where the pressure is very high, thrust blocks of cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate of 20 mm nominal size) of adequate size and shape shall be provided on all bends to transmit the hydraulic thrust to the ground, spreading it over a sufficient areas, depending upon the type of soil met with.

18.6.5 Painting

The pipes shall be painted with two coats of anticorrosive bitumastic paint of approved quality.

18.6.6 Testing of Joints

The pipes and fittings after they are laid and jointed shall be tested to hydraulic pressure of 6 Kg/ sq. cm (60 meter). The pipes shall be slowly and carefully charged with water allowing all air to escape and avoiding all shock or water hammer. The draw off taps and stop cocks shall then be closed and specified hydraulic pressure shall be applied gradually. Pressure gauge must be accurate and preferably should have been recalibrated before the test. The test pump having been stopped, the test pressure should be maintained without loss for at least half an hour. The pipes and fittings shall be tested in sections as the work of laying proceeds, having the joints exposed for inspection during the testing. Pipes or fittings which are found leaking shall be replaced and joints found leaking shall be redone, without extra payment.

18.6.7 Trench Filling

The pipes shall be laid on a layer of 7.5 cm sand and filled up to 15 cm above the pipes. The remaining portion of the trench shall then be filled with excavated earth as described in 20.3.7. The surplus earth shall be disposed off as directed.

18.6.8 Measurements

The lengths shall be measured in running metre correct to a cm for the finished work, which shall include G.I. pipe and G.I. fittings such as bends, tees, elbows reducers, crosses, plugs, sockets, nipples and nuts, but exclude brass or gun metal taps (cocks), valves, unions, lead connection pipes and shower rose. All pipes and fittings shall be classified according to their diameters, method of jointing and fixing substance quality and finish. In case of fittings of an equal bore the pipe shall be described as including all cuttings and wastage. In case of fittings of unequal bore the largest bore shall be measured.

Note: G.I. unions shall be paid for separately in external work as well as in internal work.

Digging and refilling of trenches shall either be measured separately as specified in the appropriate clauses of excavation and earth work or clubbed with main item.

18.6.9 Rate

The rate shall include the cost of labour and materials involved in all the operations described above. The rate shall not include excavation in trenches, painting of pipes and sand filling all round the pipes, unless otherwise specified.

18.7 LAYING AND JOINTING G.I. PIPES (INTERNAL WORK)

18.7.0 For internal work the galvanised iron pipes and fittings shall run on the surface of the walls or ceiling (not in chase) unless otherwise specified. The fixing shall be done by means of standard pattern holder bat clamps, keeping the pipes about 1.5 cm clear of the wall. When it is found necessary to conceal the pipes, chasing may be adopted or pipes fixed in the ducts or recess etc., provided there is sufficient space to work on the pipes with the usual tools. The pipes shall not ordinarily be buried in walls or solid floors. Where unavoidable, pipes may be buried for short distances provided adequate protection is given against damage and where so required joints are not buried. Where directed by the Engineer-in-Charge, a M.S. tube sleeve shall be fixed at a place the pipe is passing through a wall or floor for reception of the pipe and to allow freedom for expansion and contraction and other movements. In case the pipe is embedded in walls or floors it should be painted with anticorrosive bitumastic paints of approved quality. The pipe shall not come in contact with lime mortar or lime concrete as the pipe is affected by time. Under the floors the pipes shall be laid in layer of sand filling as done under concrete floors.

All pipes and fittings shall be fixed truly vertical and horizontal unless unavoidable. The pipes shall be fixed to walls with standard pattern holder bat clamps of required shape and size so as to fit tightly on the pipes when tightened with screwed bolts, these clamps shall be embedded in brick work in cement mortar 1:3 (1 cement: 3 coarse sand), and shall be spaced at regular intervals in straight lengths as shown in Table 18.12.

The clamps shall be fixed at shorter lengths near the fittings as directed by the Engineer-in-Charge.

For G.I. pipes 15 mm diameter, the holes in the walls and floors shall be made by drilling with chisel or jumper and not by dismantling the brick work or concrete. However, for bigger dimension pipes the holes shall be carefully made of the smallest size as directed by the Engineer-in-Charge. After fixing the pipes the holes shall be made good with cement mortar 1:3 (1 cement: 3 coarse sand) and properly finished to match the adjacent surface.

TABLE 18.12

Dia. of Pipe (mm)	Horizontal length (m)	Vertical length (m)
15	2	2.5
20	2.5	3
25	2.5	3
32	2.5	3
40	3	3.5
50	3	3.5
65	3.5	5
80	3.5	5

Unions will be provided to facilitate connections additions and alterations as well as for maintenance and for change of pipes. The locations where unions are to be provided will be decided with prior written approval of the Engineer-in-Charge.

18.7.1 Measurements

The lengths shall be measured in running metre correct to a cm for the finished work, which shall include G.I. pipe and G.I. fittings such as bends, tees elbows, reducers, crosses, plugs, sockets, nipples and nuts, but exclude brass or gun metal taps (cocks), valves, unions, lead connection pipes and shower rose. All pipes and fittings shall be classified according to their diameters, method of jointing and fixing substance, quality and finish. In case of fittings of an equal bore the pipe shall be described as including all cuttings and waste. In case of fittings of unequal bore, the largest bore shall be measured. Pipes laid in trenches (or without supports) and pipes fixed to walls, ceilings, etc. with supports shall be measured separately.

18.7.2 Rate

The rate shall include the cost of labour and material involved in all the operations described above. The rate shall include the cost of cutting holes in walls and floors and making good the same. This shall not however, include concealed pipe work in which case cutting of chase and making good shall be paid separately. It shall not include painting of pipes and providing sleeves, unless specified otherwise. It will also not include union which shall be paid for separately.

18.8 POLYPROPYLENE RANDOM CO-POLYMER (PP-R) PIPES

18.8.1 The PP-R is a bonded, multilayer pipe consisting of different layers of the pipe:-

(a) The inner-most layer of the pipe to be Anti – bacterial to prevent bacteria growth inside pipe surface.

(b) The middle layer to be of plain PP-R which is neither in contact with Water and nor under direct effect of the atmospheric conditions.

(c) The outer-most layer to be of U.V. stabilized PP-R to prevent the pipe surface from sunlight under exposed atmospheric conditions.

The pipes should in general be conforming to the requirements of IS 15801 except that specified with in nomenclature of the item. The pipes should have smooth inner surface with non-contracting diameters. The pipes shall be cleanly finished, free from cracks and other defects. The pipes shall be clean and well cut along ends after taking into consideration the desired length, using the pipe scissors. The Polypropylene used for manufacturing the pipe shall conform to the requirements of IS 10951 and IS 10910. The specified base density shall be between 900 kg/m^3 and 910 kg/m^3 when determined at 27°C. The resin should be mixed with sufficient quantity of colour master batches. The colour master batch should be uniform throughout the pipe surface. The standard dimension ratio (SDR) i.e. ratio of the nominal outer diameter of a pipe to its nominal wall thickness should be 7.4/11 as given in the item.

18.8.2 Fittings

Plain fittings, Chrome plated brass threaded fittings and Valves shall be as per nomenclature of item or as directed by engineer- in- charge.

(a) The plain fittings shall be Polypropylene Random Copolymer and comply with all the requirements of the pipes. The plain fittings shall comprise of Socket, Elbow, Tee, Cross, Reducer socket, Reduction Tee, End Cap, Crossover, Omega, Threaded Plug and wall clamps in available sizes.

(b) The Chrome Plated Brass threaded fittings shall be Chrome Plated Brass threaded piece molded inside Polypropylene random copolymer fitting. The maternal shall comply with all the requirements of the pipes. The Chrome plated Brass threaded fittings shall comprise of Socket, Elbow and Tee (Male & Female) in available sizes. These are the fittings for C.P. connections and for continuations from existing Galvanized Irion Pipes and fittings.

(c) The valves shall be Polypropylene Random Copolymer Valves. The valves comprise of Gate Valve, Ball Valve, Concealed stop valve and Chrome Coated Valve in available sizes.

The Valves sizes availability in Polypropylene Random Copolymer is as follows:-

(i)	Gate Valve	-	20 mm to 63 mm
(ii)	Ball Valve	-	20 mm, 25 mm, 32 mm, 40 mm, 50 mm & 63 mm
(iii)	Concealed Stop valve	-	20 mm & 25 mm
(iv)	Chrome Coated Valve	-	20 mm & 25 mm

However, the other Brass/Bronze Valves can be connected to Polypropylene Random pipes using C.P. Brass threaded fittings of desired sizes.

18.8.3 Laying and Jointing of Pipes and Fittings

The specifications described in 18.4 shall apply as far as possible. The pipes and fittings shall run in wall chase as specified. Pipes shall run only in vertical or horizontal alignment as far as possible. The installation of pipes is similar to that of the metal pipes with the only difference in the jointing procedure. The jointing of the PP-R pipes and fittings are done by fusion welding by means of a welding machine. The marking on pipe shall carry the following information:-

(c) Manufacturer's name/ trade mark
(d) PPR pipe
(e) SDR-
(f) Out side diameter and minimum wall thickness
(g) Lot No. / Batch No. containing date of manufacturing. And machine number.

18.8.4 The out side diameter of pipes, tolerance in the same and ovality of pipe shall be as given in Table 18.13 below.

TABLE 18.13
Outside Diameter, Tolerance and Ovality of Pipes

Sl. No.	*Nominal Size DN*	*Outside Diameter (mm)*	*Tolerance (Only positive tolerance) (mm)*	*Ovality (mm)*
(i)	16	16.0	0.3	1.2
(ii)	20	20.0	0.3	1.2
(iii)	25	25.0	0.3	1.2
(iv)	32	32.0	0.3	1.3
(v)	40	40.0	0.4	1.4
(vi)	50	50.0	0.5	1.4
(vii)	63	63.0	0.6	1.6
(viii)	75	75.0	0.7	1.6
(ix)	90	90.0	0.9	1.8
(x)	110	110.0	0.9	2.2

1. The values specified for tolerance on outside diameter have been calculated as 0.009DN, rounded off to the next higher 0.1 mm subject to minimum of 0.3 mm. No negative tolerances are allowed.

2. The basis for the values specified for ovality is:
   (a) For nominal outside diameters $\leq$ 75mm, the tolerance equals (0.008 DN+1.0) mm, rounded to the next higher 0.1 mm, with a minimum value of 1.2 mm.

   (b) For nominal outside diameters $\geq$ 75mm and $\leq$ 250mm, the tolerance equals 0.20 DN, rounded to the next higher 0.1 mm.

   (c) For nominal outside diameter > 250 mm, the tolerance equals 0.35 DN, rounded to the next higher 0.1 mm.

18.8.5 Wall Thickness

The minimum and maximum wall thickness of pipes shall be as given in Table 18.14 below:-

TABLE 18.14

Sl. No.	Nominal Size	SDR 11		SDR 7.4	
	DN	Min	Max	Min	Max
(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
(i)	16	-	-	2.20	2.70
(ii)	20	1.90	2.30	2.80	3.30
(iii)	25	2.30	2.80	3.50	4.10
(iv)	32	2.90	3.40	4.40	5.10
(v)	40	3.70	4.30	5.50	6.30
(vi)	50	4.60	5.30	6.90	7.80
(vii)	63	5.80	6.60	8.60	9.70
(viii)	75	6.80	7.70	10.30	11.60
(ix)	90	8.20	9.30	12.30	13.80
(x)	110	10.00	11.20	15.10	16.90

Note: The wall thickness tolerances have been calculated on the following basis:

(a) Limit deviation=0.1e + 0.2 mm rounded up to the nearest 0.1 mm.

(b) A local increase in wall thickness of up to +0.2e is permissible for e up to 10 mm and up to 0.15e for e greater than 10 mm. The mean of the measurement shall, however, still lie within the given limit deviations.

The quality of each installation system ultimately depends on the tightness, stability and lifetime of its connections. The pipe of the desired length is cut using the pipe scissors. The proper heating piece is taken and mounted on the welding machine. The welding device is switched on - Control lamp and switch lamp will lit. When ready, control lamp gets off, which means that welding temperature of 260 Degrees ±10 Degrees Celsius has been reached. The pipe end and the fitting to be welded are heated on the welding machine. Before heating the fitting and the pipe, the dirty welding tools, pipe and fitting are cleaned with a cloth. When heated up (with heating time as per the Table shown below), the pipe and the fitting is removed from the welding machine and the two pieces connected together by applying a little pressure without twisting. The joint is allowed to cool down for a few seconds. The welding process is that safe because the properly heated part of Polypropylene create a homogeneous connection.

Guidelines for Welding PP-R Pipes and Fittings (DVS Guideline 2207, Part II)

Outer diameter of pipe(mm)	*Heating Time (Seconds)*	*Cooling Period (Minutes)*
16	5	2
20	5	2
25	7	2
32	8	4
40	12	4
50	18	4
63	24	6
75	30	8
90	30	8

The same procedure shall be adapted for exposed as well as concealed fittings. The Crossovers may be used wherever the overlapping of the PP-R pipes is required. The fixing shall be done by means of Wall Support Clamps keeping the pies about 1.5 cm clear of the wall where to be laid on the surface. Where it is specified to conceal the pipes, chasing may be adopted. For pipes fixed in the shafts, ducts etc. there should be sufficient space to work on the pipes with the usual tools. Pipe sleeves shall be fixed at a place the pipe is passing, through a wall or floor for reception of the pipe and allow freedom for expansion and contraction and other movements. Fixed supports prevent any movement of the pipe by fixing it at some points. Fittings are used in creating the fixed points. Fixed supports must not but installed at bending parts and the direction changes must be done in the pipe itself. In between the fixed supports some arrangements must be done to compensate any potential elongation or shrinkage in the pipe length. For exposed straight pipes having length more than 5 meters, to compensate the expansion an expansion piece must be used.

18.8.6 Piping Installation Support

Piping shall be properly supported by means of wall support clamps as specified and as required, keeping in view the proper designing for expansion and contraction. Risers shall be supported at each floor with clamps.Due to high coefficient of thermal expansion the heat losses though the pipes is highly reduced. Therefore, for internal Bathroom hot geyser water distribution lines, the insulation is often not required.

18.8.7 Installation of Water Meter and Valves

PP-R lines shall be cut to the required lengths at the position where the meter and Valves are required to be fixed. Suitable C.P. Brass threaded fittings shall be attached to the pipes. The meter and Valves shall be fixed in a position by means of connecting pipes, jam nut and socket etc. The stop cock shall be fixed near the inlet of the water meter. The paper disc inserted in the ripples of the meter shall be removed. And the meter shall be installed exactly horizontally or vertically in the flow line in the direction shown by the arrow cast on the body of the meter. Care shall be taken to not to disturb the factory seal of the meter. Wherever the meter shall be fixed to a newly fitted pipeline, the pipeline shall have to be completely washed before fitting the meter.

18.8.8 Testing

All water supply system shall be tested to Hydrostatic pressure test. Maximum operating pressure at varying degree of temperature is given in Table 18.15:-

TABLE 18.15

Sl. No.	Temperature	SDR 11	SDR 7.4
		Pressure MPa	Pressure MPa
(i)	10	1.91	3.02
(ii)	20	1.63	2.58
(iii)	30	1.37	2.17
(iv)	40	1.15	1.84
(v)	50	0.98	1.55
(vi)	60	0.82	1.28
(vii)	70	0.62	0.98
(viii)	80	0.39	0.62
(ix)	95	0.27	0.4

The pressure test is performed in 3 steps being preliminary test, main test and final test. For the preliminary test a pressure which is 1.5 times higher than the possible working pressure is applied and this is repeated two times in 30 minutes with intervals of 10 minutes. After a test period of 30 minutes, the test pressure must not be dropped more than 0.6 bar and no leak must occur. Main test follows the preliminary test. Test time is two hours, in doing so the test pressure taken from the preliminary test must not have fallen more than 0.2 bar. After completion of these tests, the final test comes which has to be done under a test pressure of 10 bars and 5 bar in the interval of 15 minutes. Between the respective test courses, pressure has to be removed.

All leaks and defects in joints revealed during the testing shall be rectified and got approved at site by retest. Piping required subsequent to the above pressure test shall be retested in the same manner.

System may be tested in sections and such sections shall be entirely checked on completion of connection to the overhead tanks or pumping system or mains. In case of improper circulation, the contractor shall rectify the defective connections. He shall bear all expenses for carrying out the above rectifications including the tearing up and refinishing of floors and walls as required.

After commissioning of the water supply system, contractor shall test each valve by closing and opening it a number of times to observe if it is working efficiently. Valves which are not working efficiently shall be replaced by new ones.

18.8.9 Measurements

The net length of pipes as laid or fixed shall be measured in running meters correct to a cm for the finished work, which shall include PP -R pipe and fittings including plain fittings and Chrome Plated Brass Threaded fittings. Deductions for the length of valves shall be made. The cost includes cutting chases in the masonry wall and making good the same, trenching, refilling and testing of joints. The cost of gate valves/ wheel valves/ union shall be paid for separately.

18.9 CHLORINATED POLYVINYL CHLORIDE (CPVC) PIPES

18.9.1 CPVC pipes & fittings used in hot & cold potable water distribution system shall conform to requirement of IS 15778. The material from which the pipe is produced shall consist of chlorinated polyvinyl chlorides. The polymer from which the pipe compounds are to be manufactured shall have chlorine content not less than 66.5%.

The internal and external surfaces of the pipe shall be smooth, clean and free from grooving and other defects. The pipes shall not have any detrimental effect on the composition of the water flowing though it.

Diameter and wall thickness of CPVC pipes are as per given in Table 18.16 below.

TABLE 18.16

Sl.No	Nominal size	Nominal outer diameter	Mean Outside Diameter		Outer diameter at any point		Wall Thickness					
							Class 1, SDR 11			Class 3, SDR 17		
			Max	Min	Max	Min	Avg. Max	Min	Max	Avg. Max	Min	Max
(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*	*(12)*	*(13)*
(i)	15	15.9	15.8	16.0	15.8	16.0	2.2	1.7	2.2	-	-	-
(ii)	20	22.2	22.1	22.3	22.0	22.4	2.5	2.0	2.5	-	-	-
(iii)	25	28.6	28.5	28.7	28.4	28.8	3.1	2.6	3.1	-	-	-
(iv)	32	34.9	34.8	35.0	34.7	35.1	3.7	3.2	3.7	-	-	-
(v)	40	41.3	41.2	41.4	41.1	41.5	4.3	3.8	4.3	-	-	-
(vi)	50	54.0	53.9	54.1	53.7	54.3	5.5	4.9	5.5	-	-	-
(vii)	65	73.0	72.8	73.2	72.2	73.8	-	-	-	4.8	4.3	4.8
(viii)	80	88.9	88.7	89.1	88.1	89.7	-	-	-	5.9	5.2	5.9
(ix)	100	114.3	114.1	114.5	113.5	115.1	-	-	-	7.5	6.7	7.5
(x)	150	168.3	168.0	168.6	166.5	170.1	-	-	-	11.1	9.9	11.1

Notes

1. For CPVC pipes SDR is calculated by dividing the average outer diameter of the pipe in mm by the minimum wall thickness in mm. If the wall thickness calculated by this formula is less than 1.52 mm, it shall be increased to 1.52 mm. The SDR values shall be rounded to the nearest 0.5.

18.9.2 Dimensions of Pipes

The outside diameter, outside diameter at any point and wall thickness shall be as given in Table 18.16.

18.9.2.1 ***Diameter :*** The outside diameter and outside diameter at any point as given in Table 18.16 shall be measured according to the method given in IS 12235 (part 1).

18.9.2.2 *Diameter at any point :* The difference between the measured maximum outside diameter and measured minimum outside diameter in the same cross-section of pipe (also called tolerance on ovality) shall not exceed the greater of the following two values:

(a) 0.5 mm, and

(b) 0.012 d_n rounded off to the next higher 0.1 mm.

18.9.2.3 *Wall Thickness :* The wall thickness of the pipes shall be as given in Table 18.16. Wall thickness shall be measured by any of the three methods given in IS 12235 (part 1). To check the conformity of the wall thickness of the pipe throughout its entire length, it is necessary to measure the wall thickness of the pipe at any point along its length. This shall be done by cutting the pipe at any point along its length and measuring the wall thickness as above. Alternatively, to avoid destruction of the pipe, non destructive testing methods such as the use of ultrasonic wall thickness measurement gauges shall be used at any four points along the length of the pipe.

Tolerance on Wall Thickness

(a) For pipes of minimum wall thickness 6 mm or less, the permissible variation between the minimum wall thickness (e_{Min}) and the wall thickness at any point (e), (e - e_{Min}) shall be positive in the form of +y, where y=0.1 e_{Min}+0.2 mm.

(b) For pipes of minimum wall thickness greater than 6mm, the permissible variation of wall thickness shall again be positive in the form of +y, where y would be applied in two parts.

(c) The average wall thickness shall be determined by taking at least six measurements of wall thickness round the pipe and including both the absolute minimum and absolute maximum measured values. The tolerance applied to this average wall thickness from these measurements shall be within the range 0.1 e_{Min}+0.2 mm (see Table 18.16).

(d) The maximum wall thickness at any point shall be within the range 0.15e_{Min} (see Table 18.16).

(e) The results of these calculations for checking tolerance shall be rounded off to the next higher 0.1 mm.

18.9.2.4 ***Effective Length (Le) :*** If the length of a pipe is specified, the effective length shall not be less than that specified. The preferred effective length of pipes shall be 3, 5 or 6 m. The pipes may be supplied in other lengths where so agreed upon between the manufacturer and the purchaser.

18.9.3 Pipe Ends

The ends of the pipes meant for solvent cementing shall be cleanly cut and shall be reasonably square to the axis of the pipe or may be chamfered at the plain end.

18.9.4 Physical and Chemical Characteristics

18.9.4.1 ***Visual Appearance :*** The colour of the pipes shall be off-white. Slight variations in the appearance of the colour are permitted.

The internal and external surface of the pipe shall be smooth, clean and free from grooving and other defects.

18.9.4.2 ***Opacity :*** The wall of the plain pipe shall not transmit more than 0.1 per cent of the visible light falling on it when tested in accordance with IS 12235 (Part 3).

18.9.4.3 ***Effect on Water :*** The pipes shall not have any determinate effect on the composition of the water flowing through them, when tested as per 10.3 of IS 4985.

18.9.4.4 ***Reversion Test :*** When tested by the method prescribed in IS 12235 (Part 5/ Sec 1 and Sec 2), a length of pipe 200 ±20 mm long shall not alter in length by more than 5 per cent.

18. 9.4.5 ***Vicat Softening Temperature :*** When tested by the method prescribed in IS 12235 (part 2), the Vicat softening temperature of the specimen shall not be less than 110°C.

18.9.4.6 ***Density :*** When tested in accordance with IS 12235 (Part 14), the density of the pipes shall be between 1450kg/m^3 and 1650kg/m^3.

18.9.5 Mechanical Properties

18.9.5.1 ***Hydrostatic Characteristics :*** When subject to internal hydrostatic pressure test in accordance with the procedure given in IS 12235 (part 8/Sec 1), the pipe shall not fail during the prescribed test duration. The temperatures, duration and hydrostatic (hoop) stress for the test shall conform to the requirements given in Table 18.17. The test shall be carried out not earlier than 24 h after the pipes have been manufactured.

TABLE 18.17
Requirements of Pipes for Internal Hydrostatic Pressure Test
(Clause 18.9.5.1)

Sl. No.	Test	Test Temperature Min	Test Period	Hydrostatic (Hoop) Stress
		°C	h	MPa
(1)	*(2)*	*(3)*	*(4)*	*(5)*
(i)	Acceptance	20	1	43.0
(ii)	Type	95	165	5.6
(iii)	Type	95	1000	4.6
(iv)	Type	95	8760	3.6 (Test for thermal stability)

18.9.5.2 ***Thermal Stability by Hydrostatic Pressure Testing :*** When subject to internal hydrostatic pressure test in accordance with the procedure given in IS 12235 (Part 8/Sec 1) and as per requirement given in Table 18.17, Sl. No. (iv), the pipe shall not burst or leak during the prescribed test duration.

18.9.5.3 ***Resistance to External Blow at 0°C :*** When tested by the method prescribed in IS 4985, with classified striker mass and drop height as given in Table 18.18, the pipe shall have a true impact rate of not more than 10 per cent.

TABLE 18.18
Classified Striker Mass and Drop Height Conditions for the Falling Weight Impact Test
(Clause 18.9.5.3)

Sl. No.	Nominal Pipe Size	Mass of Falling Weight	Falling Height
	mm	Kg	mm
(1)	*(2)*	*(3)*	*(4)*
(i)	15	0.5±0.5%	300±10
(ii)	20	0.5±0.5%	400±10
(iii)	25	0.5±0.5%	500±10
(iv)	32	0.5±0.5%	600±10
(v)	40	0.5±0.5%	800±10
(vi)	50	0.5±0.5%	1000± 10
(vii)	65	0.8±0.5%	1000±10
(viii)	80	0.8±0.5%	1200±10
(ix)	100	1.0±0.5%	1600±10
(x)	150	1.6±0.5%	2000±10

18.9.5.4 ***Flattening Test :*** When tested by the method prescribed in IS 12235 (part 19), pipe shall show no signs of cracking, splitting and breaking.

18.9.5.5 ***Tensile Strength :*** When tested by the method prescribed in IS 12235 (Part 19), the tensile strength at yield shall not be less than 50 MPa at 27 ± 2°C.

18.9.6 Sampling and Criteria for Conformity

The sampling procedure and criteria for conformity shall be as given in Annexure F.

18.9.7. Marking

18.9.7.1 Each pipe shall be clearly and indelibly marked in ink/paint or hot embossed on white base at intervals of not more than 3 m. The marking shall show the following:

(a) Manufacturer's name or trade-mark

(b) Outside diameter,

(c) Class of pipe and pressure rating, and

(d) Batch or lot number

18.9.7.2 ***BIS Certification Marking :*** Each pipe may also be marked with the Standard Mark.

18.9.8 Fittings

The fittings shall be as follows:

(a) Plain CPVC solvent cement fittings from size 15 mm to 160 mm.

(b) Brass threaded fittings.

(c) Valve from size 15 mm to 160 mm

(d) Brass Threaded Fittings: All types of one end brass threaded male/female adaptors in various fittings like coupler, socket, elbow, tee are available for transition to other plastic/metal piping and for fixing of CP fittings. Ball, Gate valves in CPVC are available in all dimensions. All fittings shall carry the following information:

(1) Manufacturer's name/trade mark.

(2) Size of fitting

18.9.9 Piping Installation Support and Spacing

18.9.9.1 ***Concealed Piping:*** Pipes can be concealed in chases. The pipes and fitting are to be pressure tested prior to concealing the chases. To maintain alignment of CP fittings while joining, all alignment of fittings and pipe shall be done correctly. DO NOT USE NAILS FOR HOLDING OF PIPES IN THE CHASES.

18.9.9.2 ***External Installations:*** For pipes fixed in the shafts, ducts etc. there should be sufficient space to work on the pipes. Pipes sleeves shall be fixed at a place the pipe is passing through a wall or floor so as to allow freedom for expansion and contraction. Clamping of the pipe is done to support it while allowing the freedom for movement.

All pipes exposed to sunlight shall be painted with a water based acrylic paint emulsion to enhance UV protection. Pipes in trenching shall be laid in accordance to the Good Plumbing practices followed for Metal piping.

Recommended Support Spacing (Distance between Pipe Clamps Horizontal Support)

Pipe Size	*Horizontal Support (In meters)*			
	Temperature			
	23°C	*38°C*	*60°C*	*82°C*
16 mm (1/2")	1.22	1.22	1.07	0.92
20 mm (3/4")	1.53	1.37	1.22	0.92
25 mm (1/0")	1.68	1.3	1.37	0.92
32 mm (1 1/4")	1.83	1.68	1.53	1.22
40 mm (1 1/2")	1.98	1.83	1.68	1.22
50 mm (2")	2.29	2.14	1.98	1.22

18.9.9.3 ***Expansion LOOP:*** CPVC systems, like all piping materials, expand and contract with changes in temperatures. CPVC pipes shall expand 7.5 cm per 30 m length for a 40^0C temperature change. Expansion does not vary with Pipe size. Thermal expansion can be generally be accommodated at changes in direction. On a long straight run, an offset or loop based on the following chart is required.

Nominal Pipe Size	*Length of Run (Meter), Loop length in cms.*				
	6 metre	*12 metre*	*18 metre*	*24 metre*	*30 metre*
15 mm	43	56	69	79	86
20 mm	48	66	81	91	104
25 mm	53	74	91	104	117
32 mm	58	81	102	117	130
40 mm	63	89	109	127	142
50 mm	71	102	124	145	63

18.9.10 Testing

All water supply systems shall be tested to hydrostatic pressure test. The pressure tests are similar to the test pressure used for other plastic/metal pipes. System may be tested in sections and such section shall be entirely checked on completion of connection to the overhead tank or pumping system or mains.

18.9.11 Measurements

The net length of pipes as laid or fixed shall be measured in running meters correct to a cm for the finished work, which shall include CPVC pipe and fittings including plain and Brass threaded fittings and jointing solvent cement.

18.10 PE-AL-PE PIPES

18.10.1 The PE-AL-PE pipes are bonded, multilayer pipes consisting of metal aluminium and polyethylene i.e. metallic pipe bonded with adhesive both internally and externally by polyethylene coating. The layers of PE-AL-PE pipes are:-

(i) The interior layer of polyethylene

(ii) The adhesive layer

(iii) Aluminium tube

(iv) The adhesive layer

(v) The external layer of polyethylene

Polyethylene composite pressure pipes have welded aluminium tube reinforcement between inner and outer polyethylene layers, inner and outer polyethylene layer being bonded to aluminium tube by melt adhesive and are manufactured as per IS 15450

The specially manufactured compression joints fittings should be used for PE -AL-PE pipes which are available in 3 types i.e. brass, composite and composite external sealing. Either of these fittings should be used. The external sealing fittings should be used only for cold water applications.

18.10.2 (i) Polyethylene compounds shall conform to IS 7328 as follows:
(a) PEEWA 45 T006 for black pipes and
(b) PEELA 45 T006 for coloured pipes.

(ii) Aluminium shall have following properties:
(a) Minimum elongation: 20%
(b) Ultimate tensile strength: 100 MPa.
The aluminium strip shall have nominal thickness as specified in Table 18.19 (i). Tolerances on all thickness for all sizes shall be (+) 0.02 mm.

TABLE 18.19 (i)
Aluminium Thickness and Tolerances for PE-AL-PE Pipe

S. No.	*Nominal Pipe Size (mm)*	*Nominal Aluminium Thickness (mm)*
(i)	1216	0.20
(ii)	1620	0.25
(iii)	2025	0.25
(iv)	2532	0.30
(v)	3240	0.30
(vi)	4050	0.30

(iii) Dimensions of pipes shall be as given in Table 18.19 (ii).

TABLE 18.19 (ii)

S. No.	Nominal pipe size (mm)	Nominal outside diameter (OD) (mm)	Total wall thickness		Outer PE layer Thickness Minimum (mm)
			Minimum (mm)	Maximum (mm)	
(i)	1216	16	1.75	2.00	0.40
(ii)	1620	20	2.00	2.25	0.40
(iii)	2025	25	2.45	2.70	0.40
(iv)	2532	32	2.80	3.20	0.40
(v)	3240	40	3.40	3.80	0.40
(vi)	4050	50	4.00	4.40	0.40

(iii) Dimensions of pipes shall be as given in Table 18.19 (ii).

(iv) The PE-AL-PE composite pipe shall be pressure rated for maximum water pressures of 1.38 MPa at 23°C and 1.10 MPa at 60°C.

18.10.3 Jointing

While jointing PE-AL-PE pipes, following steps are required to be taken to ensure a leak proof and strong pipe joint:-

(a) Cut the pipe square by cutter to the required and proper length.

(b) Select the fitting to be used and dismantle its nuts and split rings.

(c) Place the nut and split ring over the pipe. Ensure that 'O' rings are in proper position of insert.

(d) Prepare the end of pipe to be jointed for roundness and chamfer by using beveling tool. Push the pipe over the insert and inside the support groove fully.

(e) Push the split ring and nut towards connector till split ring touches the support groove.

(f) Tighten the nut over connector with spanner.

If the joints are required to be dismantled for any reason, the 'O' ring and split ring should be inspected before reassembling the joint for any damage. If any ring is found damaged, the same should be replaced. All other components can be reused. The joint sealing with fittings is done by silicone rubber ring. No thread sealing is involved. Tightening of the nuts is required only for compressing the spilt ring over the pipe, hence excessive tightening of the nuts is to be avoided. In case threading is required for fixing valves and fixtures, then select the fittings already having male or female thread as per the requirement.

18.10.4 Fixing in Portion of PE-AL-PE Pipes

For installation of PE-AL-PE pipes and fittings, following steps are required to be taken to ensure easy and faster installation:-

18.10.4.1 Measure the exact length of pipe required from fitting to fitting.

18. 10.4.2 Cut pipe to required length by using PE-AL-PE pipe cutter to ensure clean and square cut. If the cut is not proper then the joint will not be proper/leak proof.

18.10.4.3 Use external bending spring for straightening of the PE-Al-PE pipes which are available in coils. If there are any bends in between then insert the external bending spring over the pipe and bend it to required angle. Move the spring after bending to next bending location. After putting the pipe in position completely, remove the spring. If the ends of pipes are required to be bent then the external bending spring may not support the pipe fully. In such cases, use internal bending spring. Use of bending springs facilitates bending of pipe to desired radius without causing any deformation to the pipe.

18.10.4.4 While connecting the fitting to the end of the pipe, follow the jointing procedure.

The PE-AL-PE pipe can be bent easily to the required shape. The bending shall be done in such a way that the bending radius is not less than 5 times the outer diameter of the pipe. As the pipe stays in shape, elbows are generally not required. Due to the unique jointing system, unions are not at all required. Bending of PE-AL-PE pipe in 'L' shape is not recommended. Use elbow in case it is absolutely necessary.

18.10.4.5 PE-AL-PE pipe can be installed in both internal and external work. For concealed work the walls can be recessed by hand or mechanical router for speed. Where PE-AL-PE pipe are installed on the surface, the maximum clipping center should be kept as Table 18.20.

Table 18.20

Pipe size	*Horizontal (mm)*	*Vertical (mm)*
1216	800	1000
1620	800	1000
2025	1000	1200
2532/3250	1200	1500

The pipes installed on surface must have two additional clamps at fittings other than as specified above.

18.10.4.6 It is necessary to provide clip/hook at the threaded fittings.

18.10.4.7 Only Teflon Tape should be used on threads instead of 'Dhaaga/ Safeda'. While for fittings, specially designed rubber "Seal" should be used.

18.10.5 For pressure testing the pipeline system, specially designed test plugs are to be used in female thread elbows instead of ordinary GI nipples with MS plugs before covering the pipes in chases.

18.10.6 Diameter of pipes should be increased from 16 mm OD to 20 mm OD when the user points exceed three. The head recommended for flush valve in gravity flow system is minimum 10 meters for 3240 mm size pipe. For optimum calculations and further design IS 15450 and "manufacturer's plumbing design guidelines" should be referred.

18.10.7 Storing Precautions

18.10.7.1 PE -AL- PE pipe should be stacked carefully so as to prevent them from falling or causing damage with any external sharp edged material. PE-AL-PE pipe is a tough material but needs greater protection from accidental damages when installed in comparison to metallic pipes.

18.10.7.2 Where PE-AL- PE pipe is to be connected to heavy items such as pumps or valves it is likely to impose undue strain in the pipes, hence the pump or valve should be supported directly using the support bracket.

18.10.7.3 The PE-AL-PE pipe are malleable, hence these should be protected from any heavy load/ impact and drilling etc. Where these pipes are provided under the ground, adequate cover as per IS 15450 should be provided.

18.10.8 The maximum allowable parameters for various components of PE-AL-PE piping system are given in Table 18.21.

TABLE 18.21

Fluid	*Service temperature deg 'C'*	*Maximum allowable service pressure in bar*			
		PE-AL-PE pipe	*Fitting Internal Sealing*	*Fitting Internal Sealing*	*Fitting end Seal*
			Brass	*Composite*	*Composite*
Water	Ambient	15	13	10	10
	65	10	10	10	-
	80	10	10	4	-

Before the pipes are covered or put to use, these should be tested for any leakage as per the following table:-

The requirement of hydraulic test pressure are given in the following table at 20°C & 60°C temperature respectively using water.

TABLE 18.22

Description	*Pressure in MPa*	
Nominal Pipe Size	*1 Hour Test (20°C)*	*10 Hour Test (60°C)*
1216	3.0	2.50
1620	2.70	2.50
2025	2.60	2.50
2532	2.30	2.10
3240	2.20	2.00

18.11 MAKING CONNECTION OF G.I. DISTRIBUTION BRANCH WITH G.I. MAIN

18.11.1 Preliminary Work

A pit of suitable dimensions shall be dug at the point where the connection is to be made with the main and earth removed up to 15 cm below the main. The flow of water in the water main shall also be disconnected by closing the sluice or wheel valves on the mains.

18.11.2 Making Connection

For cutting and jointing 18.6.2 and 18.6.3 shall apply. The G.I. main shall first be cut. Water if any collected in the pit shall be bailed out and, ends of the G.I. pipes threaded. The connection of distribution pipe shall then be made after fixing G.I. tee of the required size to the G.I. main and fittings such as Jam nut, G.I. socket connecting piece etc.

18.11.3 Testing of Joints

After laying and jointing, the pipes and fittings shall be inspected under working condition of pressure and flow. Any joint found leaking shall be redone and all leaking pipes removed and replaced without extra payment.

The pipes & fittings after they are laid shall be tested to hydraulic pressure of 6 kg./sq.cm. (60 m). The pipes shall be slowly and carefully charged with water allowing all air to escape and avoiding all shock of water hammer. The draw of laps and stop cocks shall then be closed and specified hydraulic pressure shall be applied gradually. Pressure gauge must be accurate and preferably should have been recalibrated before the test. The test pump having been stopped, the test pressure should be maintained without loss for at least half an hour. The pipes and fittings shall be tested in sections as the work of laying proceeds, having the joints exposed for inspection during the testing.

18.11.4 Finishing

The portion of the pipe in the pit shall be painted with bitumastic paint and encased with sand 15 cm all-round. The pit shall be filled with earth in level with the original ground surface watered, rammed and the area dressed.

18.11.5 Measurements

The work of making connections shall be enumerated.

18.11.6 Rate

The rate shall include the cost of labour and materials involved in all the operations described above.

18.12 FIXING BRASS AND GUN METAL WATER FITTINGS

18.12.0 The fitting shall be fully examined and cleared of all foreign matter before being fixed. The fitting shall be fitted in the pipe line in a workman like manner. The joints between fittings and pipes shall be leak-proof when tested to a pressure of 17.5 kg/sq.cm. The defective fittings and joints shall be replaced or redone.

18.12.1 Measurements

Fittings shall be enumerated.

18.12.2 Rate

The rate shall include cost of all the material and labour involved in all the operation described above.

18.13 FIXING FERRULES

18.13.1 For fixing ferrule the empty main shall be drilled and tapped at 45 degree to the vertical and the ferrule screwed in. The ferrule must be so fitted that no portion of the shank shall be left projecting within the main into which it is fitted.

18.13.2 Measurements

Ferrule shall be enumerated.

18.13.3 Rate

The rate shall include the cost of all materials and labour involved in fixing the ferrule.

18.14 INSTALLATION OF FIRE HYDRANT

18.14.1 The hydrant shall be fully examined and cleared of all foreign matter before being fixed. The fixing shall be done on the water main which shall be of minimum 80 mm dia. The flanged end of the hydrant shall be fixed to the flanged outlet of a tee in the water main by means of bolts, nuts and 3 mm rubber insertion or chemically treated compressed fiber board 1.5 mm minimum thickness and of weight not less than 0.183 gm. per sq.cm. This can also be fixed by means of flanged tail piece which may be connected to the water main by C.I. specials.

18.14.2 Measurements

Fire hydrant shall be enumerated.

18.14.3 Rate

The rate shall include the cost of materials and labour involved in all the operations described above against relevant item of work.

18.15 INSTALLATION OF SLUICE VALVE

18.15.1 The valve shall be fully examined and cleared of all foreign matter before being fixed. The fixing of the valve shall be done by means of bolts, nuts and 3 mm rubber insertions or chemically treated compressed fiber board 1.5 mm minimum thickness and of weight not less than 0.183 gm./ sq.cm. with the flanges of spigot and the socketed tail pieces drilled to the same specification in case of S&S pipes and with flanges in case of flanged pipes. The tail pieces shall conform to IS 1938. These shall be jointed to the pipe line by means of lead caulked joints.

18.15.2 Measurements

Sluice valve shall be enumerated.

18.15.3 Rate

The rate shall include the cost of material and labour involved in all the operations described above.

18.16 INSTALLATION OF WATER METER AND STOP VALVE (FIG. 18.3 and 18.4)

18.16.0 The G.I. line shall be cut to the required length at the position where the meter and stop cock are required to be fixed. The ends at the pipe shall then be threaded. The meter and stop cock shall be fixed in position by means of connecting pipes, G.I. jam nut and socket etc. The stop cock shall be fixed near the inlet of the water meter. The paper disc inserted in the nipples of the meter shall be removed and the meter installed exactly horizontal or vertical in the flow line in the direction shown by the arrow cast on the body of the meter. Care shall be taken that the factory seal of the meter is not disturbed. Wherever the meter shall be fixed to a newly fitted pipe line, the pipe line shall have to be completely washed before fitting the meter. For this purpose a piece of pipe equal to the length of the meter shall be fitted in the proposed position of the meter in the new pipe line. The water shall be allowed to flow completely to wash the pipe line and then the meter installed as described above by replacing the connecting piece.

18.16.1 Testing of Joints

Testing of joints shall be done as described in 18.6.6.

18.16.2 Measurements

The work of fixing meters and stop cocks shall be counted in numbers separately according to the diameters.

18.16.3 Rate

The rate shall include the cost of labour and materials involved in all the operations described above excluding the cost of stop cock and water meter.

18.17 FIXING SURFACE BOX (FIG. 18.6)

18.17.1 The C.I. surface box shall be fixed on the top of masonry chamber in plain or reinforced cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size) as the case may be.

18.17.2 Measurements

Masonry chambers shall be enumerated under the relevant items.

18.17.3 Rate

The rate shall include the cost of materials and labour involved in all the operations described above, except the excavation in saturated soil, soft or decomposed and hard rock if met with. The difference of cost, between ordinary soil and saturated soil or soft or decomposed or hard rock as the case may be, shall be paid for separately.

18.18 POLYETHYLENE WATER STORAGE TANKS

18.18.1 Material

Polyethylene used for manufacture of tanks and manhole lids may be high density (HDPE), low density (LDPE) or linear low density (LLDPE) and shall conform to IS 10146. Polyethylene shall be compounded with carbon black so as to make the tank resistant to ultra violet rays from the sun. The percentage of carbon black content in polyethylene shall be 2.5 ± 0.5 percent and it shall be uniformly distributed. The materials used for the manufacture of tank, manhole lid and fittings shall be such that they neither contaminate the water nor impart any taste, colour, odour or toxity to water.

18.18.2 Manufacture and Finish

The tanks shall be manufactured by rotational moulding process. Each tank and the manhole lid shall be single piece having arrangement for fixing and locking the manhole lid with the tanks. Excess material at the mould parting line and near the top rim shall be neatly cut and finished. The internal and external surface of the tanks shall be smooth, clean and free from hidden internal defects like air bubbles, pit and metallic or other foreign material inclusion. Capacity of the tank, minimum weight of the empty tank (without manhole lid) and the manufacture brand name shall be embossed on the top surface of the tank near manhole.

18.18.3 Shape, Size and Capacity

The tank shall be cylindrical vertical with closed top having a manhole. Diameter and height of the tank of various capacities shall be as per manufacturer's specifications and a clearance of ± 3 percent shall be permitted on these dimensions. Capacity of the tank or up to the bottom of the inlet location whichever is less. Capacity of the tank shall be specified. Extra capacity if any shall be ignored.

18.18.4 Weight and Wall Thickness

Minimum weight of the empty tank (exclusive of manhole lid fittings) and the minimum wall thickness of top, bottom and sides shall be specified in Table 18.23. Wall thickness shall be checked beyond 150 mm of the edge where the direction the plane of tank surface changes.

18.18.5 Installation and Fittings

The flat base of the tank shall be fully supported over its whole bottom area on a durable rigid flat and level platform sufficiently strong to stand without deflection the weight of the tank when fully filled with water. Depending upon the capacity and location tanks may be suitably anchored as per the directions of the Engineer-in-Charge. For inlet, outlet and other connections fully threaded GI, HDPE or PVC connections with hexagonal check nuts and washers on either side of the tank wall shall be provided. Holes for threaded connections shall be drilled and not punched. Pipes entering of leaving the tank shall be provided with unions and suitably supported on a firm base to avoid damage to the tank walls.

18.18.6 Manhole Lid

The lid shall rest evenly and fit over the rim of the manhole so as to prevent the ingress of any foreign matter into the tank. The lid shall be provided with suitable arrangement for locking it with the tank.

18.18.7 The tank and its components shall conform to the local bye-laws for preventions of mosquito menace.

18.18.8 Measurements

Dimensions shall be measured to the nearest cm. and weight of the empty tank shall be recorded to the nearest 100g. Capacity of the tank as defined in 18.18.3 shall be calculated to the nearest litre.

TABLE 18.23

S.No	Capacity	*Minimum Wall Thickness*	*Minimum Weight of Empty Tank*
	litres	mm	kg
1	2	3	4
1.	200	4.4	7.8
2.	300	4.4	9.0
3.	400	5.5	15.0
4.	500	6.0	18.0
5.	700	6.6	23.5
6.	1000	7.0	33.0
7.	1250	7.0	40.0
8.	1500	7.0	47.0
9.	1700	7.0	54.0
10.	2000	8.2	64.0
11.	2500	8.2	81.0
12.	3000	8.8	96.0
13.	4000	10.4	138.0
14.	5000	10.7	191.0
15.	6000	10.7	209.0
16.	7500	10.7	250.0
17.	10000	11.5	363.0
18.	15000	11.5	550.0
19.	20000	13.2	814.0

18.18.9 Rates

The rate shall include the cost of the tank, manhole lid, carriage and delivery at the place specified. Hoisting, installation, fittings, platform and anchoring shall be payable separately.

18.19 TUBE WELLS WITH HAND PUMPS

18.19.1 Casing Pipe

The casing pipe shall be of M.S. or W.I. of 100 mm dia. and strong enough to stand hammering and vibrations to which it is subjects.

18.19.2 Filter and Brass Strainer

The filter shall consist of a G.I. pipe of the required diameter with 15 mm diameter holes covered with brass strainer both inside and outside. It shall have a driving point riveted or welded to it.

18.19.3 Hand Pump

This shall be of approved quality. It shall be complete with necessary bolt and nuts for joining to the masonry or concrete base.

18. 20 CUTTING HOLES IN WALL UPTO 30 × 30 CM

18.20.0 Square holes of size as specified or as directed by the Engineer-in-Charge shall be cut in the masonry. Any damage to the adjoining portion or to any other item shall be made good as directed by the Engineer-in-Charge. All dismantled material shall be removed from the site.

18.20.1 Masonry Work

Brick work etc. shall be made good by using the same class of brick, tile or stone masonry as was cut during the execution of work. The mortar to be used shall be cement mortar 1:4 (1 cement: 4 fine sand) or as directed by the Engineer-in-Charge.

18.20.2 Finishing

Cement mortar in 1:4 mix (1 cement: 4 sand) shall be used for plastering or pointing, as may be required. Sand shall be fine or coarse, as used in the original work. The surface shall be finished with two or more coats of white wash, colour wash, distemper or painting as required but where the surface is not to be white washed, colour washed, distempered or painted; it shall be finished smooth with a floating coat of neat cement or as required to match with the surrounding surfaces.

18.20.3 Measurements

The holes shall be enumerated.

18.20.4 Rate

The rate shall include the cost of labour and materials required for all the operations described above.

18.21 CUTTING HOLES IN R.C.C. FLOORS (UPTO 15 × 15 CM)

18.21.0 Square holes of size as specified shall be cut in R.C.C. floor and roofs for passing drain pipe etc. Any damage to the adjoining portion or to any other item shall be made good as directed by the Engineer-in-Charge. All the dismantled material shall be removed from the site.

18.21.1 Cement Concrete

After insertion of drain pipe etc. the hole shall be repaired with cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size) and the surface finished to match with the existing surface. The top and bottom shall be finished properly to make the joint leak proof. The specifications for cement concrete work and finishing etc. shall be the same as detailed under relevant sub-heads.

18.21.2 Measurements

Holes shall be enumerated.

18.21.3 Rate

The rate shall include the cost of labour and material required for all the operations described above except the pipe which shall be paid for separately.

18.22 CUTTING CHASES IN MASONRY WALLS

18.22.1 Making Chases

Chases are made in the walls for housing G.I. Pipes etc.

I. Cutting of chases in one brick thick and above load bearing walls :

(i) As far as possible services should be planned with the help of vertical chases. Horizontal chases should be avoided.

(ii) The depths of vertical chases and horizontal chases shall not exceed one third and one sixth of the thickness of the masonry respectively.

(iii) When narrow stretches of masonry (or short lengths of walls) such as between doors and windows, cannot be avoided, they should not be pierced with openings for soil pipes or waste pipes or timber joints, etc. Where there is a possibility of load concentration, such narrow lengths of walls shall be checked for stresses and high strength bricks mortar or concrete walls provided, if required.

(iv) Horizontal chases when unavoidable should be located in the upper or lower one third of height of storey and not more than three chases should be permitted in any stretch of a wall. No continuous horizontal chase shall exceed one metre in length. Where unavoidable, stresses in the affected area should be checked and kept within the permissible limits.

(v) Vertical chases should not be closer than 2 m in any stretch of a wall. These shall be kept away from bearings of beams and lintels. If unavoidable, stresses in the affected area should be checked and kept within permissible limits.

(vi) Masonry directly above a recess, if under than 30 cm (Horizontal dimension) should be supported on lintel. Holes in masonry may be provided up to 30 cm width x 30 cm height without any lintel. In the case of circular holes in masonry, no lintel should be provided up to 40 cm in diameter.

II. Cutting of chases in half brick load bearing walls

No chase shall be permitted in a half brick load bearing wall and as such no recessed conduits and concealed pipes shall be provided in half brick thick load bearing walls.

III. Cutting of chases in half brick non-loading bearing walls

In case of non load bearing half brick walls services should be planned with the help of vertical chases. Horizontal chases should be provided only when unavoidable.

IV. Cutting of chases in stone masonry walls

The provision (i) to (vi) under Sl. No. I are equally applicable to stone masonry walls also.

Note:

1. No inclined chase shall be permitted in brick masonry or stone masonry walls. In case inclined chases are unavoidable these shall be cut with written approval of the Engineer-in-Charge, and shall be repaired properly to his satisfaction. However, in half brick masonry wall, no inclined chase will be permitted.
2. Chases shall be made by chiseling out the masonry to proper line & depth. Any damage to the adjoining portion or to any other item shall be made good, as decided by the Engineer-in-Charge, for which no extra payment shall be made. All dismantled material shall be removed from site.

18.22.2 Filling Chases

After G.I. Pipes etc. are fixed in chases, the chases shall be filled with cement concrete 1:3:6 (1 cement: 3 coarse sand: 6 graded stone aggregate 20 mm nominal size) or cement mortar 1:4 (1 cement: 4 coarse sand) as may be specified or otherwise directed by the Engineer-in-Charge and made flush with the masonry surface. The concrete surface shall be roughened with wire brushes to provide a key for plastering.

18.22.3 Measurements

Chases shall be measured in running meter correct to a cm.

18.22.4 Rates

The rate shall include the cost of labour the materials involved in all the operations described above excluding the cost of providing pipes etc. which shall be paid separately.

18.23 CP BRASS BIB COCK

The CP brass bib cock shall be conforming to IS : 8931. The body shall be of chromium plated copper alloy and external and internal surfaces shall be clean, smooth and free from sand. The 15mm nominal bore shall be designated by the nominal bore of the pipe outlet to which the bib cocks are normally fitted.

The dimensions of body for Bib Cock shall be as per table given to IS : 8931. Each bib cock shall be legibly marked with the Manufacture's name and trade mark.

18.24 CP BRASS LONG NOSE BIB COCK

The CP brass long nose bib cock shall be conforming to IS standards. The body shall be of chromium plated copper alloy and external and internal surfaces shall be clean, smooth and free from sand. The 15mm nominal bore shall be designated by the nominal bore of the pipe outlet to which the bib cocks are normally fitted.

The weight of long nose Bib Cock shall be less than 810 grams. Each bib cock shall be legibly marked with the Manufacture's name and trade mark.

18.25 CP BRASS LONG BODY BIB COCK

The CP brass long body bib cock shall be conforming to IS standards. The body shall be of chromium plated copper alloy and external and internal surfaces shall be clean, smooth and free from sand. The 15mm nominal bore shall be designated by the nominal bore of the pipe outlet to which the long body bib cocks are normally fitted.

The weight of long body Bib Cock shall be less than 690 grams. Each bib cock shall be legibly marked with the Manufacture's name and trade mark.

18.26 CP BRASS STOP COCK (CONCEALED)

The CP brass stop cock shall be conforming to IS : 8931. The body shall be of chromium plated copper alloy and external and internal surfaces shall be clean, smooth and free from sand. The 15mm nominal bore shall be designated by the nominal bore of the pipe outlet to which the stop cocks are normally fitted.
The dimensions of body for stop Cock shall be as per table given to IS : 8931. Each stop cock shall be legibly marked with the Manufacture's name and trade mark.

18.27 CP BRASS ANGLE VALUE

A valve with the inlet and outlet at right angles to each other and is intended to facilitate servicing of water fittings or appliances.

The CP brass angle valve shall be conforming to IS: 8931. The body shall be of chromium plated copper alloy and external and internal surfaces shall be clean, smooth and free from sand. The 15mm nominal bore shall be designated by the nominal bore of the pipe outlet to which the angle valves are normally fitted.

The dimensions of body for angle valve shall be as per table given to IS: 8931. Each angle valve shall be legibly marked with the Manufacture's name and trade mark.

18.28 CP BRASS EXTENSION NIPPLE

The body shall be of chromium plated copper alloy and external and internal surfaces shall be clean, smooth and free from sand. The size of CP brass extension nipple shall be 15mm x 50mm.

18.29 PTMT BIB COCK

The PTMT (Poly-tetra Methylene Terepthalate) bib cock shall be of appropriate size as specified and weight should not be less than as specified. External and internal surfaces shall be clean and smooth with good finish. Its colour shall be uniform. Each fitting shall be legibly marked with the manufacture's name and trade mark. Teflon tape shall be used on threads while fixing to make them leak proof.

18.30 PTMT STOP COCK

The PTMT (Poly-tetra Methylene Terepthalate) stop cock shall be of appropriate size as specified and weight should not be less than as specified. External and internal surfaces shall be clean and smooth with good finish. Its colour shall be uniform. Each fitting shall be legibly marked with the manufacture's name and trade mark. Teflon tape shall be used on threads while fixing to make them leak proof.

18.31 PTMT PILLAR COCK

The PTMT (Poly-tetra Methylene Terepthalate) pillar cock shall be of appropriate size as specified and weight should not be less than as specified. External and internal surfaces shall be clean and smooth with good finish. Its colour shall be uniform. Each fitting shall be legibly marked with the manufacture's name and trade mark. Teflon tape shall be used on threads while fixing to make them leak proof.

18.32 PTMT PUSH COCK

The PTMT (Poly-tetra Methylene Terepthalate) push cock shall be of appropriate size as specified and weight should not be less than as specified. External and internal surfaces shall be clean and smooth with good finish. Its colour shall be uniform. Each fitting shall be legibly marked with the manufacture's name and trade mark. Teflon tape shall be used on threads while fixing to make them leak proof.

18.33 PTMT GRATING

The PTMT (Poly-tetra Methylene Terepthalate) grating shall be of appropriate size as specified. External and internal surfaces shall be clean and smooth with good finish. Its colour shall be uniform. Each fitting shall be legibly marked with the manufacture's name and trade mark.

18.34 PTMT BALL COCK

The PTMT (Poly-tetra Methylene Terepthalate) ball cock shall be of appropriate size as specified and weight should not be less than as specified .External and internal surfaces shall be clean and smooth with good finish. Its colour shall be uniform. Each fitting shall be legibly marked with the manufacture's name and trade mark. Teflon tape shall be used on threads while fixing to make them leak proof.

18.35 PTMT ANGLE STOP COCK

The PTMT (Poly-tetra Methylene Terepthalate) angle stop cock shall be of appropriate size as specified and weight should not be less than as specified. External and internal surfaces shall be clean and smooth with good finish . Its colour shall be uniform. Each fitting shall be legibly marked with the manufacture's name and trade mark. Teflon tape shall be used on threads while fixing to make them leak proof.

18.36 PVC CONNECTION PIPE

The PVC connection pipe with PTMT nuts, collar and bush shall be conforming to IS: 1024. The standard size of PVC connection pipe shall be designated by the nominal bore with length. A sample of each kind of fitting shall be got approved from the Engineer-in-charge and supplies made according to the approved sample. PVC connection pipe shall be enumerated and rate shall include the cost of material and labour involved in fixing the same.

18.37 PTMT EXTENSION NIPPLE FOR WATER TANK PIPE

The standard size of PTMT extension Nipple for water tank pipe, fitting shall be designated by the nominal bore weighing not less than prescribed in the item. A sample of each kind of fitting shall be got approved from the Engineer-in-charge and supplies made according to the approved sample. PTMT extension Nipple for water tank pipe shall be enumerated and rate shall include the cost of material and labour involved in fixing the same.

18.38 DISINFECTING C.I WATER MAINS BY FLUSHING WITH WATER

Disinfecting C.I water mains of different diameter pipe by flushing with water containing bleaching powder @0.5 gms per litre of water and cleaning the same with fresh water, operation to be repeated three times including getting the sample of water from the disinfected main and shall be tested in the municipal laboratory and final sample obtained shall confirm to the standards.

18.39 CHROME PLATED BRASS BATTERY BASED INFRARED SENSOR OPERATED PILLAR COCK

The chrome plated brass battery based infrared sensor operated pillar cock shall be of chromium plated copper alloy and external and internal surface shall be clean, smooth and free from sand. The 15 mm nominal bore shall be designated by the nominal bore of the pipe outlet to which the chrome plated brass battery based infrared sensor operated pillar cock are normally fitted.

Each chrome plated brass battery based infrared sensor operated pillar cock shall be legibly marked with the manufacture's name and trade mark. Chrome plated brass battery based infrared sensor operated pillar cock shall be enumerated and rate shall include the cost of material and labour involved in fixing the same.

APPENDIX A

TOLERANCES FOR CAST IRON (CENTRIFUGALLY CAST) PIPES

(Clause 18.3.10)

Dimensions	*Nominal diameter (DN)*	*Tolerances in mm*
(a) External diameter of barrel (DE)	All diameters.	± 1/2f = ± (4.5 + 0.0015 DN)
(b) Internal diameter of socket (DI)	All diameters.	± 1/3f = ± (3 ± 0.001 DN)
(c) Depth of socket (P)	(1) Up to and including 600 mm	± 5
	(2) Over 600 mm and up to and including 1000 mm	± 10

Note : (1) f is the caulking space of the joint in millimeters and is equal to 9 + 0.003 DN.

(2) The jointing tolerances applicable to rubber joints (mechanical or push in joints) shall be as specified by their manufacturer and shall be within the tolerances specified above.

Tolerance on Thickness

Dimensions	*Tolerance in mm*
(a) Wall thickness	– (1 + 0.05 e)
(b) Flange thickness	± (2 + 0.05 b)

Where e = is the thickness of the wall in millimeters and
b = is the thickness of the flange in millimeters.

Tolerance on Length

Dimensions	*Tolerance in mm*
(a) Socket and spigot, and plain ended pipes	± 25
(b) Flanged pipes	± 10

APPENDIX B

TOLERANCES FOR SPECIALS OF CAST IRON PIPES

(Clause 18.3.10.2)

Tolerances in Diameter

Dimension	Nature of joint	Nominal diameter (DN)	Tolerance in mm
External diameter of spigot (DE) f or ± (4.5 + 0.0015 DN)	Lead joints	All diameters	±1/2
Internal diameter of socket (DI) f or ± (3 + 0.001 DN)	Lead joints	All diameters	±1/3
Depth of socket (P)	Lead joints	Up to and including 600 mm	± 5
		Over 600 mm up to and including 1000 mm.	± 10
		Over 1000 mm up to and including 1500 mm.	± 15

Tolerances on Thickness

Dimension	Tolerance in mm
Wall thickness	– (2 + 0.05 e)
Flange thickness	± (3 + 0.05 b)

Where e = the standard thickness of the wall in millimeters, and
b = the standard thickness of the flange in millimeters.

Tolerance on Lengths

Type of fitting	*Nominal diameter*	*Tolerance in mm*
Socket fittings and flange spigot pieces	Up to and including 450 mm	± 20
	Over 450 mm	± 20 – 30
Flanged fittings	All diameters	± 10

APPENDIX C

PARTICULARS OF MEDIUM GRADE G.I. PIPES

(Clause 18.3.11.3)

Nominal bore	Dimension of pipes			Weight of pipe	
	Outer diameter		Thickness	Plain end	Screwed end socket
	Max	Min			
(mm)	(mm)	(mm)	(mm)	(kg/m)	(kg/m)
6	10.6	9.8	2.0	0.404	0.407
8	14.0	13.2	2.3	0.641	0.645
10	17.5	16.7	2.3	0.839	0.845
15	21.8	21.0	2.6	1.21	1.22
20	27.3	26.5	2.6	1.56	1.57
25	34.2	33.3	3.2	2.41	2.43
32	42.9	42.0	3.2	3.10	3.13
40	48.8	47.9	3.2	3.56	3.60
50	60.8	59.7	3.6	5.03	5.10
65	76.6	75.3	3.6	6.42	6.54
80	89.5	88.0	4.0	8.36	8.53
100	115.0	113.1	4.5	12.2	12.50
125	140.8	138.5	4.8	15.90	16.40
150	166.5	163.9	4.8	18.90	19.50

Tolerance in Thickness and Weight

A) **Thickness**

1. Butt welded medium tubes — + not limited, – 10 per cent
2. Seamless tubes — + not limited, – 12.5 per cent

B) **Weight**

1. Single tube (light series) — + 10 percent, - 8 per cent
2. Single tube (medium and heavy series) — ± 10 per cent
3. For quantities per load of 10 tonnes, min (light series) — ± 5 per cent, – 8 per cent
4. For quantities per load of 10 tonnes, min (medium and heavy series) — ± 7.5 per cent

APPENDIX D

PROCEDURE FOR PRESSURE TEST

(Clause 18.5.6)

1. Each valved section of the pipe shall be slowly filled with water and all air shall be expelled from the pipe through hydrants and blow-offs. If these are not available at high places, necessary tapping may be made at points of highest elevation before the test is made and plugs inserted after the tests have been completed.

2. If the trench has been partially back-filled the specified pressure based on the elevation of the lowest point of the line or section under test and corrected to the elevation of the test gauge, shall be applied by means of a pump connected to the pipe in a manner satisfactory to the Engineer-in-Charge. The duration of the test shall not be less than 5 minutes.

3. Examination under Pressure: All exposed pipes, fittings, valves, hydrants and joints should be carefully examined during the open-trench test. When the joints are made with lead, all such joints showing visible leaks shall be recaulked until tight. When the joints are made with cement and show seepage or slight leakage, such joints shall be cut out and replaced as directed by the authority. Any cracked or defective pipes, fittings, valves or hydrants discovered in consequence of this pressure test shall be removed and replaced by sound material and the test shall be repeated until satisfactory to the Engineer-in-Charge.

4. If the trench has been back-filled to the top, the section shall be first subjected to water pressure normal to the area and the exposed parts shall be carefully examined. If any defects are found, they shall be repaired and the pressure test repeated until no defects are found. The duration of the final pressure tests shall be at least one hour.

Procedure for Leakage Test

5. Leakage is defined as the quantity of water to be supplied into the newly laid pipe, or any valved section thereof, necessary to maintain the specified leakage test pressure after the pipe has been filled with water and the air expelled.

No pipe installation shall be accepted until the leakage is less than the number of cm^3/h determined by the formula:

$$ql = \frac{ND\sqrt{P}}{3.3}$$

Where ql = the allowable leakage in cm^3/h.
N = number of joints in the length of the pipe line.
D = diameter in mm, and
P = the average test pressure during the leakage testing kg/cm^2.

6. Variation from Permissible Leakage: Should any test of pipe laid in position discloses leakage greater than that specified in Para 5 the defective joints shall be repaired until the leakage is within the specified allowance.

APPENDIX E

GUIDELINES FOR STORAGE AND INSTALLATION OF CPVC PIPES

E-1 STORAGE

CPVC pipes of all sizes are packed in polyethylene packing rolls and both the ends of the packed roll are sealed with air bubble film cap in order to provide protection during handling and transportation. After packing, the whole bunch of pipes is tightened with polypropylene/ HDPE strapping. Each role is then marked with size/type of the pipe, lot number and quantity. The packed pipe rolls are stored in their respective racks in properly covered storage area. Apart from providing protection during handling and transportation, the packing rolls also protect the pipe from ultra violet rays.

E-2 INSTALLATION GUIDELINES

E-2.1 Visually inspect pipe ends before making the joint. Use of a chamfering tool will help identify and crakes, as it will catch on to any crack.

E-2.2 Pipe may be cut quickly and efficiently by several methods. Wheel type plastic tubing cutters are preferred. Ratchet type cutter or fine tooth saw are another options. However, when using the ratchet cutter be certain to score the exterior wall by rotating the cutter blade in circular motion around the pipe. Do this before applying significant downward pressure to finalize the cut. This step leads to a square cut. In addition, make sure ratchet cutter blades are sharp. Cutting tubing as squarely as possible provides optimal bonding area within a joint.

E-2.3 Burrs and filings can prevent proper contact between the tube and fittings during the assembly, and should be removed from the outside and inside of the tube. A chamfering tool is preferred, but a pocket knife or file is also suitable for this purpose.

E-2.4 Use only CPVC cement jointing. Use CPVC cement, which is fully recommended by the manufacturer.

E-2.5 When using adhesive solution/solvent cement be certain of proper ventilation.

E-2.6 When making a join, apply a heavy, even coat of cement to the pipe end. Use the same applicator without additional cement to apply a thin coat inside the fitting socket. Too much cement can cause clogged waterways. Do not allow excess cement to puddle in the fitting and pipe assembly. This could result in a weakening of the pipe wall and possible pipe failure when the system is pressurized.

E-2.7 Rotate pipe one-quarter to one-half turn while inserting it into the fitting socket and remove the excess adhesive solution/solvent cement from the joint with clean rag.

E-2.8 When making a transition connection to metal threads, use a special transition fitting or CPVC male threaded adapter whenever possible. Do not over-torque plastic threaded connections. Hand tight plus one-half turn should be adequate.

E-2.9 Hang or strap CPVC systems loosely to allow for thermal expansion. Do not use metal straps with sharp edges that might damage the tubing.

E- 2.10 CPVC stub outs for lavatories, closets and sinks are appropriate. However, on areas where there is a likelihood that movement or impact abuse will occur, metal pipe nipples may be amore appropriate stub-out material. Showerheads, tub spouts and outside still cocks are examples.

E-2.11 When connected to a gas water heater, CPVC tubing should not be located within 50 cm of the flue. For water heaters lacking reliable temperature control, this distance may be increased up to 1 m a metal nipple or flexible appliance connector should be utilized. This measure eliminates the potential for damage to plastic piping that might result from excessive radiant heat from the flue.

APPENDIX F

SAMPLING AND CRITERIA FOR CONFORMITY OF CPVC PIPES

(Clause 18.9.6)

F-1 ACCEPTANCE TESTS

F-1.1 Acceptance test are carried out on samples selected from a lot for the purpose of acceptance of the lot.

F-1.2 Lot

All CPVC pipes in a single consignment of the same class, same size and manufactured under essentially similar conditions shall constitute a lot.

F-1.3 For ascertaining conformity of the lot to the requirements of the specification, samples shall be tested from each lot separately.

F-1.4 Visual and Dimensional Requirements

F-1.4.1 The number of test samples to be taken from a lot shall depend on the size of the lot and the outside diameter of the pipe, and shall be in accordance with Table F-1.

TABLE F-1
Scale of Sampling of Visual Appearance and Dimensional Requirements
(Clause F-1.4.1 and F-1.4.3)

Sl. No.	Number of pipes in the lot	Sample number	Sample size	Cumulative sample size	Acceptance number	Rejection number
(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*
(i)	Up to 1000	First	13	13	0	2
		Second	13	26	1	2
(ii)	1001 to 3000	First	20	20	0	2
		Second	20	40	1	2
(iii)	3001 to 10000	First	32	32	0	3
		Second	32	64	3	4
(iv)	10001 & above	First	50	50	1	4
		Second	50	100	4	5

F-1.4.2 These pipes shall be selected at random from the lot and in order to ensure the randomness of selection, a random number table shall be used. For guidance and use of random number tables, IS-4905 may be referred to. In the absence of a random number table, the following procedure may be adopted:

Starting from any pipe in the lot, count them as 1, 2, 3, etc, up to r and so on, where r is the integral part of N/n, N being the number of pipes in the lot, and n the number of pipes in the sample. Every rth pipe so counted shall be withdrawn so as to constitute the requires sample size.

F-1.4.3 The number of pipes given for the first sample in col. 4 of Table F-1, shall be taken from the lot and examined for visual and dimensional requirements given in Table 18.16 and 18.9.4.1. A pipe failing to satisfy any of these requirements shall be considered as defective. The lot shall be deemed to have satisfied these requirements, if the number of defectives found in the firm sample is less than or equal to the corresponding acceptance number given in col. 6 of Table F-1. The lot shall be deemed not to have met these requirements, if the number of defectives found in the first sample is greater than or equal to the corresponding rejection number given in col. 7 of Table F-1. If, however, the number of defectives found in the first sample lies between the corresponding acceptance and rejection numbers given in cols. 6 and 7, a second sample of the size given in col. 4 shall be taken

and examined for the requirements. The lot shall be considered to have satisfied these requirements. The lot shall be considered to have satisfied these requirements if the cumulative sample is less than or equal to the corresponding acceptance number given in col. 6, otherwise not.

F-*1.5 Reversion Test*

F-1.5.1 The lot, having satisfied visual and dimensional requirements, shall be tested for reversion as given in 18.9.4.4.

F-1.5.2 For this purpose, the number of pipes given for the first sample in col. 4 of Table F-2 shall be taken from the lot. The sample pipe failing the reversion test shall be considered as defective. The lot shall be deemed to have met the requirements given in this specification for the reversion test, if the number of defectives found in the first sample is less than or equal to the corresponding acceptance number given in col. 6. This lot shall be deemed not to have met these requirements, if the number of defectives found in the first sample is greater than or equal to the corresponding rejection number given in col. 7 if, however, the number of defectives in the first sample lies between the corresponding acceptance and rejection numbers given in col. 6 and col. 7, a second sample of size given in col. 4 shall be taken and examined for the requirements. The lot shall be considered to have satisfied the requirements, if the number of defectives found in the cumulative sample is less than or equal to the corresponding acceptance number given in col. 6, otherwise not.

TABLE F-2
Scale of Sampling for Reversion, Vicat Softening Temperature and Density Test
(Clause F-1.5.2, F-1.6.2 and F-1.7.2)

Sl. No.	Number of pipes in the lot	Sample number	Sample size	Cumulative sample size	Acceptance number	Rejection number
(1)	(2)	(3)	(4)	(5)	(6)	(7)
(i)	Up to 1000	First	5	5	0	2
		Second	5	10	1	2
(ii)	1001 to 3000	First	8	8	0	2
		Second	8	16	1	2
(iii)	3001 to 10000	First	13	13	0	2
		Second	13	26	1	2
(iv)	10001 & above	First	20	20	0	3
		Second	20	40	3	4

F-1.6 Vicat Softening Test

F-1.6.1 The lot, having satisfied visual and dimensional requirements shall be tested for Vicat softening temperature as given in 18.9.4.5.

F-1.6.2 For this purpose, the procedure adopted for sampling and criteria for conformity shall be the same as that for reversion under F-1.5.2 using Table F-2.

F-1.7 Density

F-1.7.1 The lot, having satisfied the visual and dimensional requirements, shall be tested for density as given in 18.9.4.6.

F-1.7.2 For this purpose, the procedure adopted for sampling and criteria for conformity shall be the same as that for reversion under F-1.5.2 using Table F-2.

F-1.8 Resistance to External Blow at 0°C

F-1.8.1 The lot, having been found satisfactory according to F-1.4, F-1.5, F-1.6 and F-1.7 shall be tested for resistance to external blow at 0°C as given in 18.9.5.3.

F-1.8.2 For this purpose, the procedure adopted for sampling and criteria for conformity shall be as specified in Table 18.18 and Table F-3.

TABLE F-3
Scale of Sampling for Resistance to External Blow at 0°C

Sl. No.	Number of pipes in the lot	Sample number	Sample size	Cumulative sample size	Acceptance number	Rejection number
(1)	(2)	(3)	(4)	(5)	(6)	(7)
(i)	Up to 3000	First	3	3	0	2
		Second	3	6	1	2
(ii)	3001 to 10000	First	3	5	0	2
		Second	5	10	1	2
(iii)	10000 & above	First	8	8	0	2
		Second	8	10	1	2

F-1.9 Internal Hydrostatic Pressure Test (Acceptance Test) F-1.9.1 The lot having been found satisfactory according to F-1.4, F-1.5, F-1.6, F -1.7 and F-1.8 shall be subjected to the requirements of the acceptance test for internal hydrostatic pressure as given in 18.9.5.1 and Table 18.17 Sl.No. (i).The number of pipes to be taken from the lot shall depend on the size of the lot and shall be according to Table F-4.

TABLE F-4
Scale of Sampling for Internal Hydrostatic Test
(Clause F-1.9.1 and F-1.9.3)

Sl. No.	Number of pipes in the lot	Sample size	Acceptance number
(1)	(2)	(3)	(4)
(i)	Up to 3000	2	0
(ii)	3001 to 10000	3	0
(iii)	10000 & above	5	0

F-1.9.2 The pipes shall be taken at random from the lot. In order to ensure the randomness of selection, procedures given in IS 4905 may be followed.

F-1.9.3 Number of Tests and Criteria for Conformity

The number of test samples shall be as given in Table F-4. The lot shall be considered to have satisfied the requirements for this test, if the number of test samples failing in this requirement is equal to the corresponding acceptance number given in column 4 of Table F-4.

F-2 TYPE TESTS

F-2.1 Type tests are intended to prove the suitability and performance of a new composition or a new size of pipe. Such tests, therefore, need to be applied only when a change is made in polymer composition or when a new size of pipe is to be introduced. Type test for compliance with 18.9.4.2, 18.9.4.3, 18.9.5.1 (Type test only) and 18.9.5.4 shall be carried out.

F-2.1.1 ***Verification of Malfunction Temperature*** T_{mal}

For this test, the manufacturer to the testing authority one assembly, selected preferably from a regular production lot.

F-2.1.2 *Opacity*

For this test, the manufacturer or the supplier shall furnish to the testing authority one sample of the pipe of the thinnest wall section, selected preferably from a regular production lot.

F- 2.1.2.1 The sample so selected shall be tested for compliance with requirements for opacity as given in 18.9.4.2.

F-2.1.2.2 If the sample passes the requirements of the opacity test, the type of the pipe under consideration shall be considered to be eligible for approval, which shall be valid for a period of one year.

F-2.1.2.3 In case the sample fails in the test, the testing authority, at its discretion, may call for a fresh sample and subject the same to the opacity test. If the sample passes the repeat test, the type of pipe under consideration shall be considered eligible for approval. If the sample fails in the repeat test, the type of pipe shall not be approved. The manufacturer or the supplier may be asked to improve the design and re-submit the product for type approval.

F-2.1.2.4 At the end of the validity period (normally one year) or earlier, if necessary, the testing authority may call for a fresh sample for opacity test for the purpose of type approval.

F-2.1.3 ***Test for Effect on Water***

For this type test, the manufacturer or the supplier shall furnish to the testing authority three samples of the smallest size of pipe taken from each machine (selected preferably from a regular production lot).

F-2.1.3.1 Three samples so selected shall be tested for compliance with the requirements for effect on water as given in 18.9.4.3.

F-2.1.3.2 If all three samples pass the requirements for effect on water, the type test of the pipe under consideration shall be considered to be eligible for approval, which hall be normally valid for a period of one year.

F-2.1.3.3 In case any of the samples fails in this test, the testing authority, at its discretion, may call for fresh samples not exceeding the original number, and subject them to the test for effect on water. If, in the repeat test, no single failure occurs, the type of pipe under consideration shall be considered eligible for type approval. If any of the samples fails in the repeat test, the type of pipe shall not be approved. The manufacturer or the supplier may be asked to improve the design and resubmit the product for type approval.

F-2.1.3.4 At the end of the validity period (normally one year) or earlier, if necessary, the testing authority may call for fresh samples for effect on water test for the purpose of type approval.

F-2.1.4 ***Internal Hydrostatic Pressure Test (Type Test) and thermal Stability***

For this type test, the manufacturer or the supplier shall furnish to the testing authority, three samples of pipes of different diameters and different classes (selected preferably from a regular production lot).

F-2.1.4.1 Three samples so selected shall be tested for compliance with the requirements of type test given in Table 18.9.4.3.

F-2.1.4.2 If all the three samples pass the requirements of the quality test, the type of pipe under consideration shall be considered to be eligible for type approval which shall be normally valid for a period of one year.

F-2.1.4.3 In case any of the samples fail in this test, the testing authority, at its discretion, may call for fresh samples not exceeding the original number and subject them to the type test. If, in the repeat test, no single failure occurs, the type of pipe shall be considered for type approval. If any of the samples fails in the repeat tests, the type of pipe shall not be approved. The manufacturer or the supplier may be asked to improve the design and resubmit the product for type approval.

F-2.1.4.4 At the end of the validity period (normally one year) or earlier, if necessary, the testing authority may call for fresh samples for type test for the purpose of type approval.

F-2.1.5 ***Tensile Strength Test (Type Test)***

For this type test, the manufacturer or the supplier shall furnish to the testing authority, five samples of pipe of different diameters and different class (selected preferably from a regular production lot).

F-2.1.5.1 Five samples so selected shall be tested for compliance with the requirements of type test given in 18.9.5.4.

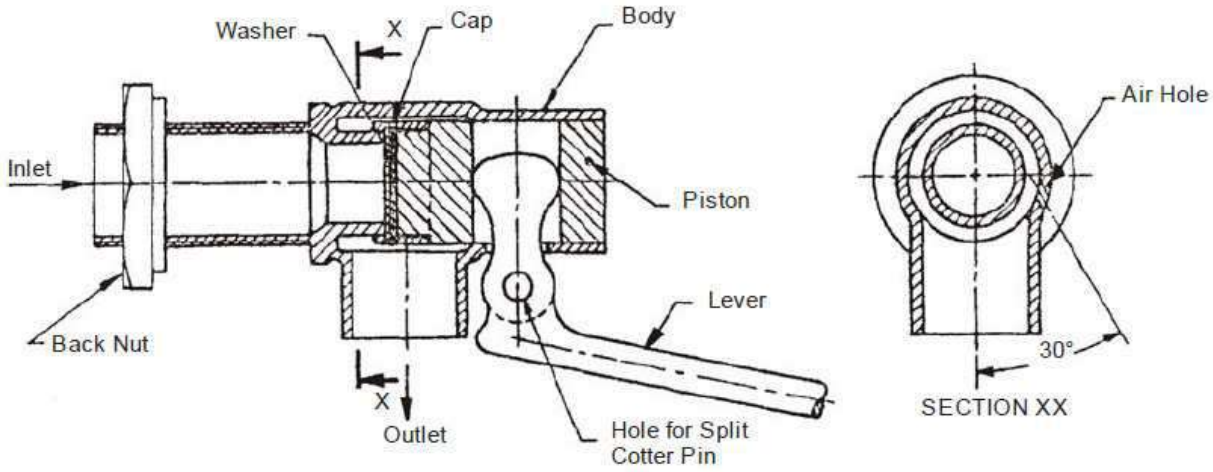
F-2.1.5.2 If all the five samples pass the requirement of the quality test, the type test of pipe under consideration shall be considered to be eligible for type approval which shall be normally valid for a period of one year.

F-2.1.5.3 In case any of the samples fails in this test, the testing authority, at its discretion, may call for fresh samples not exceeding the original numbers and subject them to the type test. If, in the repeat test no single failure occurs, the type of pipe shall be considered for type approval. If any of the samples fail in the repeat tests, the type of pipe shall not be approved. The manufacturer or the supplier may be asked to improve the design and resubmit the product for type approval.

F-2.1.5.4 At the end of the validity period (normally one year) or earlier, if necessary, the testing authority may call for fresh samples for type test for the purpose of type approval.

BALL VALVE (ASSEMBLY)

Sub Head : Water Supply
Clause : 18.3.1

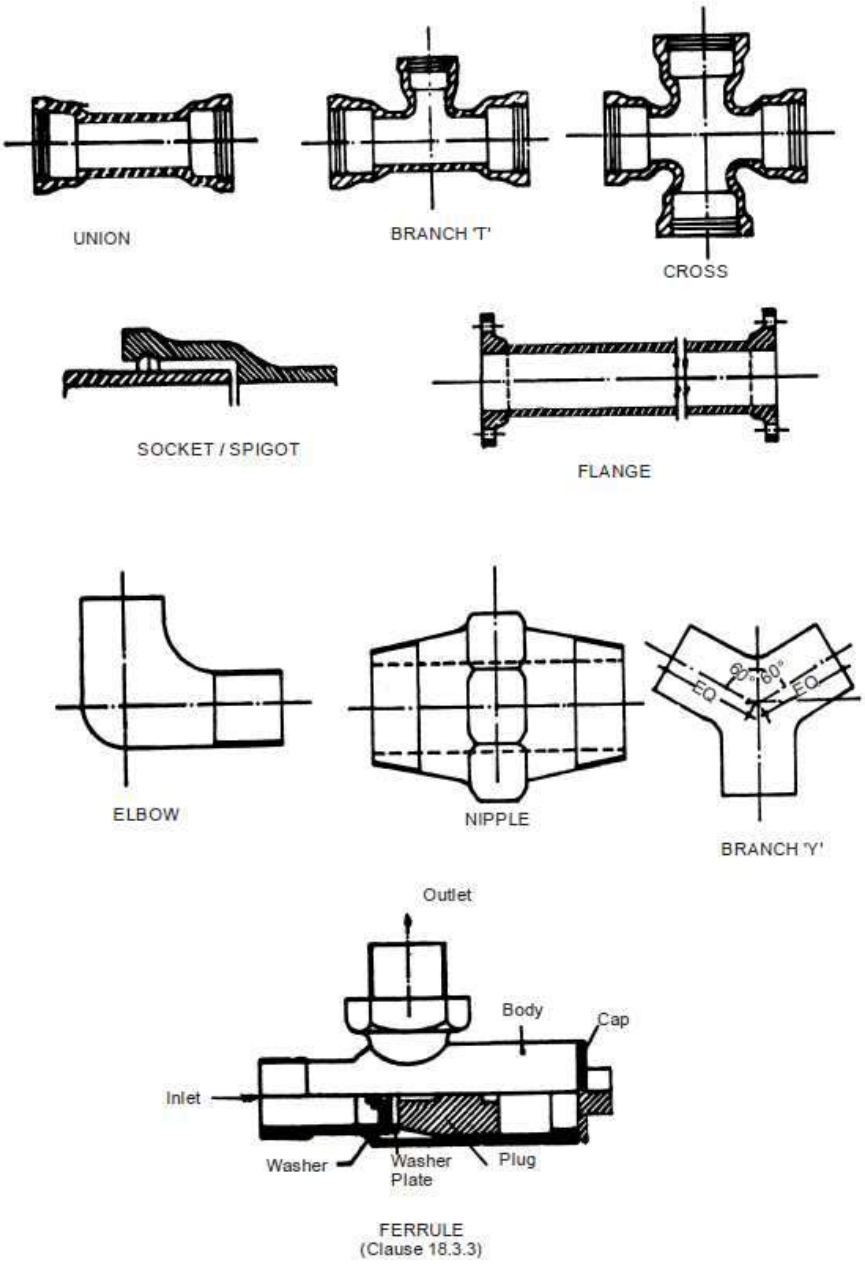


Note : The shapes of the component parts are only illustrative but the dimensions and minimum requirements, where specified, are binding.

Fig. 18.1 : Ball Valve (Assembly)

FITTINGS & SPECIALS

Sub Head : Water Supply
Clause : 18.3.9

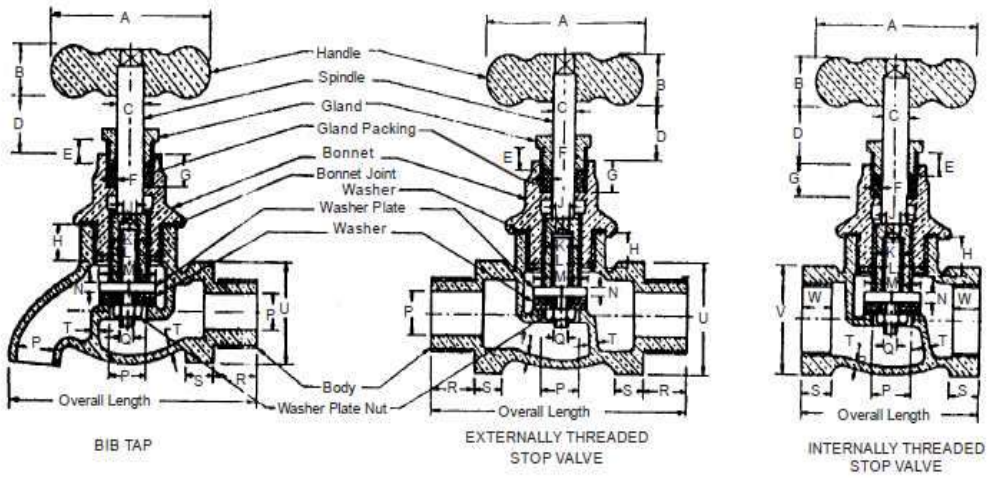


Drawing not to Scale

Fig. 18.2 : Fittings & Specials

BIB TAP & STOP VALVE

Sub Head : Water Supply
Clause : 18.3.2



All dimensions in millimetres

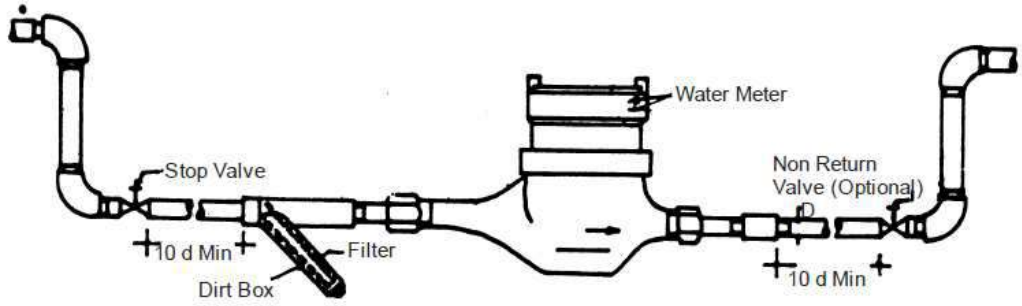
Dimensions → / Nominal sizes ↓	A	B	C	D	E	F	G	H	J	K	L	M	N	P +0.0 -0.5	Q	R	S	T	U	V	W	Lift of washer plate (with washer in position)
	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.
8	47.8	13.3	7.8	16.5	6.3	2.0	7.9	7.0	3.8	10.0	M20x1.5	14.3	2.8	6.5	2.4	11.0	4.7	1.6	15.2	19.5	7	3.5
10	54.0	14.0	9.4	18.7	7.5	2.0	9.5	9.5	4.7	11.5	M20x1.5	15.9	3.2	9.0	3.2	11.4	7.9	2.0	20.8	23.3	7	4
15	54.0	14.0	9.4	19.0	7.5	2.0	9.5	11.0	5.6	11.5	M24 1.5	19.0	3.2	13.0	4.1	15.0	9.5	2.0	25.6	28.3	9	4.5
20	60.4	15.7	10.9	20.1	8.9	2.5	11.1	12.5	6.4	13.5	M30x1.5	25.4	4.0	18.0	4.9	16.3	10.3	2.0	30.5	33.0	10.5	6
25	66.8	18.0	12.5	23.0	10.1	2.5	12.7	13.0	7.1	17.0	M39x1.5	33.3	4.0	23.0	4.9	19.1	11.0	2.8	37.6	42.4	11.5	7
32	74.6	20.5	14.1	30.9	11.4	2.5	14.3	16.0	7.8	19.0	M48x1.5	40.1	4.3	30	5.9	21.4	12.7	3.2	47.2	52.1	13.5	9.5
40	82.5	22.0	15.7	33.3	12.7	2.5	15.9	17.5	8.6	20.5	M56x1.5	47.7	5.5	36	6.6	21.4	14.3	3.2	56.4	58.5	13.5	11
50	95.0	25.3	17.3	35.9	14.0	2.5	17.4	17.5	12.5	26.0	M72x1.5	63.5	6.3	46	8.3	25.1	15.9	4.0	70.1	71.5	16.5	14.5

Note 1 : Length of thread R includes cut back under hexagon, if any.
Note 2 : The values of K are for core diameter.
Note 3 : The diameter of U and V are for face to face.
Note 4 : The dimension F is packing space.

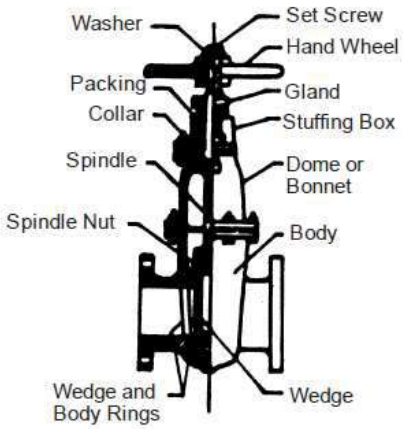
Fig. 18.3 : Bib Tap & Stop Valve

COCKS VALVES & METER

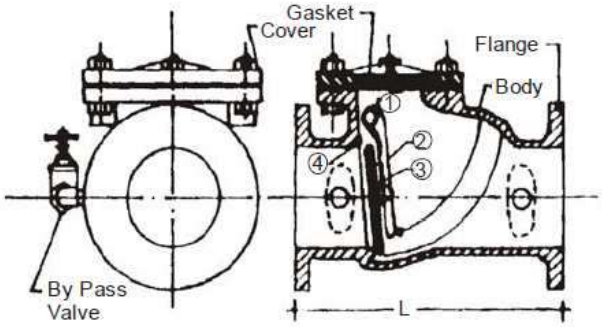
Sub Head : Water Supply
Clause : 18.3.15



WATER METER ASSEMBLY



SLUICE VALVE
(Clause 18.3.13)



NON-RETURN VALVE
(Clause 18.3.8)

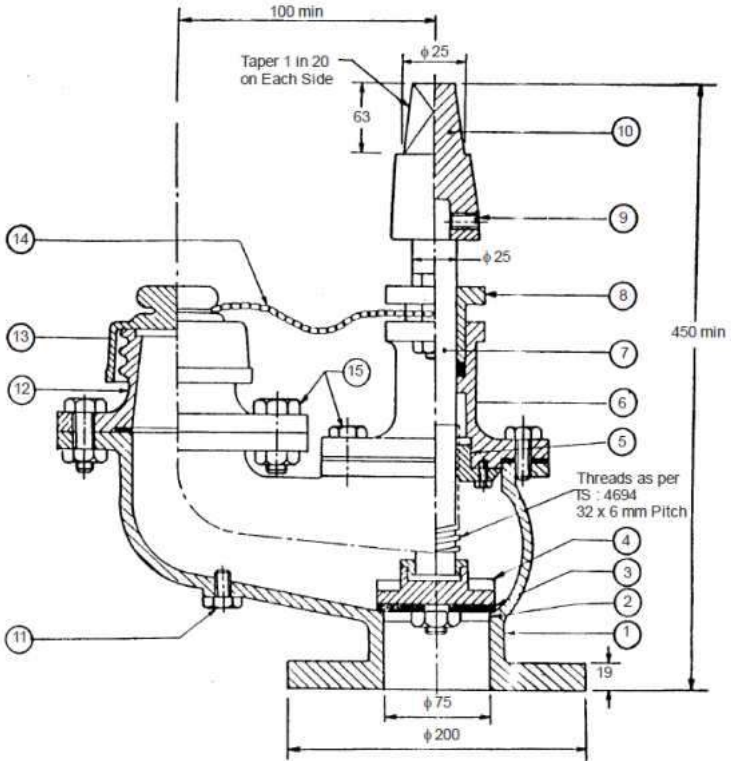
① Hinge Pin
② Hinge
③ Door
④ Body Ring

Drawing not to Scale
All Dimensions are in MM

Fig. 18.4 : Cocks Valves & Meter

UNDERGROUND FIRE HYDRANT, SLUICE-VALVE GATE

Sub Head : Water Supply
Clause : 18.3.4



No	Description	Mat.	Mat. Specification
1	Body	C.I.	IS 210-1972 FG-200
2	Valve Seat	G.M.	IS 318-1981 LTB-2
3	Washer	Rubber	IS 937-1981
4	Valve	G.M.	IS 318-1981 LTB-2
5	Spindle Nut	G.M.	IS 318-1981 LBT-2
6	Bonnet	C.I.	IS 210-1978 FG-200
7	Spindle	Brass	IS 319-1989
8	Gland	C.I.	IS 210-1978 FG-200
9	Grush Screw (12 mm)	M.S.	IS 6094-1981
10	Spindle Cap	C.I.	IS 210-1978 FG-200
11	Drain Bolt	M.S.	-
12	Outlet	G.M.	IS 318-1981 LTB-2
13	Cap	C.I.	IS 210-1978 FG-200
14	Chain	Gal. MS	-
15	Nut and Bolt	M.S.	-

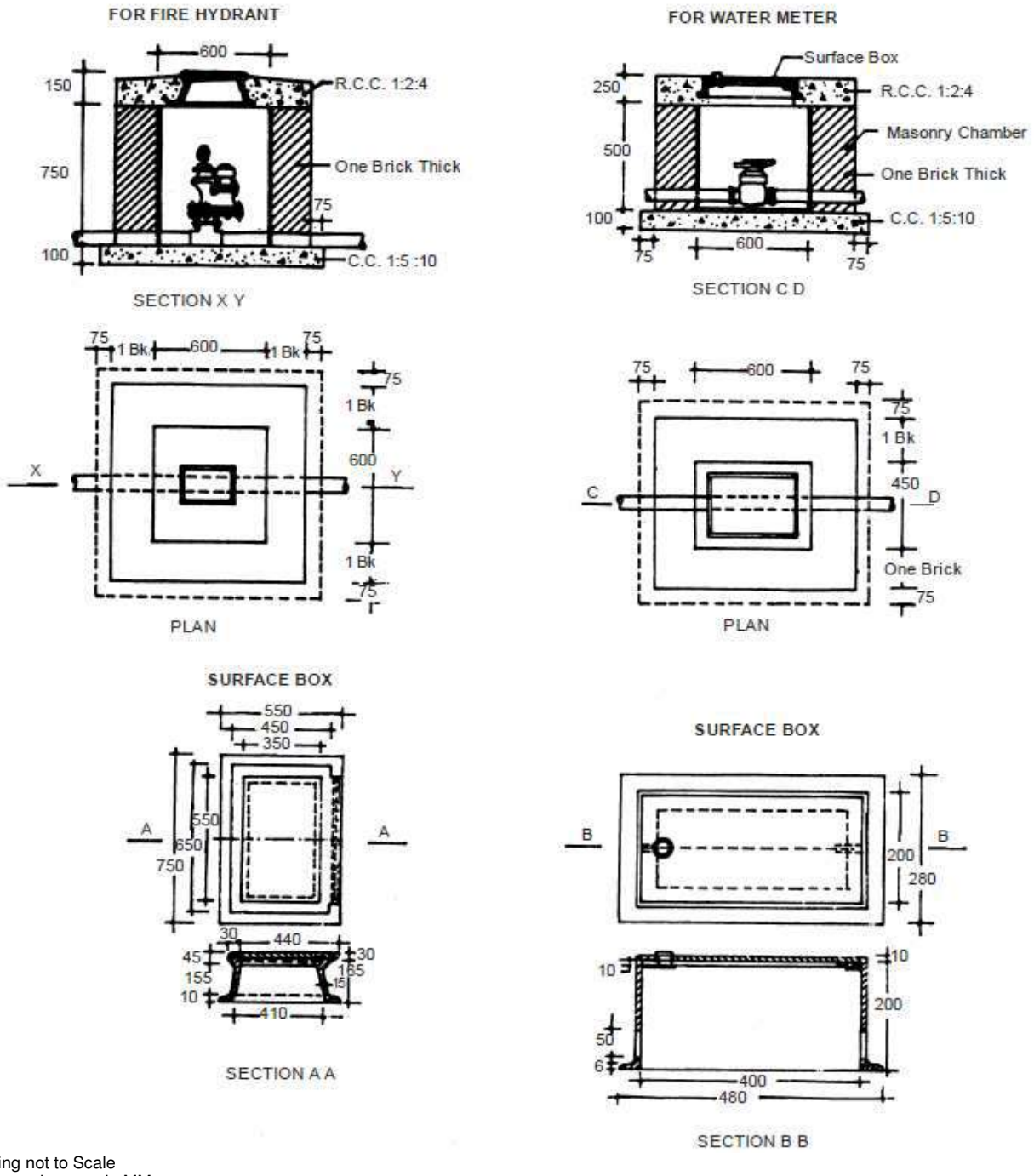
TOLERANCES AS PER IS 2102-1962

All Dimensions are in MM

Fig. 18.5 : Underground Fire Hydrant, Sluice-Valve Gate

MASONRY CHAMBERS & SURFACE BOXES

Sub Head : Water Supply
Clause : 18.3.14

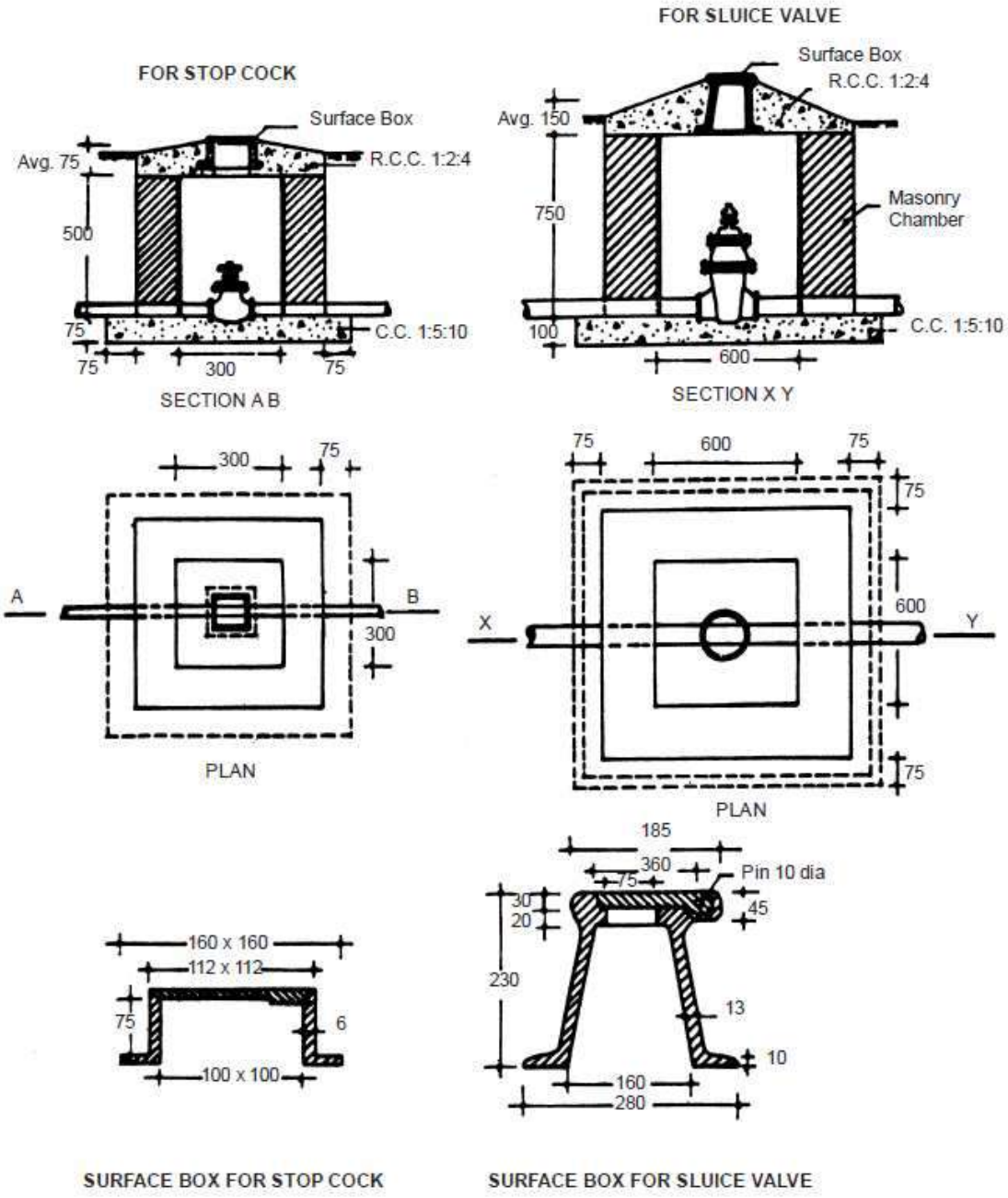


Drawing not to Scale
All Dimensions are in MM

Fig. 18.6 : Masonry Chambers & Surface Boxes

MASONRY CHAMBERS & SURFACE BOXES (Contd.)

Sub Head : Water Supply
Clause : 18.3.14

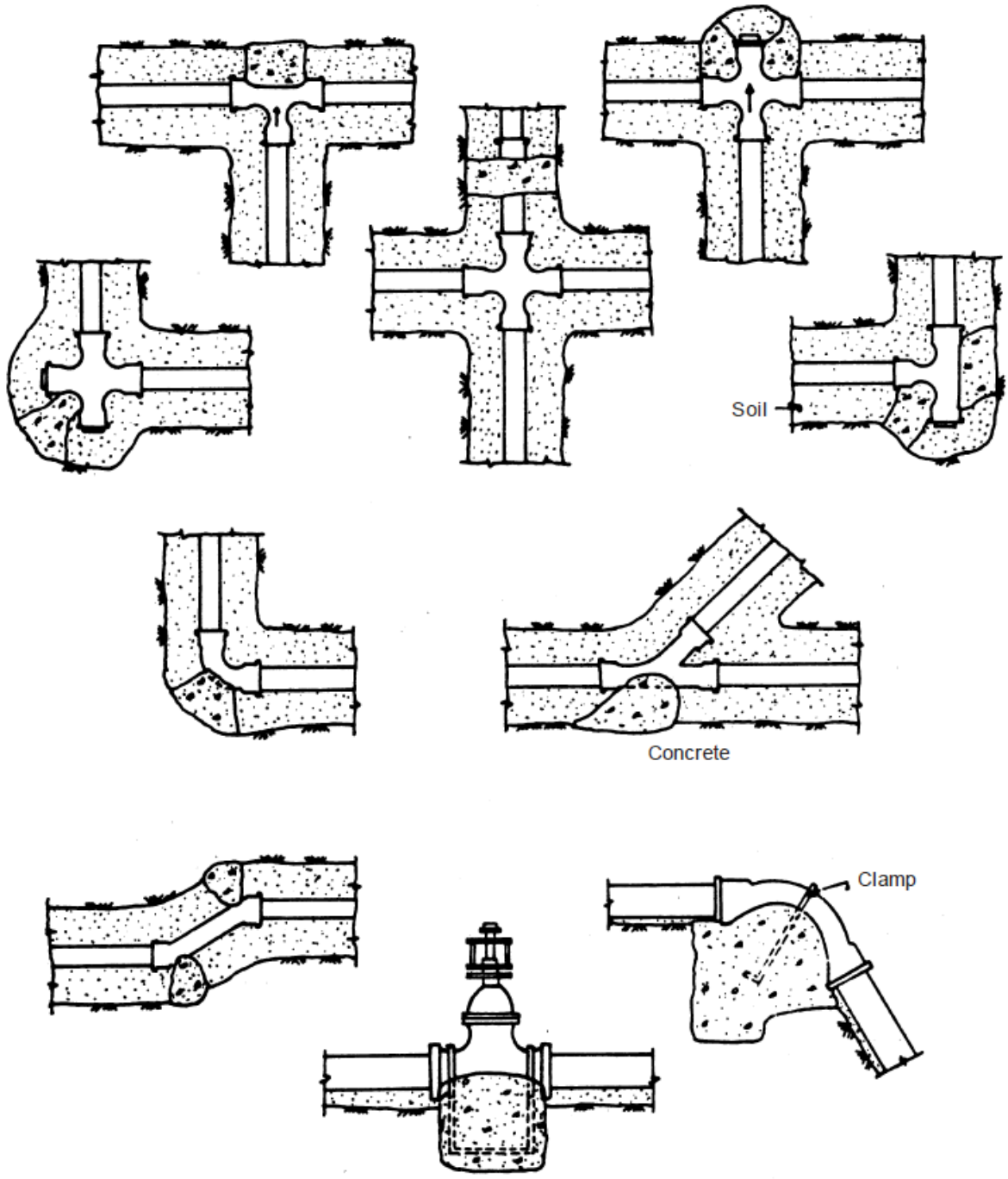


Drawing not to Scale
All Dimensions are in MM

Fig. 18.7 : Masonry Chambers & Surface Boxes (Contd.)

THRUST BLOCKS

Sub Head : Water Supply
Clause : 18.4.6

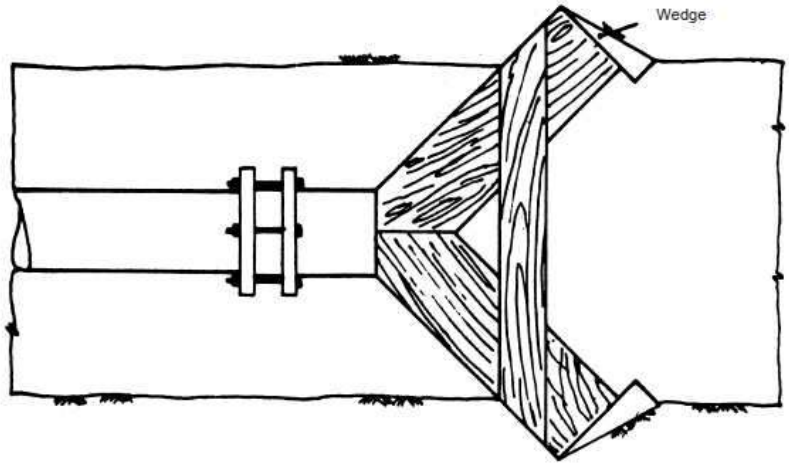


Drawing Not to Scale

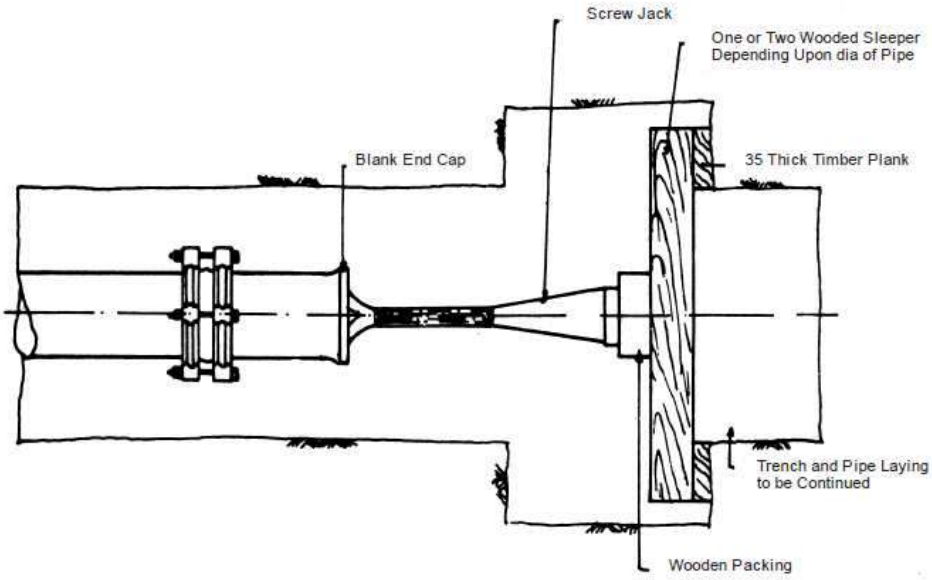
Fig. 18.8 : Thrust Blocks

HYDROSTATIC TESTS
(END CLOSURE FOR PIPES)

Sub Head : Water Supply
Clause : 18.4.8



FOR PIPES UPTO 125 NOMINAL DIA



FOR PIPES OF NOMINAL DIA OVER 125

Drawing Not to Scale
All Dimensions are in mm

Fig. 18.9 : Hydrostatic Test (End Closure for Pipes)

SUB HEAD : 21.0

ALUMINIUM WORK

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LIST OF BUREAU OF INDIAN STANDARD (BIS) CODES

S. No.	*BIS. No.*	*Subject*
1.	IS 733	Wrought Aluminium and Aluminium Alloys, Bars, Rods and Sections (For General Engineering Purposes) -Specification
2.	IS 737	Wrought Aluminium and Aluminium alloy sheet and strip for general engineering purposes -Specification
3.	IS 1285	Wrought Aluminium and Aluminium Alloy, Extruded Round Tube and Hollow sections (For General Engineering Purposes) - Specification
4.	IS 1868	Anodic coating on Aluminium and its Alloys-Specification
5.	IS 1948	Specification for Aluminium Doors, Windows and Ventilators
6.	IS 3908	Specification for Aluminium equal leg angles
7.	IS 3909	Specification for Aluminium unequal leg angles
8.	IS 3965	Dimensions for wrought Aluminium and Aluminium Alloys bars, rods and sections.
9.	IS 5523	Method of testing anodic coating on aluminium and its alloys.
10.	IS 6012	Measurement of coating thickness by Eddy Current Method
11.	IS 6315	Floor springs (Hydraulically regulated) for heavy doors-Specifications
12.	IS 6477	Dimensions of extruded hollow section and tolerances
13.	IS 12823	Wood products- Pre-laminated particle board -Specifications.
14.	IS 14900	Transparent Float glass- Specifications.

21.0 ALUMINIUM WORK

21.0 TERMINOLOGY

Bar

Any solid section, other than round, with at least one dimension of 10 mm or more.

Rod

Any round solid section with a diameter of 10 mm or greater.

Extruded Round Tube

A circular hollow extrusion of uniform wall thickness not subjected to cold drawing.

Hollow Section

An extruded shape other than round tube, the cross section of which completely encloses a void or voids and which is not subject to cold drawing.

Anodized Aluminium

Aluminium with an anodic coating, produced by an electrolytic oxidation process, in which the surface of the aluminium is covered with a coating, generally an oxide, to give protective and decorative properties.

Pre-laminated Particle Board

A particle board laminated on both surface by synthetic impregnated base papers under the influence of heat and pressure with finished foil under the pressure or pressure and heat depending on type of binder used.

Floor Spring (Hydraulically Regulated)

A device used to close the door so as to slow down its speed before it reaches its closed position.

Single Action Floor Spring (Hydraulically Regulated)

A device used to close the door in one direction only so as to slow down its speed before it reaches to its closed position.

Double Action Floor Spring (Hydraulically Regulated)

A device used to close the door in both directions so as to slow down its speed before it reaches its closed position.

Shoe

The device fixed to the bottom of the door leaf in order to hoist it to the floor spring.

Top Centre Pivot

The device to secure the upper portion of the door leaf and the door frame above.

Right Hand Floor Spring

A floor spring suitable for use on an anticlockwise door; an anticlockwise door is one which when viewed from above, rotates in anticlockwise direction about its hinge while opening.

Left Hand Floor Spring

The floor spring suitable for use on clockwise door a clockwise door is one which, when viewed from above, rotates in clockwise direction about its hinge while opening.

Sash

It is a complete window unit whether fixed or open type.

Composite Window

Window unit having two or more sashes joined together with one or more coupling members.

Centre – Hung Ventilator

A ventilator horizontally pivoted at the centre on both sides. Top half opens inwards and bottom half opens outwards.

21.1 ALUMINIUM

21.1.1 Aluminium Sections

Aluminium sections used for fixed/openable windows, ventilators, partitions, frame work & doors etc. shall be suitable for use to meet architectural designs to relevant works and shall be subject to approval of the Engineer-in- Charge for technical, structural, functional and visual considerations. The aluminium extruded sections shall conform to IS 733 and IS 1285 for chemical composition and mechanical properties. The stainless steel screws shall be of grade AISI 304.

The permissible dimensional tolerances of the extruded sections shall be as per IS 6477 and shall be such as not to impair the proper and smooth functioning/operation and appearance of door and windows.

Aluminium glazed doors, windows etc. shall be of sizes, sections and details as shown in the drawings. The details shown in the drawings may be varied slightly to suit the standards adopted by the manufacturers of the aluminium work, with the approval of Engineer-in-Charge. Before proceeding with any fabrication work, the contractor shall prepare and submit, complete fabrication and installation drawings for each type of glazing doors, windows, ventilators and partition etc. for the approval of the Engineer-in- Charge. If the sections are varied, the contractor shall obtain prior approval of Engineer-in-Charge and nothing extra shall be paid on this account.

21.1.2 Anodising

Standard aluminium extrusion sections are manufactured in various sizes and shapes in wide range of solid and hollow profiles with different functional shapes for architectural, structural glazing, curtain walls, doors, window & ventilators and various other purposes. The anodizing of these products is required to be done before the fabrication work by anodizing/electro coating plants which ensures uniform coating in uniform colour and shades. The extrusions are anodized up to 30 micron in different colours. The anodized extrusions are tested regularly under strict quality control adhering to Indian Standard.

21.1.3 Powder Coating

21.1.3.1 ***Material:*** The powder used for powder coating shall be Epoxy/polyester powder of make approved by the Engineer- in-Charge. The contractor shall give detailed programme for powder coating in advance, to facilitate the inspection by Engineer-in-Charge or his authorized representative.

21.1.3.2 ***Pre-treatment:*** Each aluminium alloy extrusion or performed section shall be thoroughly cleaned by alkaline or acidic solutions under the conditions specified by chemical conversion coating supplier and then rinsed. A chemical conversion coating shall be applied by treatment with a solution containing essentially chromate ions or chromate and phosphate ions as the active components as applicable. The amount of the conversion coating deposited depends on the type used by the conversion coating chemical supplier. The conversion coating shall be thoroughly rinsed either with the solution specified by the conversion coating chemical supplier or with de-mineralized water and then dried at the temperature for the time specified by the conversion coating chemical supplier. The contractor shall submit the detail specifications and application procedure for application of conversion coating for approval of Engineer- in-Charge. The metal surface after the conversion coating pretreatment and prior to the application of the coating shall be free from dust or powdery deposits.

21.1.3.3 ***Process:*** The polyester powder shall be applied by electrostatic powder spray method. Before start of powder coating the contractor shall submit detail specification for application of polyester powder from manufacturer of the polyester powder for approval of Engineer-in-Charge. The powder coating shall be applied as per the specification approved by Engineer-in-Charge.

21.1.3.4 ***Thickness:*** The thickness of the finished polyester powder coating measured by micron meter shall not be less than 50 micron nor more than 120 micron at any point.

21.1.3.5 ***Performance Requirements for the Finish***

(i) *Surface appearance:* The finish on significant surfaces shall show no scratches when illuminated and is examined at an oblique angle, no blisters, craters; pinholes or scratches shall be visible from a distance of about 1 m. There shall not be any visible variation in the colour of finished surfaces of different sections and between the colours of different surfaces of same section.

(ii) *Adhesion:* When a coated test piece is tested using a spacing of 2 mm between each of the six parallel cuts (the cut is made through the full depth of powder coating so that metal surface is visible) and a piece of adhesive tape, approximately 25 mm x 150 mm approved by the Engineer-in-Charge is applied firmly to the cut area and then removed rapidly by pulling at right angles to the test area, no pieces of the finish other than debris from the cutting operation shall be removed from the surface of the finish.

21.1.3.6 ***Protection of Powder Coated / Anodizing Finish :*** It is mandatory that all aluminium members shall be wrapped with self adhesive non-staining PVC tape, approved by Engineer-in-Charge.

21.1.3.7 ***Measurement:*** All the aluminium sections including snap beading fixed in place shall be measured in running meter along the outer periphery of composite section correct to a millimeter. The weight calculated on the basis of actual average (average of five samples) weight of composite section in kilogram correct to the second place of decimal shall be taken for payment. (Weight shall be taken after anodizing). The weight of cleat shall be added for payment. Neither any deduction nor anything extra shall be paid for skew cuts.

21.1.3.8 ***Rate:*** The rate shall include the cost of all the materials, labours involved in all the operations as described in nomenclature of item and particular specification.

21.2 PANELING MATERIAL

21.2.1 Pre-laminated Particle Board

A particles board laminated on both surfaces by synthetic resin impregnated base papers under heat and pressure. Pre -laminated particle boards shall be of two grades, namely, Grade I and II corresponding to IS 3087 & 12823. Each of the grades specified shall be of four types, namely, Types-I, II, III, and IV classified by the surface abrasion characteristics specified in Table 21.1. The grade and types of pre-laminated particle board shall be represented by symbols as follows:

Grade	*Type*	*Designation*
Grade 1	Type I	PLB-11
	Type II	PLB-12
	Type III	PLB-13
	Type IV	PLB-14
Grade 1	Type I	PLB-21
	Type II	PLB-22
	Type III	PLB-23
	Type IV	PLB-24

TABLE 21.1
Physical and Mechanical Properties
(Para 21.2.1)

Sl. No.	Properties	Flat Pressed Three Layer, Multilayer and Graded	
		Grade-I	Grade-II
(i)	Density variation (Max.) Percent	± 10	± 10
(ii)	Water absorption (Max)		
	(a) 2 hours	7.0	15.0
	(b) 24 hours	15.0	30.0
(iii)	Thickness swelling (Max.), percent, 2 hours	5.0	8.0
(iv)	Modulus of rupture (Min) N/mm^2		
	(a) Up to 20 mm thickness	15.0	11.0
	(b) Above 20 mm thickness	12.5	11.0
(v)	Tensile strength perpendicular to surface (Min.) N/m^2		
	(a) Up to 20 mm thickness	0.45	0.3
	(b) Above 20 mm thickness	0.4	0.3
(vi)	Tensile strength perpendicular to surface (Min.) N/mm^2		
	(a) After cyclic test*	0.2	-
	(b) After accelerated water resistance test**	0.15	-
(vii)	Screw withdrawal strength (Min.), N:		
	(a) Face	1250	1250
	(b) Edge	850	750
(viii)	Abrasion resistance (Min.) in number of revolutions		
	(a) Type I	450	450
	(b) Type II	250	250
	(c) Type III	80	80

* *Cyclic Test :* Specimen are immersed in water at 27±2° C for a period of 72 hours, followed by drying in air at 27 ± 2° C for 24 hours and then heating in dry air at 70° C for 72 hours. Three such cycles are to be followed and then specimens are tested for tensile strength perpendicular to the surface.

** *Accelerated Water Resistance Test:* Specimens are immersed in water at 27±2° C and water is brought to boiling and kept at boiling temperature for two hours. Specimens are then cooled in water to 27±2° C and tested for tensile strength perpendicular to the surface.

21.2.1.1 ***Particle Board:*** Synthetic resin bonded flat pressed three layers, multilayer and graded particle board defined in IS 3087 having superfine surface shall be used for production of prelaminated particle board. For ECO Marks the particle board shall also conform to the requirements of ECO Mark specified in IS 3087.

21.2.1.2 ***Impregnated Base Paper:*** Printed or plain coloured absorbent base paper having a weight of 60 -140 g/m^2 impregnated in a suitable synthetic resin and dried to a volatile content of 4-8 per cent shall be used for pre-lamination on both surfaces of particle board.

21.2.1.3 ***Impregnated Overlay:*** An absorbent tissue, paper having a weight of 18-40 g/m^2 impregnated in a suitable synthetic resin and dried to a volatile content of 4-8 per cent shall be used for the manufacture of pre-laminated particle board.

21.2.1.4 ***Manufacture:*** Particle boards having superfine and closed surface with high face strength and steep density gradient across the thickness is used for making prelaminated particle boards. Impregnated base papers rich in a synthetic resin are placed on either side of the particle board and the assembly is taken inside a short cycle single opening lamination press or a multi day light press. Under heat and pressure the resin flows and forms a permanent bond with particle board.

The top surface of impregnated paper comes in contact with special surface chromium plates or steel caul plates and takes the impression of surface finish of these cauls. Hot boards are extracted out of the short cycle press and cooled in air, whereas cooling of boards is done inside the dress in multiday light type. Care should be taken to keep cycle times low in the press to avoid heat penetration to the centre of the boar edge.

The impregnated overlay paper may be used by placing it over the impregnated base paper (IBP) on one surface while using a normal IBP on the other surface and pressure. The impregnated overlay becomes transparent after pressing. Such boards are used for high surface abrasion application.

In case of finished foil particle boards, the finished foil is pasted on both surfaces of particle board after spreading suitable synthetic glue on board's surface and passing the assembly in a roller press or a flat press under the influence of pressure and/or heat depending on the type of binder used.

21.2.1.5 ***Finish*****:** The finish of the paper overlaid board depends on the surface of caul plates used. Common surface finishes in use are glossy, matt textured (soft, Swede, wood pore and leather), etc. The surface finish of the foil finished boards depends on the original finish of the foil used.

21.2.1.6 ***Dimensions and Tolerances:*** Dimensions and tolerances shall conform to IS 12049.

21.2.1.7 ***Testing:*** One sample for every 100 sqm. or part thereof shall be taken and testing done as per IS 12823. For quantity less than 100 sqm, the test certificate from manufacturer shall be relied upon. The Engineer-in-charge may ask for testing even if the quantity is less than 100 sqm.

21.2.2 Aluminium Sheet

21.2.2.1 Aluminium Sheets for use as panels shall be 1.25 mm thick aluminium alloy sheet conforming to IS 737. Aluminium alloy sheet for use in general paneling work shall be of types and thickness as specified and conforming to the requirement of IS 737. Aluminium sheets shall be of approved make and manufacturer. Aluminium panel may be prefabricated units manufactured on modular or non-modular dimension.

21.2.2.2 ***Fixing:*** The required size of panel, keeping sufficient margin to be inserted inside the section, shall be cut to correct size and fixed firmly in the frame with CP brass or aluminium or stainless steel screws of star headed, counter sunk and matching size groove. Joints sealed with epoxy resin or silicon sealant to make the unit water proof.

21.2.3 Float Glass

21.2.3.1 The glass shall be clear float glass and should be approved by the Engineer in Charge. It shall be clear, float transparent and free from cracks subject to allowable defects. The float glass shall conform to the IS 14900.

21.2.3.2 ***Thickness :*** The thickness of float glass shall depend on the size of panel. The tolerance in thickness shall be as under:

TABLE 21.2

Nominal Thickness (in mm)	Tolerance (in mm)
4.0	± 0.3
5.0	± 0.3
6.0	± 0.3
8.0	± 0.6

21.2.3.3 *Allowable Defects:* The allowable defects shall be as per Table 21.3 below:

TABLE 21.3

Sl. No.	*Defects*	*Central*	*Outer*	*Remarks*
1.	Gaseous inclusion. Max size, mm	3.0	6.0	Separated by at least 30.0 cm
2.	Opaque gaseous inclusion. Max size. mm	3.0	6.0	Separated by at least 60.0 cm
3.	Knots, dirt and stones, Max size. mm	1.0	1.0	Separated by at least 30.0 cm
4.	Scratches, Rubs and Crush	Faint	Light	Separated by at least 30.0 cm
5.	Bow, percent. Max	0.5	0.5	See 21.2.4.3
6.	Reams, Strings and lines	Light	Light	See 21.2.4.4
7.	Waviness	Nil	Nil	See 21.2.4.5
8.	Sulphur stains	Nil	Nil	
9.	Corner breakage and chip	Not more than nominal thickness of float glass		

21.2.3.4 *Allowable Cluster of Defects:* The allowable cluster of defects mentioned under Sl. No. 1, 2 & 3 of Table 21.3 shall be as per IS 14900.

21.2.4 Tests

21.2.4.1 *Thickness:* The thickness of float glass shall be measured with micrometers or a caliper which is graduated to 0.01 mm or with a measuring instrument having an equivalent capacity.

21.2.4.2 *Scratches, Rubs and Crush :* Place the sample of float glass in a vertical position approximately 50 cm from the viewer's position and look through it using either day light without direct sunlight or a background light suitable for observing each type of defect.

Intensity of Scratches, Rubs, Crush	*Intensity Distance Limit*
Faint	Shall not be detectable beyond 50 cm
Light	Detectable between 50-100 cm and not beyond 100 cm.

21.2.4.3 *Bow :* Depending on the side on which bow is present, stand the sample vertically on a wooden plank. Stretch a thread edge to edge. Measure the longest perpendicular. Distance from the thread to the surface of float glass facing the thread and express it as percentage of the length of float glass from edge along the thread.

21.2.4.4 *Reams, Strings and Lines :* Focus a light projector with a 500 W lamp and an objective lens with an approximate 5 cm aperture and about 30 cm focal length on a flat white projection screen placed about 760 cm from the light source in a dark room. Place the float glass in a vertical position parallel to the screen between the light and the screen. Move the glass slowly towards the screen with a vertical oscillating motion. The shadowgraph read out is the distance at which the distortion just blends with the general shadow of the glass on the screen.

TABLE 21.4

Intensity of Reams, Strings and Lines	Intensity Distance Limit
Light	7.5 cm
Medium	5.0 cm
Heavy	2.5 cm

21.2.4.5 *Perspective Distortion:* When tested as per test procedure described below it shall not give distorted vision of straight stripe pattern.

Test Procedure for Perspective Distortion

Perspective distortion shall be examined by looking through the specimen glass which may be placed at about 4.5 m distance in such a direction that the incident angle to it is 50 degree (4 mm or above) and by observing a screen set up perpendicularly to the line of vision about 4.5 m further ahead of the specimen over the total width of about middle part of the specimen from the horizontal direction. The specimen glass shall be kept with the drawn direction at manufacture vertical and, on the surface of the screen, the strip pattern of white and black parallel straight lines of 25 mm width and inclined 45 degrees from the vertical shall be provided and its surface shall be luster less.

21.3 EPDM- GASKETS

The EPDM Gaskets shall be of size and profile as shown in drawings and as called for, to render the glazing, doors, windows, ventilators etc. air and water tight. Samples of gaskets shall be submitted for approval and the EPDM gasket approved by Engineer- in- Charge shall only be used. The contractor shall submit documentary proof of using the above material in the work to the entire satisfaction of Engineer-in-Charge.

The EPDM gasket shall meet the requirements as given in Table 21.5 below:

TABLE 21.5

Sl. No.	Description	Standard Follow	Specification
1	Tensile strength Kg.f/cm^2	ASTM-D 412	70 Min.
2	Elongation at break %	ASTM-D 412	250 Min.
3	Modulus 100% Kgf/cm^2	ASTM-D 412	22 Min.
4	Compression set % at 0° CC 22 Hrs.	ASTM-D 395	50 Max.
5	Ozone resistance	ASTM-D 1149	No visible cracks

21.4 SEALANT

21.4.1 The sealants of approved grade and colour shall only be used. The silicone for perimeter joints (between Aluminium section and RCC/Stone masonry) shall be of make approved by the Engineer in Charge.

21.4.2 Method of Application

Surface Preparation : Clean all joints and glazing pockets by removing all foreign matter and contaminants such as grease, oil, dust, water, frost, surface dirt, old sealants or glazing compounds and protective coatings.

21.4.3 Masking

Areas adjacent to joints shall be masked to ensure neat sealant lines. Masking tape shall not be allowed to touch clean surfaces to which the silicone sealant is to adhere. Tooling shall be completed in one continuous stroke immediately after sealant application and before a skin forms and masking shall be removed immediately after tooling.

21.4.4 Application

Install backer rod of appropriate size and apply silicone sealant in a continuous operation using a positive pressure adequate to properly fill and seal the joint. The silicone sealant shall be tooled with light pressure to spread the sealant against backing material and the joint surfaces before a skin forms. A tool with convex profile shall be used to keep the sealant within the joint. Soap or water shall not be used as a tooling aid. Remove masking tape as soon as silicone joint is tooled.

Tolerance: A tolerance of + 3 mm shall be allowed in the width of silicone joints. The depth of the joints at throat shall not be less than 6 mm.

21.5 REFLECTIVE GLASS

21.5.1 Definitions

(i) ***Shading Coefficient:*** The shading coefficient is the ratio of total solar transmittance to the transmittance through 3.2 mm (1/8") clear glass. Windows with low shading coefficient values improve comfort for building, lower the total cooling load of the building and help smooth out of the difference in cooling loads between perimeter & core zones.

(ii) ***Luminous Efficacy Constant (Ke)*** indicates a windows relative performance in rejecting solar heat-while transmitting day light. It is the ratio of the visible transmittance to the shading coefficient; clear glass which lets in roughly equal amounts of visible light and solar near-infrared energy has a Ke close to 1.0. The solar radiation contains about 50% invisible near-infrared & ultra violet light. Therefore, a perfectly selective glazing, which would all allow visible light pass through while blocking all of the invisible near-infrared & ultraviolet light, would have Ke of about 2.0.

(iii) ***Resistance to Heat Conduction (R-valve):*** It is a measure of resistance to heat flow that occurs because of temperature difference between the two sides of the windows. The inverse of R-value is termed as U-value.

21.5.2 Reflective Glass

This is an ordinary float glass with a metallic coat to reduce solar heat. Clear glass transmits most of the sunlight that shines upon it, and most of the solar heat as well; the metallic coated glass i.e. reflective glass has better shading coefficients because they reflect rather than absorb infrared energy. However, most of reflective glazing blocks day light more than solar heat.

21.5.2.1 ***Types of Coatings:*** There are two types of reflective glass, Pyroltic (Hard) coated and vacuum (soft) coated.

(i) ***Pyroltic :*** It is a coating applied during glass manufacture. The coating is fused into the glass at 1200°C.

(ii) ***Vacuum Coated Glass:*** It involves the deposition of metal particles on the glass surface by a chain reaction in a vacuum vessel. It is often called a soft coat; because the coating is more susceptible to damage than hard coat glass. Where toughening of product is required, the product must be toughened first & then vacuum coated. Vacuum coated products have better shading coefficient values than pyroltic products.

21.5.2.2 ***Performance of Reflective Glass:*** The performance of reflective glass 6 mm of nominal thickness is given below:

Sl. No.	Parameter	Threshold Ratio In %age
1	Visible Light - Transmittance (%) - Reflectance (%)	 15-46 12-24
2	Total Solar Energy: - Transmittance (%) - Reflectance (%)	 16-24 8-12
3	Ultra Violet Rays: - Transmittance (%)	 2-10
4	U-Value - Summer - Winter	 0.58 0.45
5	Shading Coefficient	0.25-0.35

21.5.2.3 ***Testing:*** The reflective glass shall be tested for the followings:

(i) *Physical/Field Test:* In a true reflective glass, when a pointed pencil is placed, then tip of pencil (physical) & image should coincide.

(ii) *Lab. Test:* In the lab, the reflective glass shall be tested for the parameter specified in 21.5.2.2 above.

21.5.2.4 Fixing of glass shall be done as specified.

21.6 DOOR, WINDOW, VENTILATOR AND PARTITION FRAMES

21.6.1 Frame Work

First of all the shop drawings for each type of doors/windows/ventilators etc. shall be prepared by using suitable sections based on architectural drawings, adequate to meet the requirement/ specifications and by taking into consideration varying profiles of aluminium sections being extruded by approved manufacturers. The shop drawings shall show full size sections of glazed doors, windows, ventilators etc. The shop drawings shall also show the details of fittings and joints. Before start of the work, all the shop drawings shall be got approved from the Engineer-in-Charge.

Actual measurement of openings left at site for different type of door/window etc. shall be taken. The fabrication of the individual door/windows/ventilators etc. shall be done as per the actual sizes of the opening left at site. The frames shall be truly rectangular and flat with regular shape corners fabricated to true right angles. The frames shall be fabricated out of section which have been cut to length, mitered and jointed mechanically using appropriate machines. Mitered joints shall be corner crimped or fixed with self tapping stainless steel screws using extruded aluminium cleats of required length and profile. All aluminium work shall provide for replacing damaged/broken glass panes without having to remove or damage any member of exterior finishing material.

21.6.2 Fixing of Frames

The holes in concrete/masonry/wood/any other members for fixing anchor bolts/fasteners/screws shall be drilled with an appropriate electric drill. Windows/doors/ventilators etc. shall be placed in correct final position in the opening and fixed to Sal wood backing using stainless steel screws of star headed, counter sunk and matching size groove. of required size at spacing not more than 250 mm c/c or dash fastener. All joints shall be sealed with approved silicone sealants.

In the case of composite windows and doors, the different units are to be assembled first. The assembled composite units shall be checked for line, level and plumb before final fixing is done. Engineer -in-Charge in his sole discretion may allow the units to be assembled in their final location if the situation so warrants. Snap beadings and EPDM gasket shall be fixed as per the detail shown in the shop drawings.

Where aluminium comes into contact with stone masonry, brick work, concrete, plaster or dissimilar metal, it shall be coated with an approved insulation lacquer, paint or plastic tape to ensure that electrochemical corrosion is avoided. Insulation material shall be trimmed off to a clean flush line on completion.

The contractor shall be responsible for the doors, windows etc. being set straight, plumb, level and for their satisfactory operation after fixing is complete.

21.6.3 Measurements

All the aluminium sections including snap beadings fixed in place shall be measured in running meter along the outer periphery of composite section correct to a millimeter. The weight calculated on the basis of actual average (average of five samples) weight of composite section in kilogram correct to the second place of decimal shall be taken for payment (weight shall be taken after anodizing). The weight of cleat shall be added for payment. Neither any deduction nor anything extra shall be paid for skew cuts.

21.6.4 Rate

The rate shall include the cost of all the materials, labour involved in all the operations as described in nomenclature of item and particular specification.

21.7 DOOR, WINDOWS AND VENTILATOR SHUTTERS

Material, fabrication and dimensions of aluminium doors, windows and ventilators manufactured from extruded aluminium alloy sections of standard sizes and designs complete with fittings, ready for being fixed into the building shall be as per IS 1948.

21.7.1 Terminology

The components of doors, windows and ventilators shall be defined as in Figure 21.1 below.

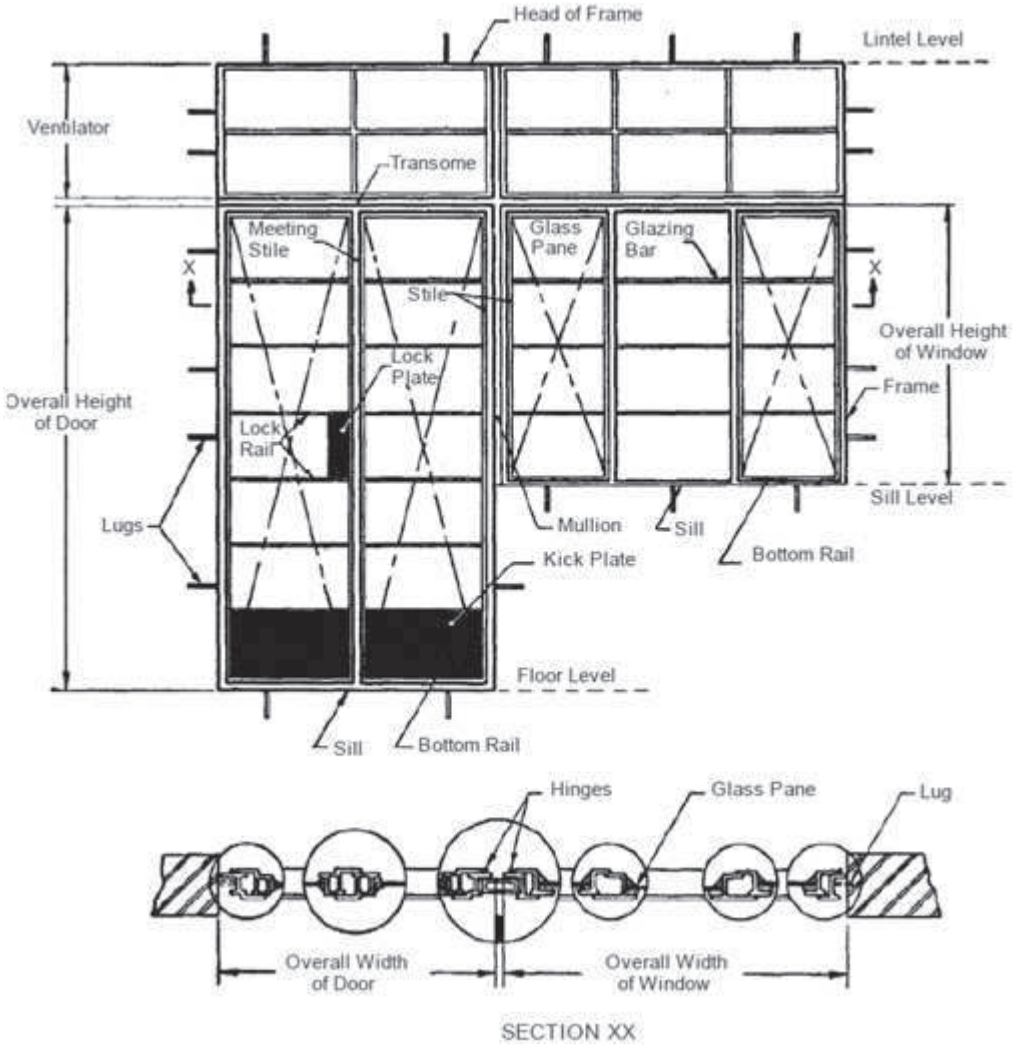
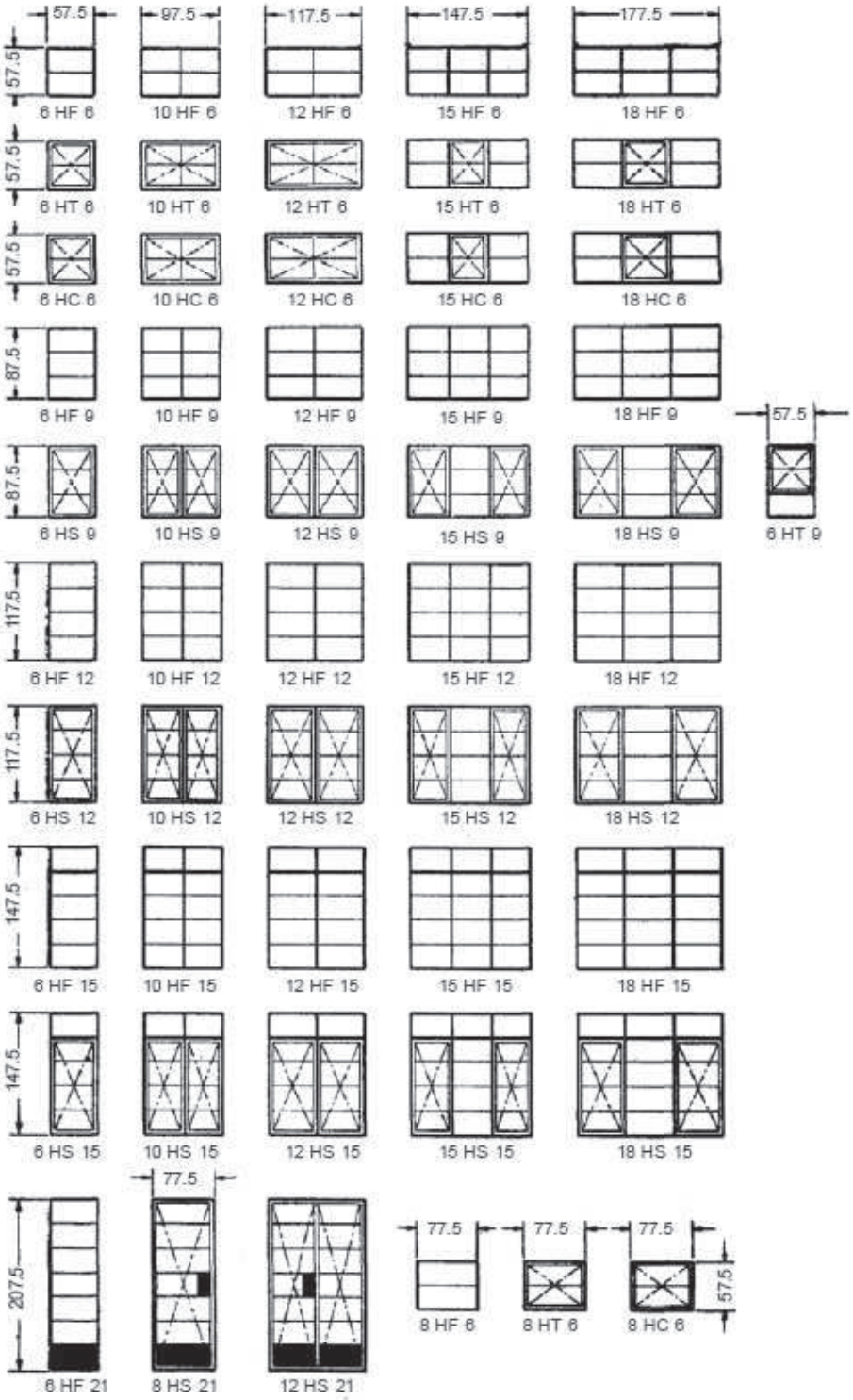


Fig. 21.1 : Terminology for Aluminium Doors, Windows and Ventilators

21.7.2 Standard Sizes, Tolerances and Designations

The types and the overall sizes of aluminium doors, windows and ventilators shall be as given in Figure 21.2. Their sizes are derived after allowing 1.25 mm clearances on all the four sides for the purpose of fitting the doors, windows and ventilators into modular openings.



Note : 1. Windows without horizontal glazing bars shall be designated by 'N' in place of 'H' in the range shown.

Note : 2. Doors and side lights shall only be coupled with 12 module (117.5 cm) high windows.

All dimensions in centimetres

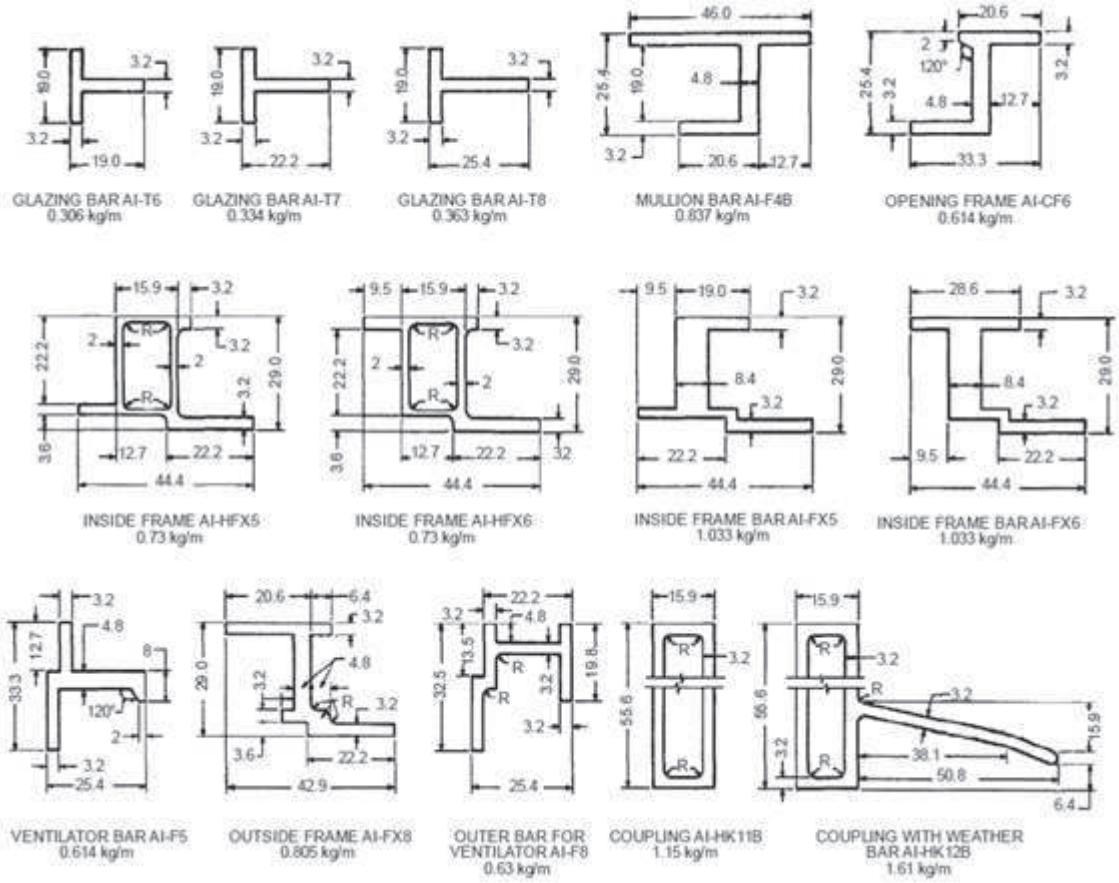
Fig. 21.2 : Types and Size of Aluminium Doors, Windows and Ventilators

21.7.3 Tolerances

The sizes for doors, windows and ventilators frames shall not vary by more than ±1.5 mm.

21.7.4 Material

Aluminium alloy extruded sections used in the manufacture of extruded window sections shall conform to IS 733. Hollow aluminium alloy sections used shall conform to IS 1285. Dimension and weight per metre run of the extruded sections shall be as given in Figure 21.3.



Note 1 : All radii R = 1.6 mm

Note 2 : The weights of sections per metre length as indicated are nominal.

All dimensions in millimeters

Fig. 21.3 : Extruded Aluminium Sections for Doors, Windows and Ventilators

21.7.5 Glass Panes

Glass panes shall weigh at least 7.5 kg/m^2 and shall be free from flaws, specks or bubbles. All panes shall have properly squared corners and straight edges. The sizes of glass panes for use in doors, windows and ventilators shall be as given in Table 21.6.

21.7.6 Screws

Screws threads of machine screws used in the fabrication of aluminium doors, windows and ventilators shall conform to IS 1362.

TABLE 21.6
Glass Sizes (Clearance Allowed)
(Clause 21.7.5)

Designation	*Quantity*	*Glass size Width X Height cm*
No Glazing Bar Fixed Type		
6NF6	1	53.0 x 53.0
10NF6	2	45.0 x 53.0
12NF6	2	55.0 x 53.0
15NF6	{2 {1	45.0 x 53.0 47.5 x 53.0
18NF6	{2 {1	55.0 x 53.0 57.5 x 53.0
6NF9	1	53.0 x 83.0
10NF9	2	45.0 x 83.0
12NF9	2	55.0 x 83.0
15NF9	{2 {1	45.0 x 83.0 47.5 x 83.0
18NF9	{2 {1	55.0 x 83.0 57.5 x 83.0
6NF12	1	53.0 x113.0
10NF12	2	45.0 x 113.0
12NF12	2	55.0 x 113.0
15NF12	{2 {1	45.0 x 113.0 47.5 x 113.0
18NF12	{2 {1	55.0 x 113.0 57.5 x 113.0
6NF15	{1 {1	53.0 x 27.0 53.0 x 113.0
10NF15	{2 {2	{45.0 x 27.0 {45.0 x 113.0
12NF15	{2 {2	55.0 x 27.0 55.0 x 113.0
15NF15	{2 {1 {2 {1	45.0 x 27.0 47.5 x 27.0 45.0 x 113.0 47.5 x 113.0
18NF15	{2 {1 {2 {1	55.0 x 27.0 57.5 x 27.0 55.0 x 113.0 57.5 x 113.0
8NF6	1	73.0 x 53.0
6NF21	{1 {1 {1	53.0 x 84.5 53.0 x 27.5 53.0 x 56.0
No Glazing Bar Top-Hung Type		
6NT6	1	50.0 x 50.0
10NT6	2	44.5 x 50.0
12NT6	2	54.5 x 50.0
15NT6	{2 {1	45.0 x 53.0 45.5 x 50.0
18NT6	{2 {1	55.0 x 53.0 54.5 x 50.0
8NT6	1	70.0 x 50.0
6NT9	{1 {1	50.0 x 51.5 53.0 x 27.5

Designation	*Quantity*	*Glass size Width X Height cm*
No Glazing Bar Centre-Hung Type		
6NC6	1	46.0 x 46.0
10NC6	2	42.5 x 46.0
12NC6	2	52.5 x 46.0
15NC6	{2 {1	45.0 x 53.0 43.5 x 46.0
18NC6	{2 {1	55.0 x 53.0 53.5 x 46.0
8NC6	1	66.0 x 46.0
No Glazing Bar Side-Hung Type		
6NS9	1	50.0 x 80.0
10NS9	2	43.5 x 80.0
12NS9	2	52.5 x 80.0
15NS9	{2 {1	43.5 x 80.0 47.5 x 83.0
18NS9	{2 {1	52.5 x 80.0 57.5 x 83.0
6NS12	1	50.0 x 110.0
10NS12	2	43.5 x 110.0
12NS12	2	52.5 x 110.0
15NS12	{2 {1	43.5 x 110.0 47.5 x 113.0
18NS12	{2 {1	53.0 x 27.0 50.0 x 110.0
6NS15	{1 {1	53.0 x 27.0 50.0 x 110.0
10NS15	{2 {2	45.0 x 27.0 43.5 x 110.0
12NS15	{2 {2	55.0 x 27.0 52.5 x 110.0
15NS15	{2 {1 {2 {1	45.0 x 27.0 47.5 x 27.0 43.5 x 110.0 47.5 x 113.0
18NS15	{2 {1 {2 {1	55.0 x 27.0 57.5 x 27.0 52.5 x 110.0 57.5 x 113.0
8NS21	{1 {1 {1	66.0 x 81.0 56.0 x 27.5 66.0 x 56.0
12NS21	{2 {2 {1 {1	50.5 x 81.0 50.5 x 56.0 50.5 x 27.5 40.5 x 27.5

Designation	*Quantity*	*Glass size Width X Height cm*
Horizontal Glazing Bar Fixed Type		
6HF6	2	53.0 x 26.0
10HF6	4	45.0 x 26.0
12HF6	4	55.0 x 26.0
15HF6	{4	45.0 x 26.0
	{2	47.5 x 26.0
18HF6	{4	55.0 x 26.0
	{2	57.5 x 26.0
6HF9	{2	53.0 x 27.5
	{1	53.0 x 26.0
10HF9	{4	45.0 x 27.5
	{2	45.0 x 26.0
12HF9	{4	55.0 x 27.5
	{2	55.0 x 26.0
15HF9	{4	45.0 x 27.5
	{2	45.0 x 26.0
	{2	47.5 x 27.5
	{1	47.5 x 26.0
18HF9	{4	55.0 x 27.5
	{2	55.0 x 26.0
	{2	57.5 x 27.5
	{1	57.5 x 26.0
6HF12	4	53.0 x 27.5
10HF12	8	45.0 x 27.5
12HF12	8	55.0 x 27.5
15HF12	{8	45.0 x 27.5
	{4	47.5 x 27.5
18HF12	{8	55.0 x 27.5
	{4	57.5 x 27.5
6HF15	{1	53.0 x 27.0
	{4	53.0 x 27.5
10HF15	{2	45.0 x 27.0
	{8	45.0 x 27.5
12HF15	{2	55.0 x 27.0
	{8	55.0 x 27.5
15HF15	{2	45.0 x 27.0
	{1	47.5 x 27.0
	{8	45.0 x 27.5
	{4	47.5 x 27.5
18HF15	{2	55.0 x 27.0
	{1	57.5 x 27.0
	{8	55.0 x 27.5
	{4	57.5 x 27.5
8HF6	2	73.0 x 26.0
6HF21	6	53.0 x 27.5
Horizontal Glazing Bar Top-Hung Type		
6HT6	2	50.0 x 24.5
10HT6	4	44.5 x 24.5
12HT6	4	54.5 x 24.5
15HT6	{4	45.0 x 26.0
	{2	44.5 x 24.5
18HT6	{4	55.0 x 26.0
	{2	54.5 x 24.5
6HT9	{1	50.0 x 26.0
	{1	50.0 x 24.5
	{1	53.0 x 27.5
8HT6	2	70.0 x 24.5

Designation	*Quantity*	*Glass size Width X Height cm*
Horizontal Glazing Bar Centre-Hung Type		
6HC6	2	46.0 x 22.5
10HC6	4	42.5 x 22.5
12HC6	4	52.5 x 22.5
15HC6	{4	45.0 x 26.0
	{2	43.5 x 22.5
18HC6	{4	55.0 x 26.0
	{2	53.5 x 22.5
8HC6	2	66.0 x 22.5
Horizontal Glazing Bar Side-Hung Type		
6HS9	3	50.0 x 26.0
10HS9	6	43.5 x 26.0
12HS9	6	52.5 x 26.0
15HS9	{6	43.5 x 26.0
	{2	47.5 x 27.5
	{1	47.5 x 26.0
18HS9	{6	52.5 x 26.0
	{2	57.5 x 27.5
	{1	57.5 x 26.0
6HS12	{2	50.0 x 26.0
	{2	50.0 x 27.5
10HS12	{4	43.5 x 26.0
	{4	43.5 x 27.5
12HS12	{4	52.5 x 26.0
	{4	52.5 x 27.5
15HS12	{4	43.5 x 26.0
	{4	43.5 x 27.5
	{4	47.5 x 27.5
18HS12	{4	52.5 x 26.0
	{4	52.5 x 27.5
	{4	57.5 x 27.5
6HS15	{1	53.0 x 27.0
	{2	50.0 x 26.0
	{2	50.0 x 27.5
10HS15	{2	45.0 x 27.0
	{4	43.5 x 26.0
	{4	43.5 x 27.5
12HS15	{2	55.0 x 27.0
	{4	52.5 x 26.0
	{4	52.5 x 27.5
15HS15	{2	45.0 x 27.0
	{1	47.5 x 27.0
	{4	43.5 x 26.0
	{4	43.5 x 27.5
	{4	47.5 x 27.5
18HS15	{2	55.0 x 27.0
	{1	57.5 x 27.0
	{4	52.5 x 26.0
	{4	52.5 x 27.5
	{4	57.5 x 27.5
8HS21	{1	66.0 x 24.0
	{4	66.0 x 27.5
	{1	56.0 x 27.5
12HS21	{2	50.5 x 24.0
	{9	50.5 x 27.5
	{1	40.5 x 27.5

21.7.7 Fabrication

Frames*:* Frames shall be square and flat, the corners of the frame being fabricated to a true right angle. Both the fixed and opening frames shall be constructed of sections which have been cut to length, mitered and welded at the corners. Where hollow sections are used with welded joints, argon-arc welding or flash butt welding shall be employed (gas welding or brazing not to be done). Subdividing bars of units shall be tenoned and riveted into the frame.

The location of the parts and details of construction of the doors, windows and ventilators are indicated in Fig. 21.4 to 21.11.

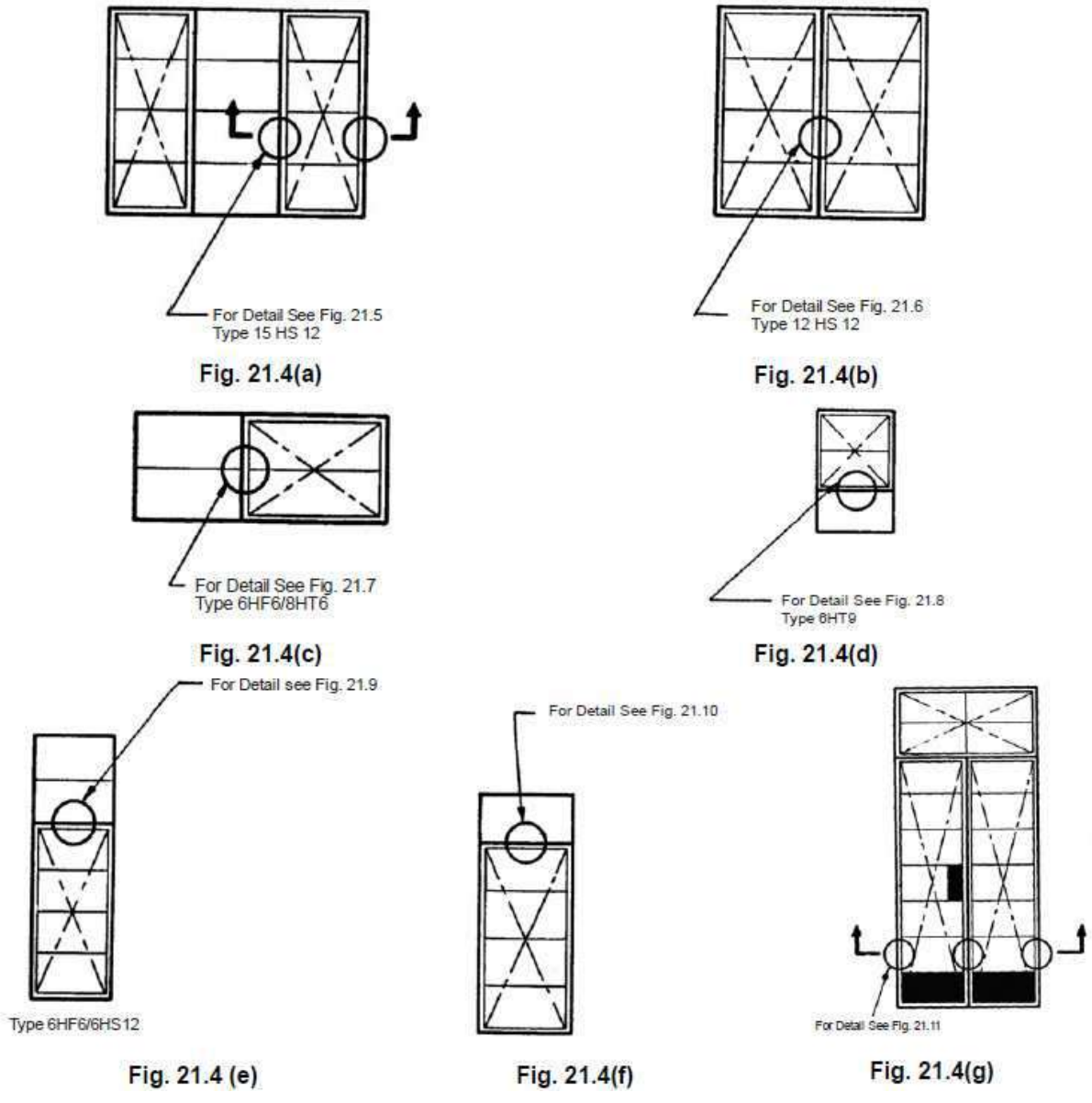


Fig. 21.4 : Location of Parts of Aluminium Doors, Windows and Ventilators for which Details are Shown

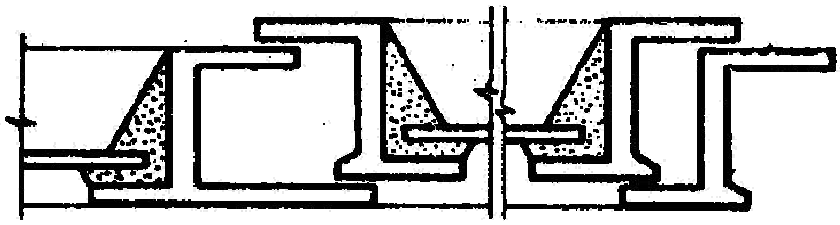


Fig 21.5 : Mullion with Fixed Glass on one Side and Side Hung on Other Side

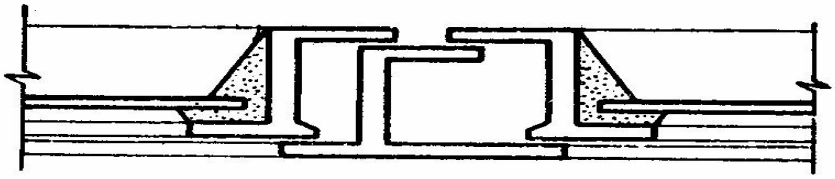


Fig 21.6 : Mullion with Side Hung Shutter Both Sides

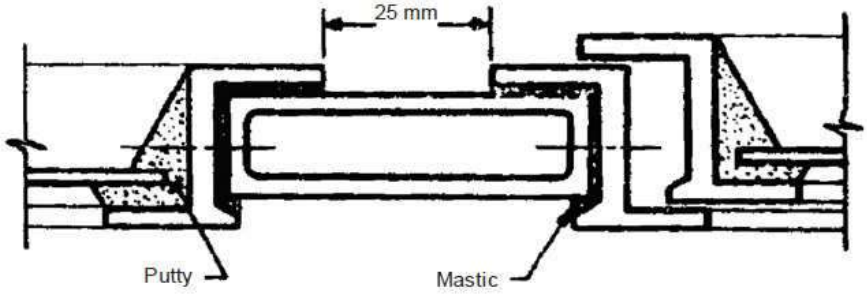


Fig 21.7 : Coupling Section Extruded for Coupling Windows Side by Side

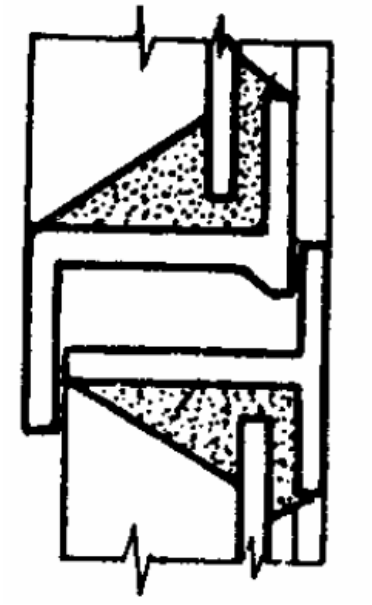


Fig 21.8 : Detail Through Bottom of Top-Hung Ventilator

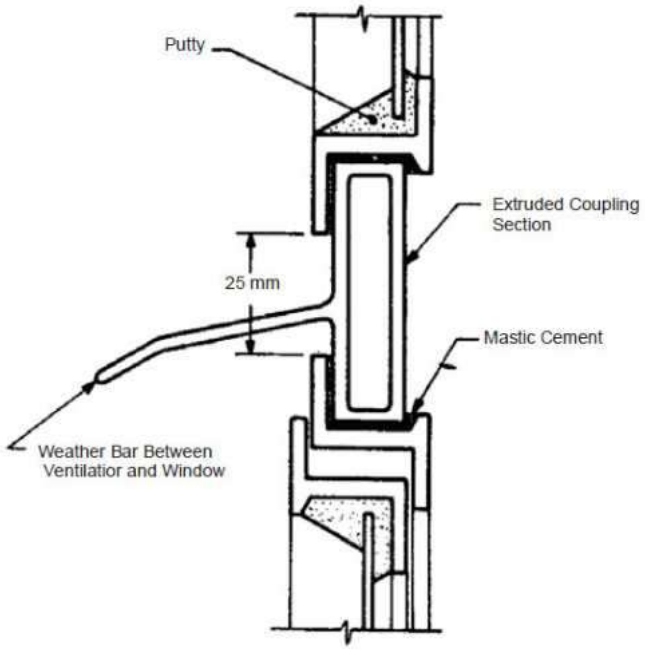


Fig 21.9 : Coupling Section Extruded having Weather Bar Fitted with Ventilators on top of Windows

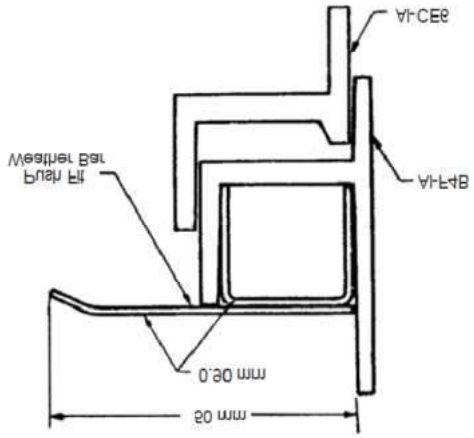


Fig 21.10 : Weather Bar over Extruded Opening Shutter with Fixed Light Above

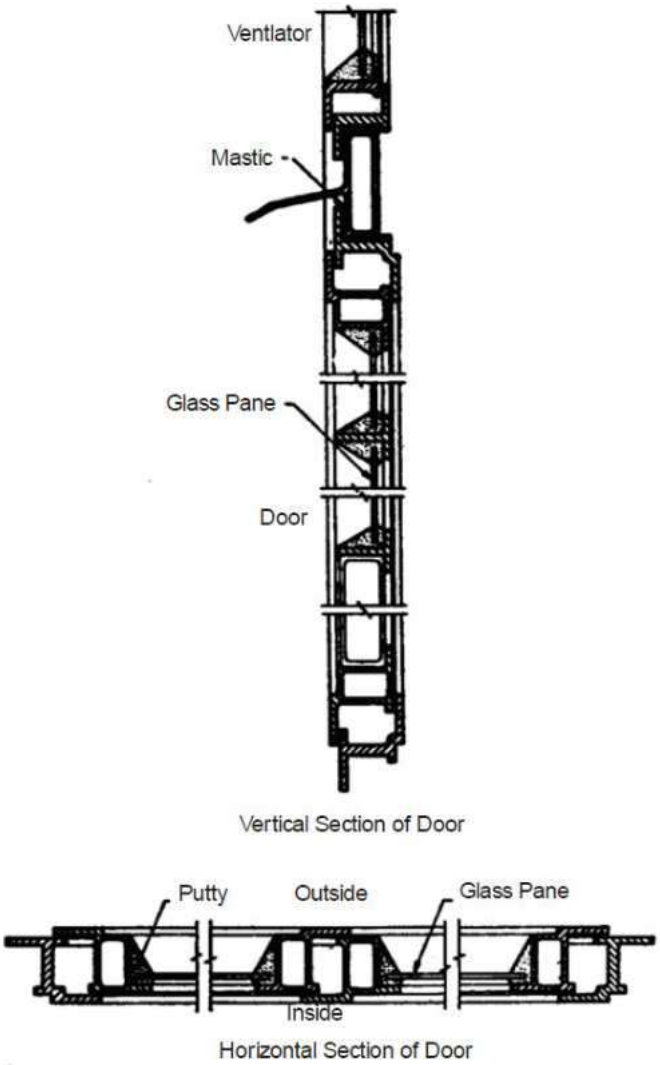


Fig 21.11 : Detail of Aluminium Double Shutter Door

21.7.8 Side-hung Shutters

For fixing aluminium alloy hinges, slots shall be cut in the fixed frame and the hinges inserted inside and may be riveted to the frame. The hinges shall normally be of the projecting type 67 mm wide (Fig. 21.12). The aluminium alloy for cast hinges shall conform to IS Designation A-5-M of IS 617. Specification for Aluminium and Aluminium Alloy Ingots and Castings for General Engineering Purpose and for extruded section of hinges to IS Designation HE10-WP or HE30-WP of IS 733. The pins for hinges shall be of stainless steel of non-magnetic type or aluminium alloy HR30. Irrespective of hinges being anodized or not, the aluminium alloy pins shall be anodized to a minimum film thickness of 0.025 mm shall be sealed with oil, wax or lanolin. Non- projecting types of hinges may also be used where ever required. (Fig. 21.13).

Frictions hinges may be provided for side-hung shutter windows, in which case peg stay may not be required. The working principle of the friction hinges is illustrated in Fig. 21.14.

The handle for side- hung shutters shall be of cast aluminium conforming to IS Designation A-5-M of IS 617 and mounted on a handle plate welded or riveted to the opening frame in such a way that it could be fixed before the shutter is glazed. The handle should have anodized finish with minimum anodic film thickness of 0.015 mm. The handle shall have a two points nose which shall engage with an aluminium striking plate on the fixed frame in a slightly open position as well as in a fast position (Fig. 21.15). The height of the handles in each type of side-hung shutters shall be fixed in approximate position as indicated in Fig. 21.16.

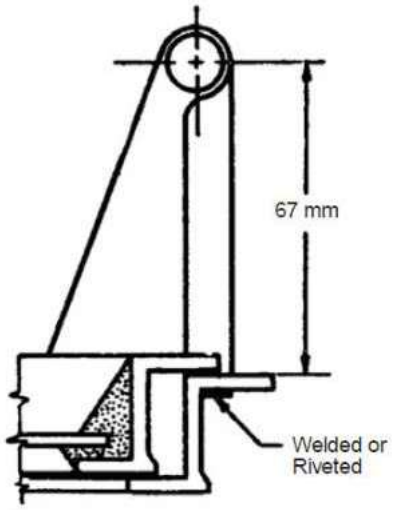


Fig. 21.12 : Typical Projecting Type Hinge for Side-Hung Shutters

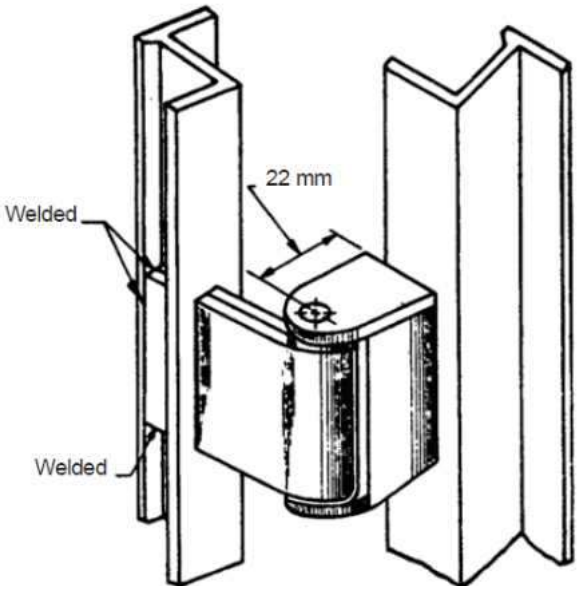


Fig. 21.13 : Typical Non-Projecting Type Hinge for Side-Hung Shutters

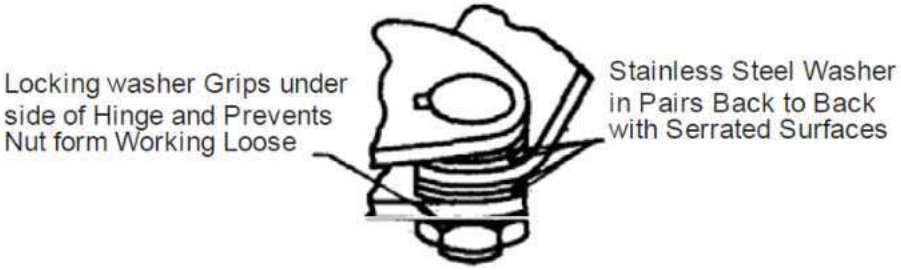


Fig. 21.14 : Illustration Showing Working Principle of Friction Stay

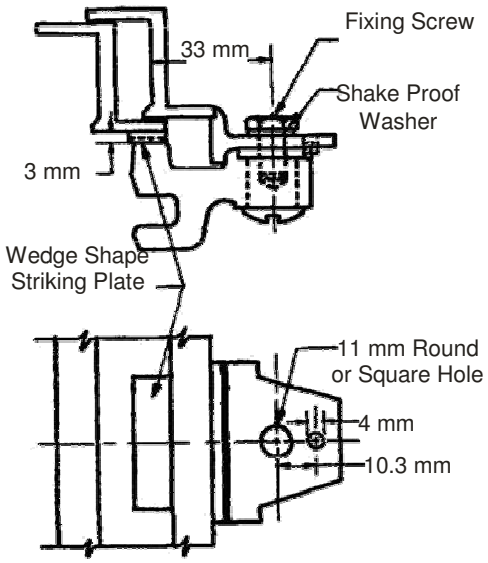


Fig. 21.15 : A Typical Handle for Side-Hung Shutter

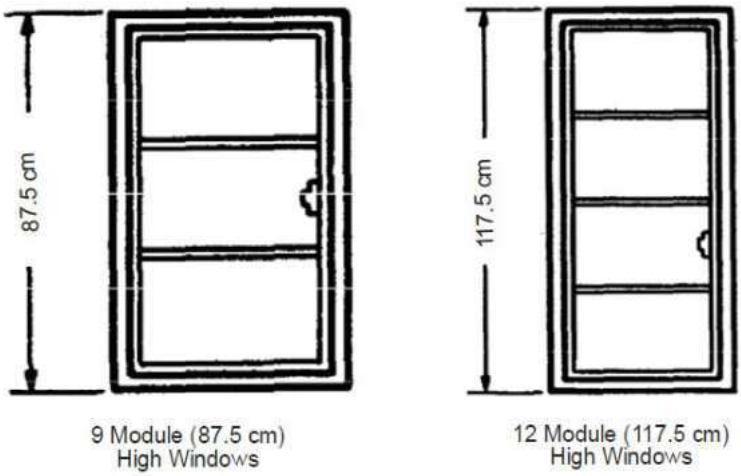


Fig. 21.16: Position of Handle Plates in Relation to Heights of 'HS' Type Windows

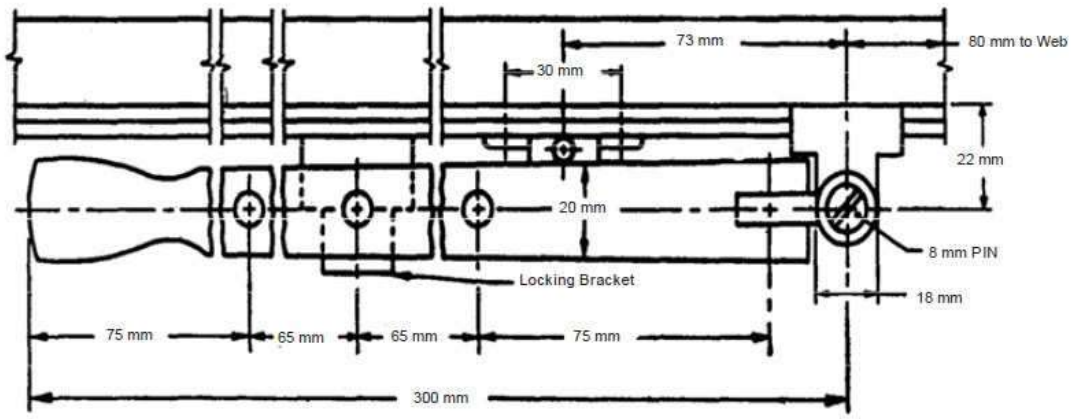


Fig. 21.17 : A Typical Peg-Stay for Side-Hung Shutters and Top-Hung Ventilators

The peg stay shall be either of cast aluminium conforming to IS 617 or folded from IS Designation NS4 aluminium alloy sheet conforming to IS:737 specification for wrought aluminium and aluminium alloys, Sheet and strip. It shall be 300 mm long, complete with peg and locking brackets (Fig. 21.17). The stay shall have holes for keeping the shutter open in three different positions. The peg and locking bracket shall be riveted or welded to the fixed frame.

Alternatively, and if specifically required by the purchaser, side- hung shutters may be fitted with an internal removable fly screen of 0.375 mm wire and equivalent to IS Sieve 100 in a 0.900 mm aluminium alloy sheet conforming to IS Designation NS3-1/2H of IS 737 applied to the outer frame of the shutter by case or extruded aluminium alloy turn-buckle at the jambs (Fig. 21.18) and by aluminium or plated bronze shoes at the sill to allow of the screen being readily removed, and with a rotor operator at the sill to permit the operation of the shutter through an angle of 90º (Fig. 21.19). On fly-screened shutters the peg stay is omitted and the normal handle shall be replaced by a locking handle to hold the shutter in the fast position.

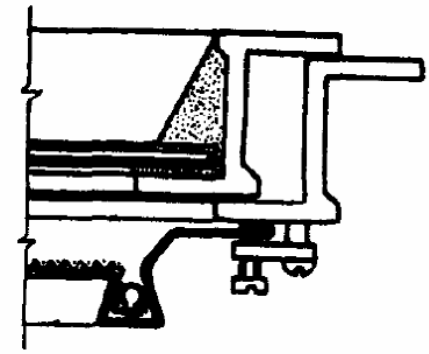


Fig. 21.18 : Detail Through Jamb Showing Turnbuckle

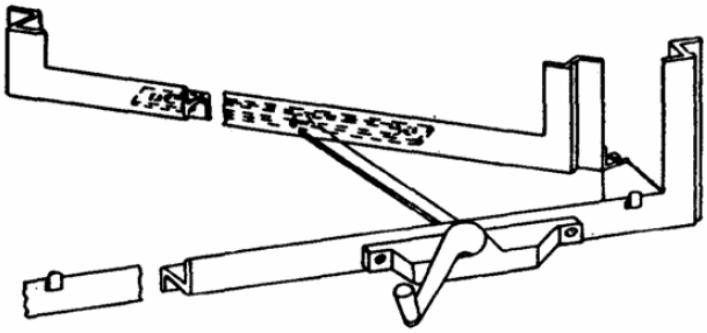


Fig. 21.19 : Typical Rotor Operator for Side-Hung Shutters Fitted with Fly Screens

21.7.9 Top-Hung Ventilators

The aluminium hinges for top- hung ventilators shall be either cast or fabricated out of extruded sections and shall be riveted to the fixed rail after cutting a slot in it. The aluminium alloy for cast hinges shall conform to IS Designation A-5-M of IS 617 and the extruded section of hinge to IS Designation HE10-WP or HE30_WP of IS 733

The pegs stay shall be 300 mm long as in side-hung shutter (Fig. 21.17). The locking bracket shall be fixed to the fixed frame.

21.7.10 Centre-Hung Ventilators (Fig.21.20)

Centre hung ventilators shall be hung on two pairs of cup pivots of aluminium alloy to IS Designation NS-4 of IS 737 and IS Designation A-5- M of IS 617 or on brass or bronze cup pivots which should be either chromium or cadmium plated and riveted to the inner and outer frames of the ventilators to permit the ventilator to swing through an angle of approximately 85º. The opening portion of the ventilator shall be so balanced that it remains open at any desired angle under normal weather condition.

Cast aluminium conforming to IS Designation A-5-M of IS 617 or bronze which shall be either chromium-plated or cadmium-plated spring catch shall be fitted in the centre of the top bar of the ventilators for the operation of the ventilator. This spring catch shall be secured to the frame and shall close into aluminium catch plate riveted or welded to the outside of the outer ventilator frame bar (Fig. 21.21).

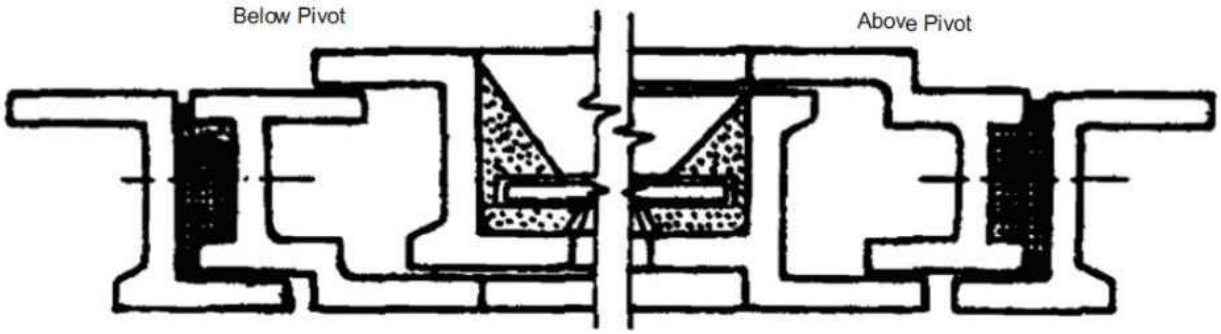


Fig. 21.20 : Detail of Horizontal Centre-Hung Ventilator

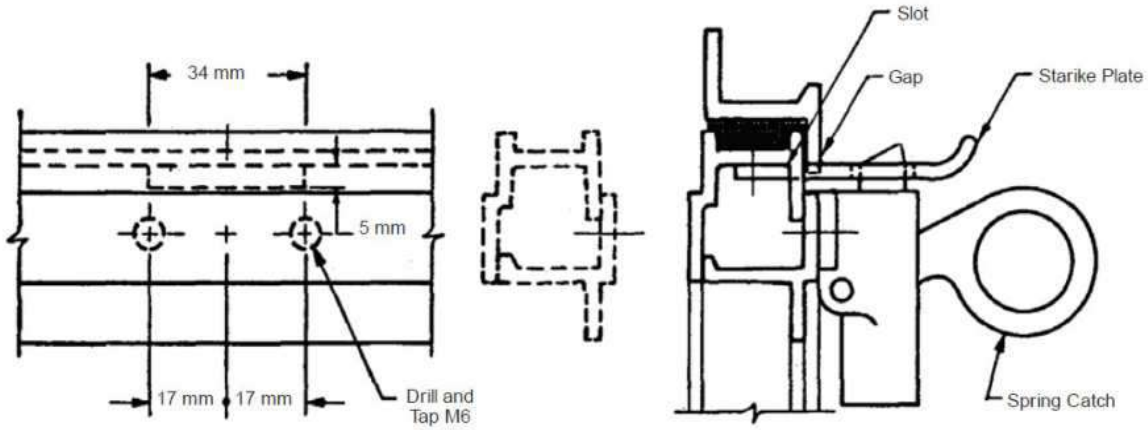


Fig. 21.21: Spring Catch for Centre-Hung Ventilator

Aluminium or cadmium plated brass cord pulley -wheel in an aluminium bracket shall be fitted at the sill of the ventilator with aluminium or galvanized or cadmium plated steel screw or, alternatively, welded together with an aluminium cord eye riveted or welded to the bottom inner frame bar of the ventilator in a position corresponding to that of pulley (Fig. 21.22).

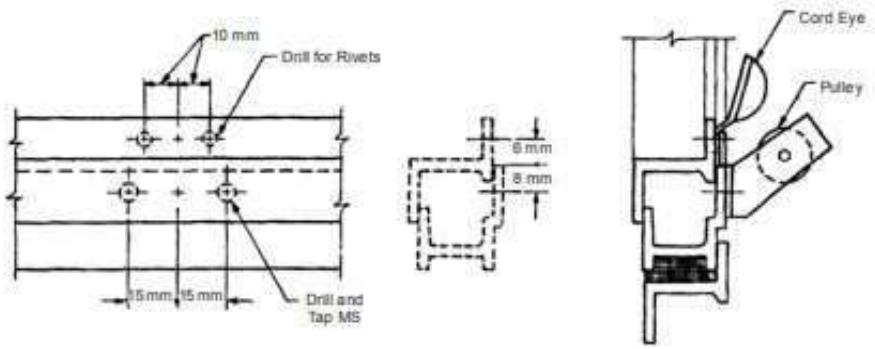


Fig. 21.22 : Cord Eye and Pulley Arrangement for Centre-Hung Ventilator

21.7.11 Doors

The outer fixed frame shall be of section A1-FX8. The shutter frame shall be of either hollow sections A1-HFX5 and A1-HFX6 (Fig. 21.3 and Fig. 21.11).

The kick panels shall be of 1.25 mm aluminium alloy sheet conforming to IS Designation NS3-1/2H of IS 737 specification for Wrought Aluminium and Aluminium Alloys, Sheet and strip and shall be screwed to the frame and the glazing bar.

Hinges –Cast of extruded aluminium alloy hinges for doors shall be of the same type as in the windows but of larger size. The hinges shall normally be of the 50 mm projecting type (Fig. 21.23). Non-projecting type of hinges may also be used (Fig. 21.24).

The handle for doors may be of the design indicated in Fig. 21.25.

A suitable lock for the door operable either from inside or outside shall be provided.

Note: From the point of view of security, the lock which is operable from only one side is better and in the case of such locks, a bolt shall be provided to make them inoperable from the other side.

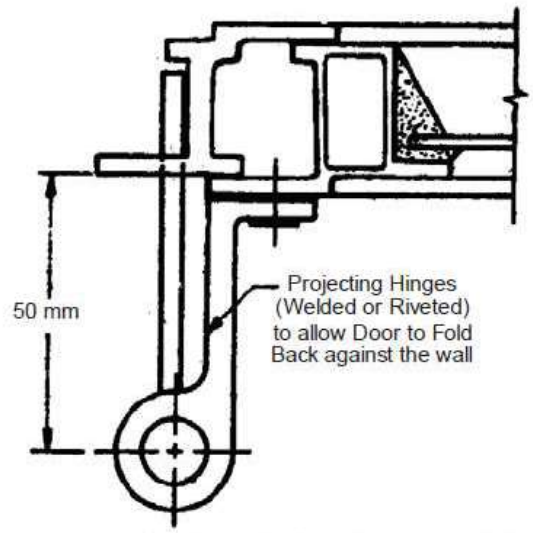


Fig. 21.23 : Typical Projecting Type Hinge for Door

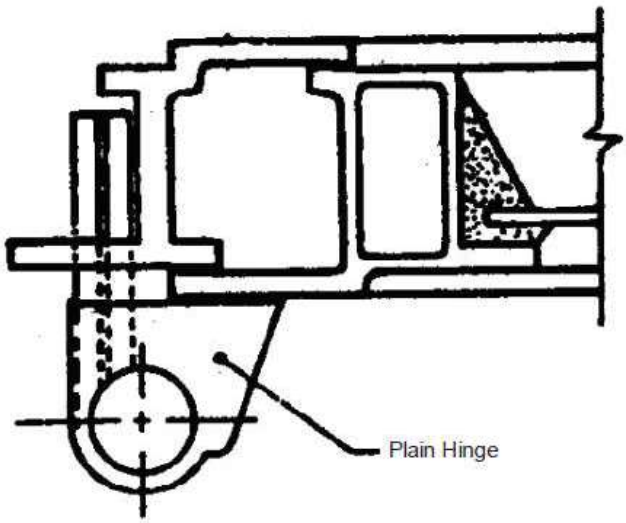


Fig. 21.24 : Typical Non-Projecting Type Hinge for Door

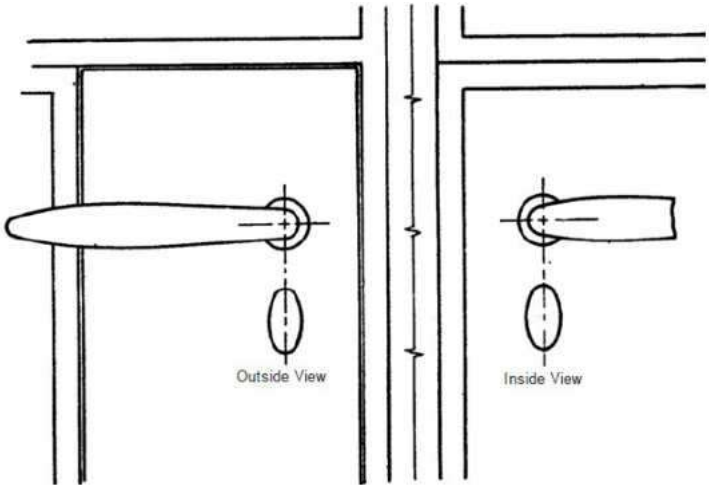


Fig. 21.25 Typical Door Handle

In double shutter doors the first closing shutter shall have a concealed aluminium alloy bolt at top and bottom (Fig. 21.26). It shall be so constructed as not to work loose or drop by its own weight.

Single and double shutter doors may be provided with a three-way bolting device (Fig. 21.27). Where this is provided in the case of double shutter door, concealed aluminium bolts may not be provided.

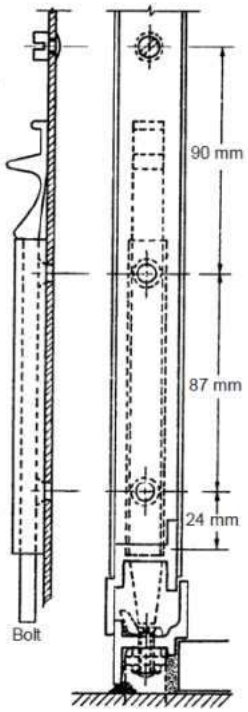


Fig. 21.26 : Typical Vertical Bolt for Double Shutter Door

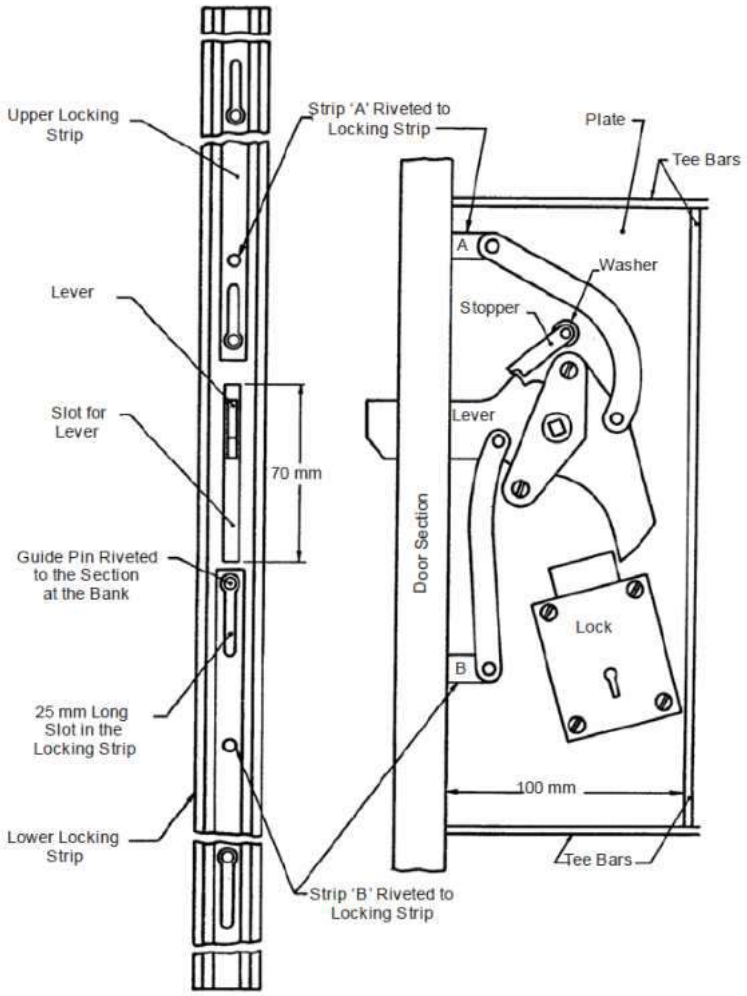


Fig. 21.27 : Typical Three-Way Bolting Device for

Doors 21.7.12 Composite Units

The doors shall be coupled to windows or side-lights by extruded aluminium sections made from aluminium alloy conforming to IS Designation HE9-WP of IS 733. The coupling member should conform to the dimensions indicated in Fig. 21.28.

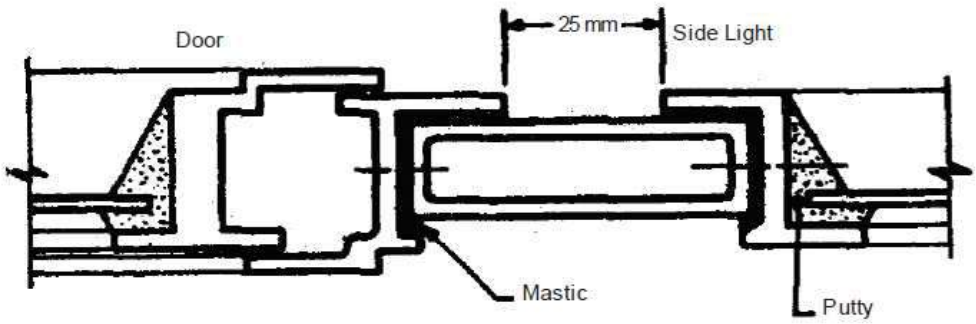


Fig. 21.28 : Coupling Section Extruded for Coupling Door to Window or Side Light

21.7.13 Weather Bar

Where a coupling member is fitted over an external opening shutter, the coupling member should incorporate an integrally extruded weather bar (Fig. 21.9).

21.7.14 Position of Bolts, Fixing Screws and Lugs

Outer frames shall be provided with fixing holes centrally in the web of the sections in the position (Fig. 21.29). Moreover, any steel lugs coming in contact with aluminium should be either galvanized or given one coat of bituminous paint.

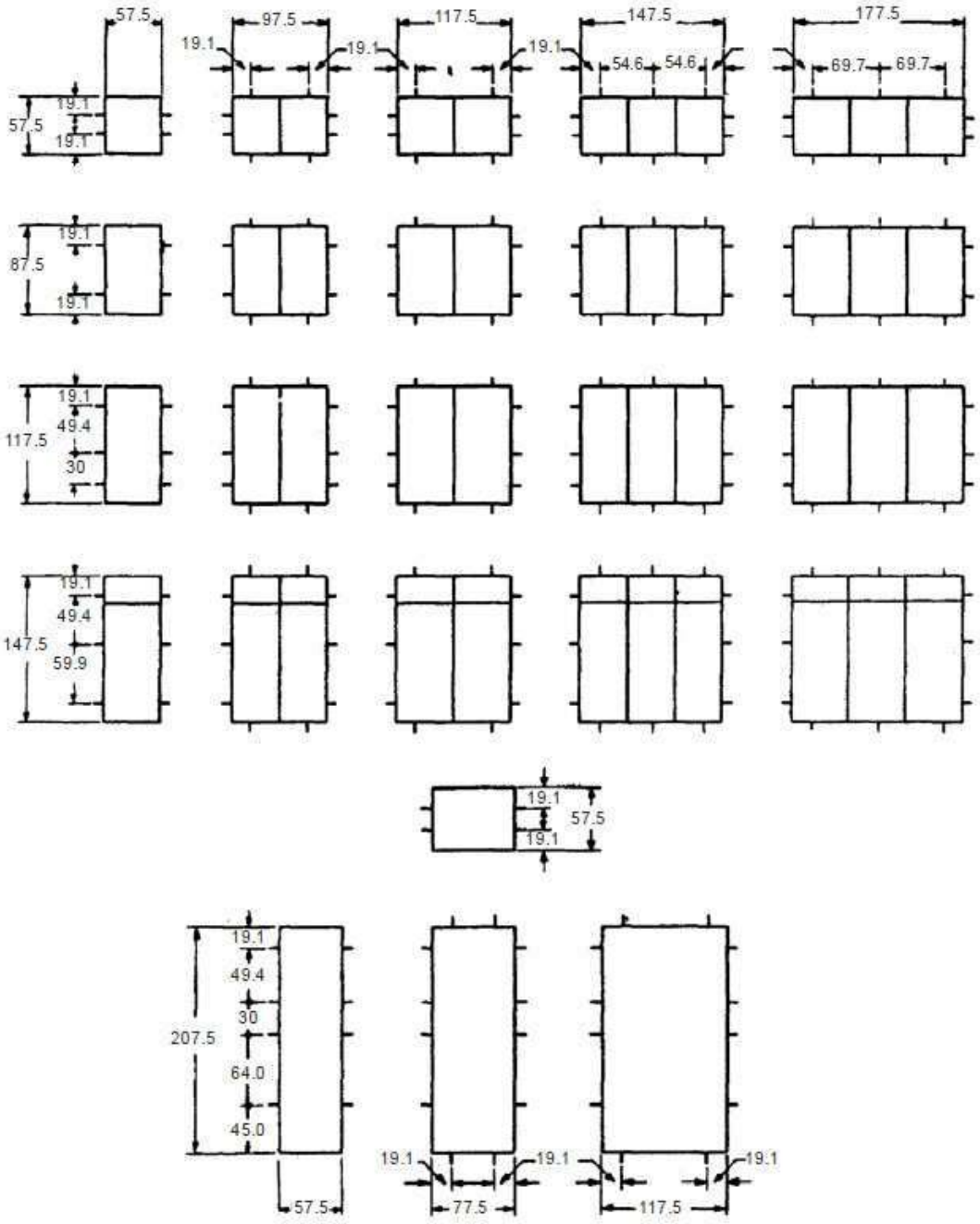


Fig. 21.29 : Chart Showing Approximate Position of Fixing Holes and Number of Fixing Lugs

The fixing screws and lugs shall be as given in Table 21.7

TABLE 21.7

Sl. No	Place of Fixing	Size of Screw or Lug
(i)	To wooden frames rebated on the outside	30 mm x No. 10 galvanized woodscrews.
(ii)	To plugs in concrete, stone or brick work rebated on the outside	-Do-
(iii)	To plugs in concrete, stone or brick work not rebated on the outside (that is plain or square jambs)	45 mm X No. galvanized wood-screws
(iv)	Direct to brick work or masonry (that is plain or square jambs)	Slotted steel adjustable lugs (natural finish) not less than 100 x 16 x 3 mm countersunk galvanized machine screws and nuts 19.0 X 6.3 mm
(v)	To steel work	Standard clips and 8 mm galvanized bolts with hexagonal nuts.

21.7.15 Finish

Alumiumum doors, windows and ventilators may be supplied in either matt, scratch-brush or polished finish. They may, additionally, also be anodized, if so required by the Engineer-in-charge. If colour anodizing is to be done then only approved light-fast shades should be used.

A thick layer of clear transparent lacquer based on methacrylates or cellulose butyrate, shall be applied on aluminium doors, windows and ventilators by the supplier to protect the surface from wet cement during installation. This lacquer coating shall be removed after installation is completed.

21.7.16 Glazing

Glazing shall be provided on the outside of the frames

If required, glazing clips may be provided as extra fittings. Four glazing clips may be provided per glass pane, except for door type 8HS21 where the glazing clips shall be six per glass pane. In case of doors, windows and ventilators without horizontal glazing bars the glazing clips shall be spaced according to the slots in the vertical members, otherwise the spacing shall be 30 cm.

Note: Glazing clips are not usually provided for normal size glass panes. Where large size glass panes are required to be used or where the door or the window is located in heavily exposed situation, holes for glazing clips have to be drilled prior to fabrication and cannot be done at any later stage. Use of glazing clips, where necessary, shall be specified while placing the order.

21.7.17 Packing

All doors, windows and ventilators shall be dispatched with the opening parts suitably secured to preserve alignment when fixing and glazing.

Fixing lugs, coupling fittings and all hardware shall be dispatched separately.

Composite windows shall be dispatched uncoupled.

21.7.18 Marking

All doors, windows and ventilators shall be suitably marked on the frames with a mark identifying the manufacturer and the type.

The units may also be marked with the BIS Certification Mark.

21.8 FITTINGS

21.8.1 Stainless Steel Friction Stay

The stainless steel friction stays of make approved by the Engineer-in-Charge shall be used. The SS friction stays shall be of grade AISI-304 and of sizes specified in nomenclature of item.

21.8.2 Lockable Handles

The lockable handle shall be of make approved by the Engineer-in-Charge and of required colour to match the colour of powder coated /anodized aluminium window sections.

21.8.3 Hydraulic Floor Spring

The hydraulic floor spring shall be heavy duty double action floor spring of make approved by the Engineer -in-Charge suitable for door leaf of weight minimum 100 kg. The top cover plate shall be of stainless steel, flushing with floor finish level. The contractor shall cut the floor properly with stone cutting machine to exact size & shape. The spindle of suitable length to accommodate the floor finish shall be used. The contractor shall give the guarantee duly supported by the company for proper functioning of floor spring at least for 10 years.

21.8.4 Tubular Handle

The tubular handle bar shall be aluminium polyester powder coated minimum 50 micron to required colour/anodized AC 15. Outer dia of tube shall be 32 mm, tube thickness 3.0 mm and centre to centre length 2115 mm $\pm$ 5 mm.

21.8.5 Measurement

Refer Para 21.6.3.

21.8.6 Rate

Refer Para 21.6.4.

21.9 LOUVERS

Aluminium extruded sections (anodized or power coated) are used for providing Louvers in aluminium door, window & partition for ventilation.

21.9.1 Fabrication

Refer Para 21.6.1.

21.9.2 Measurements

Refer Para 21.6.3.

21.9.3 Rate

Refer Para 21.6.4.

21.10 HERMETICALLY SEALED UNIT

Insulating glass shall be a double glazed unit comprising two sheets of float glass panes separated by a spacer, hermetically sealed using primary and secondary sealants. The design of insulating glass system shall consist of:

(a) Hollow Spacer Bar

The hollow aluminium spacer bar shall be of required size and shape and shall be colour anodized. The spacer bar shall have two lines of perforations in the inner surface.

(b) Desiccant

The desiccant shall be Neftomol 3 A Chemetall or equivalent.

The desiccant filled in the aluminium spacer bar shall be synthesized crystalline compounds of Aluminium Hydroxide, Caustic Soda and Sodium Silicate which absorbs water molecules. The desiccant shall be of 3 A size (A means Angstrom). The quantity of desiccant used shall not be less than 35 gm/m length of spacer bar. Filled spacer bar frame shall not be stored for more than 6 hours before assembly and sealing of the unit to ensure proper functioning of the desiccant. The contractor shall submit documentary proof of using the above material in the work.

(c) Primary Sealant

The primary sealant shall be single component approved by the Engineer in Charge, thermo plastic solvent free sealing compound based on polysosutylene. The sealant surface shall be free from cavities, depression and other defects. The contractor shall submit documentary proof of using the above material in this work.

(d) Secondary Sealant

The secondary sealant in double glazed unit shall be silicone sealant approved by the Engineer in Charge. The contractor shall submit documentary proof of using the above material in this work to the entire satisfaction of Engineer-in-Charge. Before application of silicone/ polysulphide, the surface must be cleaned and free from oil, grease, dust and other loose matter. The surfaces shall be cleaned with alcohol or other suitable solvents. Detergent or soap shall not be used to clean the surfaces. The polysulphide shall be mixed and applied mechanically using automatic mixing machine in the manner approved by Engineer-in-Charge.

Measurement

The height and width of double glazed/single glazed unit (the area of glass unit outside the snap beading shall only be measured) as fixed in place shall be measured correct to one centimeter and area calculated in sqm. correct to second place of decimal shall be taken for payment.

Rate

The rate shall include the cost of all the materials, labours involved in all the operations as described in nomenclature of item and particular specification.

21.11 BRASS LOCK

This should generally conform to IS-2209. The size of the lock shall be denoted by the length of the body towards the face and it shall be 100 mm. the measured length shall not vary more than 3 mm from the specified length. Ordinary lever mechanism with not less than 2 levers shall be provided. False lever shall not be used. Lever shall be fitted with one spring of phosphor- bronze or steel wire and shall withstand the test as provided in IS-2209. Locking-bolt spring and strike plate shall conform to IS 2209. Two keys shall be provided with each lock.

21.12 MACHINE MOULDED ALUMINIUM COVERING OVER EXPANSION

21.12.1 Material

The material to be used shall be wrought aluminium and aluminium alloy sheet confirming to IS 737 having anodic coating of AC-15 as per IS 1868 and epoxy/ polyester powder coating of minimum 50 microns and not more than 120 microns at any point. The anodic coating and epoxy/ polyester powder coating shall be of approved colour and shade as directed by the Engineer-in-charge.

The cover plate should be made of wrought aluminium and aluminium alloy sheet of thickness not less than 2.5mm. The covering sheet should be moulded aluminium, machine cut and machine holed for receiving dash fasteners with single or double anti slip serrations ready to accommodate horizontal thermal movement of approved size, shape, pattern and design fixed over expansion joints on vertical surfaces/ ceilings/ floors.

Standard protective coating should be placed on aluminium surfaces which are coming in contact with cementitious material as per manufacturers specification.

21.12.2 Installations

The substrates should be prepared as per drawing, instructions of the manufacturer and should account for anchors, fasteners and other accessories to cover the expansion joint. The sheet to be fixed to cover the expansion joint should be brought at site in required shade, size, shape, mould, design and pattern properly cut, milled and drilled holes in one row on one side to accommodate designated stainless steel dash fasteners of 8mm dia and 75mm long bolt including aluminium washers 2mm thick and 15mm dia at a staggered pitch of 200mm centre to centre in the receiving surface and providing expandable plastic sleeves in holes etc. complete as per direction of the Engineer-in-charge.

1. Necessary repairs with shrinkage resistant grout as required shall be used for preparing the surfaces on which the expansion joint covering is to be installed/ fixed.
2. True alignment and proper relationship to joints and adjoining finished surfaces measured from established lines and levels.
3. Adjustments should be made for differences between actual structural gap and nominal design gap due to ambient temperature at time of installation.
4. Fix ends to accommodate thermal expansion and contraction without buckling.
5. Fix stainless steel dash fasteners of 8mm dia and 75mm long with aluminium washers 2mm thick and 15mm dia at a staggered pitch of 200mm centre to centre.
6. Provide in continuous lengths for straight sections.
7. Install with hairline mitered corners where expansion joint cover assemblies change direction of abut other materials.
8. Terminate exposed ends of expansion joint cover as per direction of Engineer-in-charge.

21.12.3 Measurement

The finished length and breadth of the aluminium sheet shall be measured correct to milimetres and area calculated in Sqm correct to second place of decimal. The weight calculated on the basis of actual average (average of five samples) weight of composite section in kilogram correct to the second place of decimal shall be taken for payment (weight shall be taken after anodizing).

21.12.4 Rate

The rate shall include the cost of all the materials, labours involved in all the operations above and as described in the nomenclature of item and particular specification.

21.13 ANODISED ALUMINIUM GRILL

21.13.1 Material

The aluminium grill should be of approved designed and pattern as directed by the Engineer-in-charge. Standard aluminium section confirming to IS 733 and IS1285 for chemical composition and mechanical properties shall be used to meet the architectural requirements and designed to relevant works and shall be subject to approval of the Engineer-in-charge for technical, structural, functional and visual considerations. The stainless steel screws to be used shall be of grade AISI 304. The anodic coating shall be of grade AC15 and shall confirm to IS 6012. The permissible dimensional tolerances of aluminium sections shall be as per IS 6477 and shall be such that in no case it impairs the proper and smooth functioning/ operation and appearance of the door and window.

21.13.2 Fixing of Aluminium Grill

The shop drawings for each type of openings shall be prepared by using suitable approved sections based on architectural drawings, adequate to meet the requirement/ specifications and by taking into consideration varying profiles of aluminium sections being extruded by approved manufacturers. The shop drawings shall show full size sections of doors, windows, ventilators and other openings etc. The shop drawings shall also show the details of fitting and the openings to be made for the smooth operations of that fittings. Before start of the work, all the shop drawings shall be got approved from the Engineer-in-charge.

Actual measurement of openings left at site for different type of door/window etc. shall be taken. The fabrication of the individual doors/windows/ventilators etc. shall be done as per the actual sizes of the opening left at site.

The anodised aluminium grill shall be of approved design and pattern with standard section from the approved manufacturer. The grill of required size keeping sufficient margin to be inserted inside the section shall be cut to correct size and fixed firmly in the frame with approved CP brass, aluminium or stainless steel screws of star head, counter sunk and matching size. Screws threads used in the fabrication shall confirm to IS1362. Proper opening of the size appropriate for fixing and operation of handles and other fittings shall be made by cutting the grill to the size as per direction of the Engineer-in-charge.

21.13.3 Measurement

The length and breadth of the grill shall be measured correct to milimetres and area calculated in Sqm correct to second place of decimal. The weight calculated on the basis of actual average (average of five samples) weight of composite section in kilogram correct to the second place of decimal shall be taken for payment (weight shall be taken after anodizing).

21.13.4 Rate

The rate shall include the cost of all the materials, labours involved in all the operations above and as described in the nomenclature of item and particular specification.

21.14 12MM THICK FRAMELESS TOUGHENED GLASS DOOR SHUTTER

21.14.1 Material

This is a clear 12mm toughened safety glass frameless shutter having a consulate top and bottom self closer mechanism with a pivot connecting to a discrete metal patch fitting at the top and bottom corners to the door.

21.14.2 Application

The 12mm thick clear toughened safety glass frameless shutter is fixed with the help of corner patch fittings. The corner patch fittings are simply a bolt through glass metal fitting requiring a corner cut out and hole in the glass. These discrete corner patch fittings provide a sleek and clean frameless look. The lock body patch fitting can also be installed where there is a necessity to provide locking arrangements for frameless shutter. The maximum size of frameless doors shutters using corner patch fittings should not exceed from 1000mm X 2400mm. Bigger size doors should not be fixed with these fittings. The figure 21.18.1 shows the fixing of frameless door shutters with top and bottom corner patch fittings.

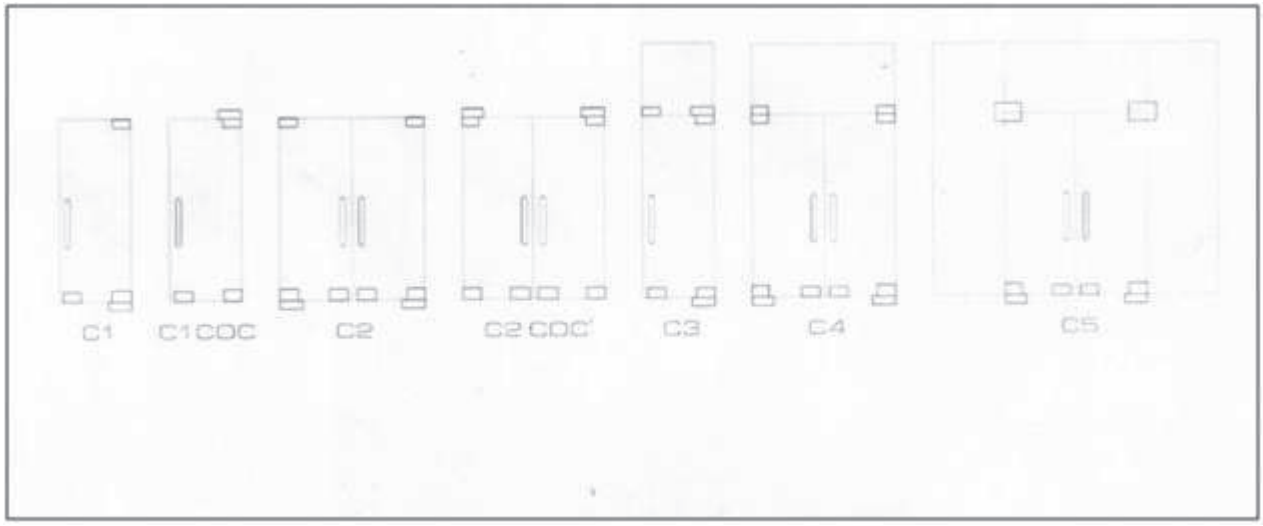


Fig. 21.30

21.14.3 Installation

The frameless toughened glass door shutters of required thickness as specified in the item should be installed with the help of 304 grade stainless steel patch fittings of approved brand and manufacturer. These fittings should be complete in all respect with top and bottom pivots and double action hydraulic floor spring types fixing arrangement. These fittings should be based on a modular system, consisting of a base unit, functional inserts, and clip-on covers in a wide range of finishes. The fittings should be suitable to support the weight of the complete glass door in such a way that the movement of the door is smooth and free. The fittings should be got approved from the engineer-in-charge and all the fixings etc. shall be done as per manufacturer specification and corresponding codes described in the description of the fitting.

21.14.4 Measurement

The finished final length/ height and width of the glass door should be measured correct to two places of decimal and overall area in sqm correct to two places of decimal should be calculated for payment.

21.14.5 Rate

The rate shall include the cost of all the materials, labours involved in all the operations above and as described in the nomenclature of item and particular specification.

21.15 NON SAG ELASTOMERIC POLYURETHANE SEALANT

21.15.1 Material

A weather protective non sag elastomeric construction sealant should be one component all purpose, moisture cured, polyurethane premium grade sealant confirming to ASTM C 920 type S, grade NS, class 35. This is to, be used as specified in the nomenclature of the item in accordance with the product manufacturers specifications and as directed by the Engineer-in-charge.

21.15.2 Preparation of surface

All surfaces, joints, walls must be sound, clean, dry, frost-free, and free of oil, grease and any other contaminants.

No priming is required or necessary usually. Priming is only required on the substrates which indicates the need of priming under testing conditions. In the situation where priming seems to be necessary after conducting the tests the manufacturer's technical representative should be consulted.

2.15.3 Masking

Area adjacent to joints shall be masked to ensure neat sealant lines. Masking tape shall be allowed to touch clean surfaces to which the sealant is to adhere. Tooling shall be completed in one continuous stroke immediately after sealant application and before a skin forms and masking shall be removed immediately after tooling.

21.15.4 Application

The closed cell backer rod of appropriate size shall be installed and the sealant should be applied in continuous operation with positive pressure adequate to fill and seal the joint. Polyurethane sealant should be gunned into joint when joint slot is at mid-point of its designed expansion and contraction. Place nozzle of gun into bottom of the joint and fill entire joint. Keep the nozzle in the joint, continue on with a steady flow of sealant preceding the nozzle to avoid air entrapment. The cartridge once opened should be used and consumed the very same day. Avoid overlapping of sealant to eliminate entrapment of air. Tool with convex profile as required and closed cell backer rod of approved quality and size is recommended to ensure full contact with joints, walls and to remove air entrapment. Remove masking tape as soon as sealant is tooled.

The closed cell backer rod is primarily a foam material with a surface skin. Make sure that backer rod is 25% larger than joint width (under compression) to offer good tooling base. The sealant should be applied by the caulking gun by putting the cartridge into the gun and putting the nozzle to the base of the joint.

Tolerance: A tolerance of + 3mm shall be allowed in sealant for joint filling.

21.15.5 Curing

Allow one week to cure the polyurethane construction sealant under standard condition. The contact with alcohol other solvent cleaners during cure should be avoided.

21.15.6 Measurement

The length should be measured in metres correct two places of decimal.

21.15.7 Rate

The rate shall include the cost of all the materials, labours involved in all the operations above and as described in the nomenclature of item and particular specification.

SUB HEAD : 22.0

WATER PROOFING TREATMENT

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LIST OF BUREAU OF INDIAN STANDARDS (BIS) CODES

S. No.	*BIS. No.*	*Subject*
1.	IS 73	Paving Bitumen Specifications
2.	IS 702	Specifications for Industrial Bitumen
3.	IS 1322	Specifications for Bitumen felts for Water Proofing and Damp Proofing.
4.	IS 2645	Specifications for Integral Cement Water Proofing Compounds
5.	IS 3370 (Part -1)	Code of Practice for Concrete Structures for the Storage of Liquid: Part -1 General Requirements.
6.	IS 3384	Specifications for Bitumen Primer for Water Proofing and Damp Proofing
7.	IS 7193	Specification for Glass Fibre Bitumen Felts
8.	IS 12200	Provision of Water Stops at Transfers Construction Joints in Masonry and Concrete Dams - Code of Practice.
9.	IS 12432 (Part-3)	Application for Spray Applied Insulation - Code of Practice Part-3 Polyurethane/ Polyisocyarurate

22.0 WATER PROOFING TREATMENT

22.0 TERMINOLOGY

Water Bars

Water bars are preformed strips of impermeable materials which are embedded in the concrete during construction.

Low Partition Walls

Parapet walls of height less than 45 cm.

Expansion Joints

Joints provided in the structure to allow for thermal expansion/construction.

Blended Cement

Cement mixed with water proofing compound in liquid or powder form.

22.1 INTEGRAL CEMENT BASED TREATMENT FOR WATER PROOFING ON HORIZONTAL SURFACE OF UNDER-GROUND STRUCTURE AT ALL DEPTH

22.1.1 Water Proofing of Horizontal Internal Surfaces of Under-ground Structure (Fig. 22.1)

(i) Preparation of Surface

The Water Proofing Treatment over the lean concrete/levelling course surface should adhere to the surface firmly, the surface of levelling course should be roughened properly when the concrete is still green. In case the surface is not made rough before the concrete is set, the work of water proofing should not be executed till proper key is provided for the base layer of Cement Mortar 1:3.

(ii) Blending Cement/Water with Water Proofing Compound

The required quantity of cement bags to be used for a particular portion of work should be emptied on a dry platform. Water proofing compound bearing ISI mark and conforming to IS 2645 should then be mixed properly with the cement. The quantity of water proofing compound to be mixed should be as prescribed by the manufacturer but not exceeding 3% by weight of cement. The quantity of cement and water proofing compound thus mixed should be thoroughly blended and the blended cement should again be packed in bags.

For the water proofing compound in liquid form, the blending is to be done with water. This can be done by taking the just required quantity of water to be mixed in the particular batch of dry cement mortar.

The required quantity of water thus collected per batch of dry cement mortar to be prepared should be mixed with liquid water proofing compound from sealed tins with ISI mark. The water thus mixed with water proofing compound shall be thoroughly stirred so that the water is blended with water proofing compound properly.

(iii) Rough Kota Stone 22 to 25 mm Thick

The stone slabs to be used for this item shall be in thickness of 22 mm to 25 mm. Larger size of stone slabs i.e. 550 mm x 550 mm or 550 mm x 850 mm shall be used to minimise the number of joints.

General requirement of Kota stone shall be as laid down in CPWD Specifications of Kota Stone flooring.

(iv) Preparation of Cement Slurry

Cement slurry shall be prepared by using 2.2 kg of blended cement per sqm. area. Each time only that much quantity shall be prepared which can be covered on the surface and the surface in turn would be covered with 25 mm thick cement mortar base within half an hour. Slurry prepared and remained unused for more than half an hour shall be totally rejected.

(v) Preparation of Cement Mortar

Cement mortar 1:3 (1 blended cement: 3 coarse sand) shall be prepared with cement/ water duly blended as explained in clause 22.1.1 (ii). Only that much quantity of cement mortar which can be consumed within half an hour, shall be prepared. Any cement mortar that is prepared and remains unused for more than half an hour shall not be used in the work and shall be rejected.

(vi) Laying Water Proofing Course

Before laying the base course of cement mortar 1:3, the lean concrete surface shall be cleaned neatly with water. Cement slurry prepared as per clause 22.1.1 (ii), shall be applied only on the area of the concrete surface, that can be covered with the cement mortar (1:3) base course within half an hour. The cement slurry should cover every spot of the surface and no place shall remain uncovered. Just after the application of cement slurry on the surface, the cement mortar prepared as per clause 22.1.1 (v) should be used for laying the base course. Base Course should be laid to a perfect level with wooden/aluminium straight edge of at least 2 mtrs. long. The top surface of cement mortar should be finished neatly and later scratched when green with a suitable instrument before the base course dries and gets hard that is just before the base course takes up initial set.

When the 25 mm thick base course is just getting set the cement slurry prepared as per clause 22.1.1 (iv) should be spread over the base course upto the area that shall be covered with just two to three stone slabs. The cement slurry shall be spread in such a way that the area of base course to be covered immediately shall be covered with slurry without any gap or dry spots. Immediately on applying cement slurry on the base course the Rough Kota Stone slab shall be laid over the base course and pressed gently so that the air gap can be removed. The slurry applied on the surface which gets spread when the stone slab is pressed shall get accumulated in the joints of adjacent stone slabs and if any gap still remains between the stone slabs the same should also be filled with additional quantity of cement slurry. For laying the stone slabs in perfect level, two stone slabs at adjacent concerns/ends shall be fixed firmly to the required level and a string stretched over the two slabs, the intermediate slabs shall then be set to the level of the string.

After filling all the joints of the Rough Kota stone Slabs with cement slurry the area of stone slab shall be laid with cement mortar 1:3. The surface of stone slabs shall be cleaned and lightly watered. Cement mortar 1: 3 prepared as per clause 22.1.1 (iv) shall be used for laying this course. For laying this course 25 mm high wooden strips shall be used and the top surface shall be finished smooth without using additional cement or slurry.

After laying 3rd course and before the mortar layer takes the initial set, Stone aggregate of 10 mm to 12 mm nominal size shall be uniformly spread and lightly pressed into the finished surface @ 8 cudm./sqm. The aggregates shall not be embedded totally inside the mortar and shall be visible on the top surface.

In cases where slope is to be provided for the water proofing layer, grading with additional cement concrete/cement mortar shall be provided and then the water proofing layer shall be laid on the graded surface. Extra payment shall however be made for the grading course.

(vii) ***Curing***

Immediately after completing the fourth layer, arrangements shall be made for the top RCC slab as quickly as possible and in the mean time till the top slab is casted the water proofing treatment shall be kept wet continuously. In case the concreting of slab gets delayed for more than 2 weeks the curing can be stopped after 14 days.

(viii) Measurement

Length and breadth shall be measured along the finished surface correct to a cm and the area shall be worked out to nearest 0.01 sqm.

(ix) Rate

The rate shall include the cost of all labour & materials involved in all the operations described above. The cost of grading with cement concrete / cement mortar shall be paid for separately.

22.1.2 Water Proofing of Internal Horizontal Surfaces of Under- ground Structure (Fig. 22.2)

Same as in 22.1.1 above except that water proofing courses will be laid on R.C.C. Slab.

22.2 INTEGRAL CEMENT BASED WATER PROOFING TREATMENT ON THE VERTICAL SURFACE OF UNDER GROUND STRUCTURES (FIG. 22.3)

(i) Preparing the Surface

The surface of the structure to be treated shall be roughed either by raking of joints in case of brick/ stone masonry or by hacking the cement concrete surface with a specifically made hacking tool just after removing shuttering. Alternately, the surface should be roughened by providing spatter dash key as explained under clause 22.1.1 (i). While doing water proofing to vertical faces from inside, it shall be ensured that water proofing treatment of floor slab is not damaged. Preferably, water proofing of vertical surface shall be done before that of horizontal surface.

(ii) Blending Cement/Water with Water Proofing Compound Same as under clause 22.1.1(ii).

(iii) Rough Kota Stone Slab

Same as explained under clause 22.1.1(iii).

(iv) Preparation of Cement Slurry

Same as explained under clause 22.1.1(iv).

(v) Preparation of Cement Mortar

Same as explained under clause 22.1.1(v).

(vi) Laying Water Proofing Course

Same as explained under clause 22.1.1(vi). Further rough kota stone are not sufficiently rough to remain in vertical position held by cement slurry. Therefore, the grip for the stone slab has to be increased and this can be done by planting 12 mm to 15 mm nominal size stone aggregate fixed with araldite on surface of each sand stone slab.

(vii) Curing

Same as explained under clause 22.1.1(vii). Further till the water proofing work on vertical face is in progress, the water proofing work done on floor slab shall be kept wet for a minimum period of 14 days. Immediately after completion of water proofing on vertical faces of side walls, the water tank shall be gradually filled with water for testing.

(viii) Measurement

Same as explained under clause 22.1.1(viii).

(ix) Rate

Same as explained under clause 22.1.1(ix).

22.3 WATER PROOFING TREATMENT TO VERTICAL AND HORIZONTAL SURFACE OF DEPRESSED PORTION OF WC, KITCHEN AND THE LIKE

22.3.1 Before the Water Proofing Treatment

Before the water proofing treatment, the internal plaster of ceiling and walls of WC block leaving the portion for dado/skirting should be completed. Grooving / chasing for doing the concealed work of GI/CI pipes/Electrical conduits should be completed. Cleaning the depressed/sunken portion of WC of all debris, extra mortar sticking to the vertical and horizontal surface etc. Necessary holes for 'P' trap /Nhani trap/Water escape pipe etc should be completed.

22.3.2 Preparing Surface and Fixing Pipes and Fittings

Before the water proofing treatment work, proper key in the concrete surface should be provided. The depressed/sunken portion should be hacked by a hacking tool, after the concrete slab is cast and when this concrete is still green.

The vertical surfaces of the depressed /sunken portion should be hacked with a hacking tool just after the shuttering is removed.

In case of old work, the water proofing treatment on such surfaces shall be permitted after making proper spatter dash key.

Fixing the 'P' trap in position and all other pipes work including the water escape pipe shall be fixed properly and the holes should be plugged carefully before taking up the water proofing work.

22.3.3 1st Course

Cement duly blended with water proofing compound as explained in clause 22.1 shall be used for preparing the cement slurry.

The consistency of the slurry should be such that 4.4 kg. of blended cement with water proofing compound is used per sq. metre area of surface to be treated. The slurry should be started from the vertical faces towards the bottom of the floor as shown in Fig. 22.4. Particular care should be taken to see that the slurry is applied to corners without leaving any gap.

22.3.4 2nd Course

Immediately on applying the blended cement slurry on the surface to be treated cement plaster 20 mm thick in CM 1:3 (1 blended cement: 3 coarse sand) shall be applied both on vertical and horizontal surfaces taking particular care to complete the entire depressed/ sunken portion of WC within a day so that the plaster can be done without any joint. Junctions shall be properly rounded. The surfaces of the plaster shall be left rough but finished in one plain and cured for a week.

On completion of the curing period both horizontal and vertical surfaces shall be cleaned properly and gently and allowed to dry.

22.3.5 3rd Course

Only after the surface is completely dried the blown or residual bitumen shall be applied @ 1.7 kg. of bitumen per sqm area.

22.3.6 4th Course

PVC sheet 400 micron thick shall be spread evenly without any kink immediately, so that the PVC sheet sticks to the surface firmly. PVC sheet shall be continued to be laid over the main slab upto 100 mm.

Overlapping of PVC sheet should be done with a minimum overlap of 100 mm, duly pasting the overlapped sheet with an application of bitumen @ 1.7 kg./ sqm.

The projections of pipes and 'P' trap outlet etc. inside the depressed/sunken portion of WC shall also be cladded with water proofing treatment layer upto a height of 150 mm, using a coat of bitumen with PVC sheet complete.

The surfaces of depressed/sunken portion of WC shall not be left without covering with specified filling material and base concrete, otherwise the PVC sheet layer may be tampered by the labour working in the vicinity.

Fixing up of WC pan, filling specified material and the top base concrete should be done as early as possible and the top horizontal layer of water proofing may be taken up later i.e. just before laying the floor tiles.

22.3.7 Measurement

Length and breadth shall be measured along the finished surface correct to a cm. and area shall be worked out to nearest 0.01 sqm. No payment however shall be made for the 100 mm overlap of PVC Sheet over the roof slab.

22.3.8 Rate

The rate shall include the cost of labour and materials involved in all operations described above.

22.4 PROVIDING WATER STOPS

22.4.1 Water stops conforming to IS 12200 for construction/expansion joints should be fabrication from a plastic compound, the basic resin of which shall be polyvinyl chloride. The compound shall contain additional resin/ plasticizer inhibitors or other materials such that when the materials is compounded it shall meet the requirement given in IS 15058.

22.4.2 Type of Joints for which Water Bars are Provided

The water bars are provided only for the movement of joints in a water retaining structure.

Different types of movement joints are as described below:

Complete Contraction Joint: This is a movement joint with deliberate discontinuity both in concrete as well as the reinforcement but no initial gap is maintained between the concrete on either side of the joint. This joint is intended to accommodate the contraction of the concrete.

Partial Contraction Joint: This is a movement joint with deliberate discontinuity in concrete but no water bar is provided and no discontinuity is provided in steel. No initial gap is maintained between the concrete on either side of joint.

Expansion Joint: This is also a movement joint with complete discontinuity in both reinforcement and concrete. It is intended to accommodate either expansion or contraction of the structure.

In general such joint requires the provision of an initial gap between the adjoining parts of the structure which accommodates expansion or contraction of the structure.

22.4.3 Types and Performance of Water Bars

Water bars are performed strips of impermeable material which are embedded in the concrete during construction so as to span across the joints and provide a permanent water tight seal during the whole range of joint movement.

The most usual form of water bars are strip with a longitudinal corrugation as shown in Fig. 22.5.

Another form of water bar of metallic type is Z shaped strip.

Water bars of copper, sheet lead, natural or synthetic rubber and plastic such as polyvinyl chloride (PVC) are also used. These bars comprise of central longitudinal hollow tube with thin walls and stiff wings of about 150 mm width.

Out of the metals available copper is most suitable as regards ductility, resistance to corrosion in air, water and concrete. However, it may be attacked by some wastes. If sheet lead is used it should be insulated from concrete by a good coat of bituminous or suitable composition. Natural synthetic rubber and plastics have very considerable advantage in handling, splicing and in making intersections.

Galvanized iron sheets may also be used with the specific permission of the Engineer-in-charge provided the liquid stored or the atmosphere around the liquid retaining structure is not excessively corrosive i.e. sewage.

The strip water bars described as above, while placing in position has to be passed through the end shutter of the first placed concrete with the result the shuttering at this point should be perfectly water tight otherwise cement slurry may escape from the concrete being laid and will ultimately weaken the structure. Therefore to avoid the above problem one can prefer moulded type of water bar.

The design of the moulded water bar with several projections need to be passed through the end shutter while placing the same in position. Another main advantage of this water bar is that since it occupies bigger proportion of the thickness of the joint it would lengthen the shortest alternative water path through the concrete.

22. 4.4 It is important to ensure proper compaction of concrete around the water bar. Proper cover to all the reinforcement shall be maintained. Sometimes to increase the bond the holes are provided in the copper water bars but in the long run it proves to be disadvantageous as it shortens the path of water through concrete. Water bars should be placed at the centre of the wall or if it is to be provided away from the centre its distance from either face of the wall shall not be less than half of the width of water bar or as specified/directed by the Engineer-in-charge.

22.4.5 Covers Plates for Joint

Sometimes joint cover plates have to be used for expansion joints mainly to avoid the risk of a fault in the water bar which is embedded. The plates to be used should be either copper or sheet lead. In case the copper plates are to be used, it should be clamped to the concrete face on each side of the joint. To ensure water tightness suitable gasket shall be used. Joint cover plates of sheet lead are also used and fixed on the joints. In this case the edges may return into grooves formed in the concrete and can be made completely water tight by lead caulking. Faces of the concrete to which sheet lead is to be fixed should be painted with bituminous or other suitable composition and the lead sheet should be similarly coated before fixing.

22.4.6 Spacing of Joints

In Reinforced Concrete floors movement joints should be spaced at not more than 7.5 m apart in two directions at right angles. The wall and floor joints should occur at the base of the wall in which case corresponding vertical joint is not important.

In concrete walls, the vertical movement joints should normally be placed at a maximum spacing of 0.75 m in reinforced walls. The maximum length desirable between vertical movement joints will depend upon the tensile strength of the walls and may be increased by suitable reinforcements.

Amongst the movement joints in floors and walls as mentioned above, expansion joint should be normally be provided at spacing of not more than 30 m between successive expansion joints or between the end of the structure and the next expansion joint, all other joints being of the contraction type.

In case of expansion joints the filling of these with bitumen filler, bitumen felt or any such material etc. shall be paid for separately in running metre. The measurement shall be taken upto two places of decimal stating the depth and width of joint.

In case joint cover plates either of copper or sheet lead with ancillaries are provided, these shall be measured and paid for separately.

22.4.7 Measurement

Length shall be measured correct to a cm and net quantities shall be calculated upto two places of decimal.

Each category of water stops/bar such as PVC, copper specifying width, thickness shall be measured and paid for separately.

22.4.8 Rate

The rate shall include all labour and materials in all the operations described above.

22.5 WATER PROOFING TREATMENT IN SUNKEN PORTION OF WCs, BATHROOMS ETC.

22.5.1 Preliminaries to be Attended

The preliminaries shall be attended as described in clause 22.3.1.

22.5.2 Preparing Surface, Fixing Pipes and Fittings

In this case, unlike as described in clause 22.3.2, no hacking of surface need be made, but only extra mortar sticking to the surface should be removed and the surface should be cleaned thoroughly. Fixing 'P' trap etc. shall be done as described in Clause 22.3.2.

22.5.3 Providing and Laying of Slurry for First Layer

The consistency of the slurry should be such as to cover the desired area by using 0.488 kg of blended cement per sqm of area.

On deciding the correct quantity of water required per sqm. area the required quantity of slurry should be prepared which can be applied over the desired surface within half an hour of mixing with 0.488 kg. of grey cement + 0.253 kg. water proofing compound as per manufacturer specifications + x litres of water per sqm. area and the required quantity of slurry thus prepared should only be used for first application.

The first layer shall be applied with painting brushes over the specified and dampened area carefully including the corners, holes on the surfaces and joints of pipes in concrete etc. and the application should continue at least upto 150 mm height of fixtures of pipes from the surface. The surface on application shall be air cured for 4 hours.

22.5.4 Providing and Laying of Slurry for Second Layer

The quantity of slurry required for second application to be covered within an hour of mixing shall be prepared with 0.242 kg. cement + 0.126 kg. water proofing compound + y litres of water per sqm. area and the required quantity of slurry thus prepared should only be used for second application.

The application of 2nd layer of slurry is same as for first layer as detailed in clause 22.5.3.

The applied surface shall be allowed to air cure for 4 hours and thereafter water curing shall be done for full 48 hours.

In case no further work as described above is to be taken up immediately on completion of water proofing treatment due to any reason it is recommended to protect the treated portion with cement plaster 1:4 as a protective layer for which separate payment shall be made to the contractor.

22.5.5 Measurement

Length and breadth shall be measured along the finished surface correct to a cm and area shall be worked out to nearest 0.01 sqm.

22.5.6 Rate

The rate shall include the cost of all labour and materials involved in all the operations described above. The cost of plastering shall be measured and paid for separately.

22.6 WATER PROOFING TREATMENT ON ROOF SLABS

22.6.1 Before taking up the water proofing work the construction of parapet walls, including finishing should be completed. Similarly, the ancillary items like haunches, khurras, grooves to tack the fibre cloth layer, fixing up of all down take pipes, water pipes and electric conduits etc. should be completed and no such work should be allowed on the area to be treated during the progress of water proofing treatment or even later.

22.6.2 Preparing Surface

There is no necessity of hacking the surface but the surface to be treated shall be cleaned including removing the mortar dropping from the surface.

22.6.3 Providing and Laying of Cement Slurry

The procedure to prepare and apply the cement slurry shall be same as detailed in clause 22.5.3 except that over projected pipes etc. slurry shall be applied just upto 100 mm height instead of 150 mm height. The slurry shall be applied upto a height of 300 mm on parapet walls and in the groove where the fibre glass cloth is to be tucked.

22.6.4 Providing and Laying of Fibre Glass Cloth (2nd Layer)

The fibre glass cloth shall be of approved brand and shall be thin, flexible uniformly bonded mat composed of chemically resistant borosilicate glass fibre distributed in random open porous structure bonded together with a thermosetting resin.

Immediately on applying the slurry on a sufficiently workable area as detailed above in clause 22.6.3 when the slurry applied is still green the fibre glass as specified shall be spread evenly on the surface without any kink and pressed in such a way that no air spaces exist. The fibre glass cloth shall be taken upto a height of 30 cm on parapet walls and tucked in the groove specially prepared at that height.

A minimum overlap of 100 mm width shall be provided when the fibre cloth has to be joined. The joining of 100 mm overlap shall be done with the same slurry used for the application on surface as first layer. The fibre cloth shall also be extended upto a height of 100 mm over pipes projecting from the surface.

22.6.5 Providing and Laying of Cement Slurry for Third Layer

The quantity of water required to prepare slurry which can cover one sqm. area of the surface to be treated shall be calculated as described in clause 22.5.3 and consider this quantity as say x litres/sqm.

On deciding the correct quantity of water required, the slurry shall be prepared by mixing 1.289 kg/m^2 of grey cement + 0.67 kg./sqm. of Water Proofing Compound +1.289 kg./sqm. of coarse sand + x litres of water. Slurry shall be prepared for the area to be covered within half an hour of mixing.

The consistency of the slurry shall be such that in one application with a brush 1.5 mm thickness of slurry can be coated on the fibre glass cloth surface.

This slurry shall be applied evenly on the entire surface covered with fibre glass cloth so that a layer of 1.50 mm thickness of slurry is formed.

The application of slurry shall be continued over the 300 mm portion of parapet wall and also the portion tucked in the groove on top.

The entire surface shall be allowed for air curing for 4 hours and later the surface shall be cured with clean water for 7 days.

On completion of curing the grooves where the fibre glass cloth is tucked shall be closed neatly with cement mortar mixed with water proofing compound and the repaired surface should be cured by clean water for 7 days.

Fourth and final layer of brick tiling if required shall be laid and paid for separately.

22.6.6 Measurement

Length and breadth shall be measured along the finished surface correct to a cm and area shall be worked out to nearest 0.01 sqm. Overlaps and tucking in a flashing grooves shall not be measured. No deductions shall be made for openings or recess or chimney stack, roof lights or Khurras of area upto 0.40 sqm, nor anything extra shall be paid for forming such openings, recess etc. For area exceeding 0.40 sqm. deduction will be made in the measurement for the full opening and nothing extra shall be paid for making such opening.

22.6.7 Rate

The rate shall include the cost of labour and material involved in all the operations described above, however the cost of brick layer with cement mortar shall be paid for separately.

22.7 INTEGRAL CEMENT BASED WATER PROOFING TREATMENT WITH BRICK BAT COBA (Fig. 22.6)

22.7.1 Before taking up the work the preliminaries to be attended shall be exactly same as described in clause 22.6.1.

22.7.2 Preparing the Surface

The surface of the slab should be roughened by scrapping when the slab concrete is still green, however, the surface need not be hacked. In case the slab is already cast and surface fairly finished, the same shall be cleaned neatly of all mortar droppings, loose materials etc with brooms/cloth.

22.7.3 Providing and Laying of Slurry under Base Coat

The quantity of water required to prepare the slurry with 2.75 kg. of blended cement to be painted over an area of 1 sqm. shall be calculated exactly as described in clause 22.5.3.

Depending upon the area of surface that has to be covered, the required quantity of slurry should be prepared using 2.75 kg. blended cement + water per sqm. area to be covered, taking particular care to see that only that much quantity of slurry shall be prepared which can be used within half an hour of preparation i.e. before the initial setting time of cement.

The prepared slurry shall be applied over the dampened surface with brushes very carefully, including the joints between the floor slab and the parapet wall, holes on the surfaces, joints of pipes, masonry/concrete etc.

The application of the slurry should continue upto a height of 300 mm on the parapet wall and also the groove as shown in Fig. 22.6. The slurry should also be applied upto a height of 150 mm over pipe projections etc.

22.7.4 Laying Base Coat 20 mm thick

Immediately after the application of slurry and when the application is still green, 20 mm thick cement plaster as base coat with cement mortar 1:5 (1 blended cement : 5 coarse sand) shall be evenly applied over the concrete surface taking particular care to see that all the corners and joints are properly packed and the application of the base coat shall be continued upto a height of 300 mm over the parapet wall.

22.7.5 Laying Brick Bat Coba

Brick bat of size 25 mm to 115 mm out of well burnt bricks shall be used for the purpose of brick bat coba.

The brick bats shall be properly dampened for six hours before laying.

Brick bats shall be laid to required slope/gradient over the base coat of mortar leaving 15-25 mm gap between two bats. Cement mortar 1:5 (1 blended cement: 5 coarse sand) shall be poured over the brick bats and joints filled properly. Under no circumstances dry brick bats should be laid over the base coat.

The haunches/gola at the junction of parapet wall and the roof shall be formed only with brick bat coba as shown in Fig. 22.6.

In case the brick bat coba is laid on the base coat immediately on initial set there will be no necessity of applying cement slurry over the base coat before laying the brick bat coba. However, if the brick bat coba is to be laid on the subsequent day, cement slurry prepared as described in clause 22.7.3 shall be applied over the top surface of the base coat, then only the brick bat coba shall be laid.

22.7.6 Application of Slurry over Brick Bat Coba

After two days of curing of brick bat coba cement slurry prepared as per clause 22.7.3 shall be applied on the surface of brick bat coba The application of slurry shall be the same as described in clause 22.5.3 which should cover the haunches/gola, and the remaining small portion of parapet wall and also inside the groove as shown in the figure.

22.7.7 Laying Finishing Layer (Protective Coat)

Immediately on applying the cement slurry over the surface of the brick bat coba and when the slurry applied is still green, the fibre glass cloth as specified in clause 22.6.4 shall be spread evenly on the surface without any kink & pressed to see that no air spaces exist. The fibre glass cloth shall be taken up to a height of 300 mm on parapet walls & tucked in the groove specially prepared at that height. 20 mm thick layer of cement plaster, without leaving any joints shall be applied with cement mortar 1:4 (1 blended cement: 4 coarse sand) over the entire fibre glass cloth including the haunches/ gola and the small portion on the parapet wall. The groove in the parapet wall over the haunches shall also be filled neatly packing the mortar firmly in the groove.

The surface of the finishing layer (protective coat) shall be neatly finished with cement slurry prepared as per clause 22.7.3. The finished surface shall be allowed to dry for a while and then pattern of 300 mm x 300 mm groove, 8 mm deep shall be made over the entire surface.

22.7.8 Curing and Testing the Treatment

The entire surface thus treated shall be flooded with water by making kiaries with weak cement mortar, for a minimum period of two weeks.

22.7.9 Measurement

The measurement shall be taken along the finished surface of treatment including the rounded and tapered portion at junction of parapet wall. Length and breadth shall be measured correct to a cm and area shall be worked out to nearest 0.01 sqm. No deduction in measurement shall be made for openings or recesses or chimney stacks, roof lights or khurras of area upto 0.40 sqm., nor anything extra shall be paid for making such openings, recesses etc. For areas exceeding 0.40 sqm., deduction will be made in the measurements for the full openings and nothing extra shall be paid for making such openings.

22.7.10 Rate

The rate shall include the cost of all labour and materials involved in all the operations described above.

22.8 WATER PROOFING TREATMENT WITH BITUMEN FELT

22.8.0 Water proofing treatment with self finished felt shall be four courses or six courses as described in the item. Four course water proofing treatment with self finished felt is a normal duty treatment suitable for buildings where the cost of roof treatment is required to be restricted.

Six course water proofing treatment with self finished felt is a heavy duty treatment suitable for important structures.

22.8.1 Materials

22.8.1.1 Self finished felt (Appendix A and B) shall conform to the type and grade given in the description of the item. This shall be one of the following types:

(i) Type 3 grade 1 hessian base felt conforming in all respects to IS 1322.

(ii) Type 2 grade 1 fibre base bitumen felt conforming to IS 1322.

(iii) Type 2 grade 2 glass fibre base felt conforming in all respects to IS 7193.

22.8.1.2 ***Bonding Materials:*** This shall consist of blown type petroleum bitumen conforming to IS 702 or residual petroleum bitumen conforming to IS 73. The bonding material shall be so selected as to withstand the local condition of temperature and gradient satisfactorily. The penetration of bitumen used shall not exceed 40 in any case. Suitable residual type petroleum bitumen of penetration 30/40 (IS grade S-35), residual type petroleum bitumen with higher penetration and low softening point and suitable blown type petroleum bitumen of IS grade 85/25 or 90/15 of approved quality shall be used.

Where proprietary brands of bonding materials are proposed to be used they shall conform in all respects to the specifications in the preceding paras.

Sl.No	Description	1st course	3rd course	5th course
		kg/sqm	kg/sqm	kg/sqm
I.	Four course treatment:	1.45	1.45	-
II.	Six course treatment:			
	(a) With type 3 grade 1 hessian base self finished bitumen felt.	1.45	1.20	1.45
	(b) With felts other than type 3 grade 1 hessian base.	1.45	1.20	1.70

22.8.1.3 ***Stone Grit and Pea- sized Gravel:*** Stone grit shall be 6 mm and down size. Where pea-sized gravel is used it shall be hard, round and free from dust, dirt etc. The stone grit or pea-sized gravel shall not be spread over vertical and sloping faces of flashings and at drain mouths. At these places the surface shall be painted with two coats of bituminous solution.

The quantity of stone grit or pea-sized gravel required for the final course of four or six course treatment with hessian base self finished bitumen felt type 3 grade 1 shall be 6 cubic decimeter/ sqm.

22.8.2 Preparation of Surface

22. 8.2.1 The surface to be treated shall have a minimum slope of 1 in 120. This grading shall be carried out with cement concrete or cement plaster with coarse sand, as per direction of Engineer-in-charge, to the average thickness required and finished smooth. Such grading shall be paid for separately.

22.8.2.2 Junctions between the roof and vertical faces of parapet walls, chimneys etc. shall be cased by running triangular fillets 7.5 x 7.5 cm size, in cement concrete. At the drain mouths, the fillets shall be suitably cut back and rounded off for easy application of water proofing treatment and easy flow of water. Cement concrete where used shall be 1:2:4 mix (1 cement: 2 coarse sand : 4 graded stone aggregate 20 mm nominal size). The provision of fillets shall be deemed to be covered by the item of water proofing and shall not be measured or paid for separately.

22.8.2.3 In existing roof where gola and drip course are provided at the junction of roof and vertical face of parapet wall, chimney stacks etc., these shall be dressed suitably and finished smooth so as to ensure an easy and gradual turning of the flashing. Any dismantlement or forming and finishing smooth the junction for forming the base of the flashing shall not be measured or paid for separately and shall be deemed to form part of the preparation of the surface in the water proofing treatment.

22.8.2.4 While the grading of roof surface is being done, it shall be ensured that the outlet drain pipe have been fixed and mouth at the entrance have been eased and rounded off properly for easy flow of water.

22.8.2.5 When any pipe passes through the roof to be treated, angular fillet of shape shown in Fig. 22.7 shall be built around it for the water proofing treatment to be taken over it. These fillets shall not be measured or paid for separately.

22.8.2.6 For carrying over and tucking in the water proofing felts into the parapet walls, chimney stacks etc. a horizontal groove 6.5 cm deep, 7.5 cm wide section with its lower edge at not less than 15 cm above the graded roof surface shall be left on the inner face of the same during construction if possible. When such groove has not been left, the same shall be cut out neatly and the base at rear of the groove shall be finished smooth with cement plaster 1:4 (1 cement: 4 coarse sand). Such cutting of the groove and its finishing smooth shall be deemed to be part of the water proofing item and shall not be measured or paid for separately. No deduction shall be made either for not making the groove or when the later has already been left in the masonry by the construction agency.

22.8.2.7 Tucking in the water proofing felt will be required where the parapet wall exceeds 45 cm in the height from the graded surface. Where the height is 45 cm or less, no groove will be required as the water proofing treatment will be carried over the top of the parapet wall to its full thickness. In the case of low dividing walls of height 30 cm or less, outlets therein shall be cut open for full height and the bottom and sides shall be rendered smooth and corners rounded and such treatment shall not be measured and paid for separately.

22.8.2.8 Where expansion joints are left in the slab, the provision of dwarf walls and/or RCC slabs for covering them and finishing the surface smooth shall be the responsibility of the construction agency, which had laid the roof slab and will not be included the operation of water proofing.

22.8.2.9 The graded surface of the roof and concrete fillets and the faces of walls shall be thoroughly cleaned with wire brushes and all loose scales etc. removed. The surface shall then be dusted off. Any crack in the roof shall be cut to 'V' section, cleaned and filled up flush with cement mortar slurry 1:4 (1 cement: 4 coarse sand) or blown type petroleum bitumen of IS grade 85/25, or approved quality conforming to IS 702. Such cleaning of the surface or treating the cracks shall not be paid for separately.

22.8.3 Priming Coat

Where so specified, or required by the Engineer- in-Charge for example under slightly damp conditions a priming coat consisting of a bitumen primer conforming to IS 3384 should be applied with brush on the roof and wall surface at 0.24 litres per sqm to assist adhesion of the bonding material (i.e. bitumen).

Such application of primer shall be paid for separately, unless specifically included in the water proofing item.

22.8.4 Underlay

Where a floating treatment of water proofing with self finished bitumen felt is required i.e. where water proofing treatment is required to be isolated from the roof structure, a layer of bitumen saturated felt (underlay) shall be spread over the roof surface and tucked into the flashing groove. No bonding material shall be used below the underlay in order to keep the underlay free of the structure. The adjoining strips of the underlay shall overlap to a minimum of 7.5 cm at sides and 10 cm at ends. The overlaps shall be sealed with the same bonding material as used for the self finished felt treatment. Unless specifically included in the water proofing item, the underlay treatment shall be paid for separately.

The underlay shall be of type 1 saturated felt conforming to IS 1322 in all respects and having a total minimum weight of the finished bitumen felt in dry condition with mica dusting powder @ 6.8 kg per 10 sqm. The roll shall not be damaged or crack on being unrolled on a fairly smooth and flat surface.

22.8.5 Treatment

22. 8.5.1 The water proofing shall consist of a four or six course treatment, as given in the description of the item, each layer of bonding materials, self finished bitumen felt or stone grit or pea sized gravel being counted as a course.

22.8.5.2 The choice of a four or six course treatment will depend on the climatic condition, the importance of the building, the durability required, cost and other relevant considerations.

22.8.5.3 A four course treatment shall consist of the following layers:

(a) Initial layer of bonding material applied hot at specified weight per unit area.

(b) 2nd layer of self finished bitumen felt conforming to the type and grade given in the description of the item.

(c) Third layer of bonding material.

(d) Final layer of stone grit of pea sized gravel spread at specified volume of material per unit area.

22.8.5.4 In a six course treatment, the first, second and third layer shall be of the same as in the four course treatment. The fourth and fifth layer shall consist of self finished felt and bonding material respectively. The sixth layer shall consist of stone grit or pea sized gravel.

22.8.5.5 The primer or underlay where required to be provided shall not count against the number of courses specified.

22.8.6 Laying

22.8.6.1 Bitumen bonding material of required grade shall be heated to the working temperature specified for the particular grade by the bitumen manufacturers and conveyed to the roof in buckets or pouring canes in weighed quantities.

Suitable working temperature for different grades of bitumen are as under:

(i) Blown type petroleum bitumen of IS grade 85/25 or 90/15 - 180 degree C.

(ii) Residual type petroleum bitumen of penetration 30/40 - 180 degree to 190 degree C (IS grade S-35).

22.8.6.2 Drain outlets shall be given a four or six course treatment as specified for the roof in the description of the item in the manner specified for the flat roof surface. Water proofing treatment shall be carried into the drain pipe or outlets by at least 10 cm. The water proofing treatment laid on the roof surface shall overlap the upper edge of the water proofing treatment in the drain outlets by at least 10 cm.

22.8.6.3 The self finished felt shall be cut to the required length, brushed clean of dusting material and laid out flat on the roof to eliminate curls and subsequent stretching. The felt shall normally be laid in length at right angles to the direction of the slope and laying shall be commenced at the lowest level and worked upto crest. The felt shall not be laid in single piece of very long lengths as they are likely to shrink; 6 to 8 m are suitable lengths. The roof surface shall be cleaned and dried before the felt treatment is begun. Each length of felt shall be laid in position and rolled up for a distance of half its length. The hot bonding material shall be poured on the roof across the full width of the rolled felt as the latter is steadily rolled out and pressed down. The pouring shall be so regulated that the correct weight of bonding material per unit area is spread uniformly over the surface. Excess bonding material that gets squeezed out at the ends shall be levelled up as laying proceeds. When the first half of the strip of felt has been bonded to the roof, the other half shall be rolled up and then unrolled on the hot bonding material in the same way. Subsequent strips shall also be laid in the same manner. Each strip shall overlap the preceeding one by at least 7.5 cm at the longitudinal edges and 10 cm at the ends. All overlaps shall be firmly bonded with hot bitumen. Streaks and trailings of bitumen near edges of laps shall be levelled by heating the overlap with a blow lamp and levelling down unevenness.

The third layer of bonding material in the four course treatment shall be carried out in a similar manner after the flashing has been completed.

22.8.6.4 In a six course treatment the third and fourth layers of bonding material and self finished felt shall be laid in the manner already described, taking care that laps in the felt are staggered from those in the second layer. The fifth layer of bonding material shall be carried out after the flashing is done (See Fig. 22.7).

22.8.6.5 ***High Parapet Walls, Chimney Stacks etc.:*** Felts shall be laid as flashings wherever junctions of vertical and horizontal surfaces occur. Longitudinal laps shall be 10 cm. The lower layer of flashing felt in a six course treatment shall overlap the roof water proofing by not less than 20 cm while the upper layer shall overlap the roofing felt by 10 cm. The minimum overlap of the flashing felt in four course specification over the roofing felt shall be 10 cm.

The flashing shall consist of the same four or six course treatment as for the roof except that the final course of stone grit or pea-sized gravel shall be replaced by an application of bituminous solution of approved quality in two coats on the vertical and sloping faces only, of the flashing. The overlap along the length of flashing shall stagger with those in the second layer of flashing felt (in a six course treatment and with the joints in the roof felt).

The upper edge of the flashing felt shall be well tucked into the flashing grooves in the parapet, chimney stacks etc. to a depth of not less than 6.5 cm. Corresponding applications of bonding material shall also be made. The flashing treatment shall be firmly held in place in the grooves with wood edges at intervals and the grooves shall be filled up with cement mortar 1:4 (1 cement: 4 coarse sand) or cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 6 mm nominal size) and surface finished smooth with the rest of the wall. The cement work shall be cured for 7 days. When dry, the exposed plaster joints of grooves shall be painted with bitumen and two coats of bituminous solution shall be applied on the vertical and sloping surface of flashing (see Fig. 22.7).

After the top flashing felt layer has been fixed, the penultimate layer of bonding material shall be applied over the roofing felt and the horizontal overlaps and vertical and sloping surfaces of the flashings at the specified rate. Stone grit or pea sized gravel shall then be spread uniformly over the hot bonding material on the horizontal roof surface at the specified quantity per unit area and pressed into it with a wooden roller.

22.8.6.6 ***Low Parapet Walls:*** Where parapet walls are of height 45 cm or less, bitumen felt flashings shall be provided in the same manner as for flashings in the case of high parapet walls except that the upper edge shall be carried upto the full height of the wall and taken right across the top of the parapet and down on the external vertical faces to a minimum distance of 5 cm (see Fig. 22.7).

22.8.6.7 ***Low Dividing Walls:*** Where low dividing walls or inverted beams are met with, the same shall be covered with a four or six layer treatment as for the main roof, the latter bearing carried down both sides of the wall and overlapping the roofing treatment as in the case of flashing of high parapet walls (see Fig. 22.7).

Drain outlets where formed in the low dividing walls, shall be given water proofing treatment of the same number of courses as specified for the flat roof surface. The bottom and sides shall be so treated that all overlaps are in the direction of flow of drainage.

22.8.6.8 ***Expansion Joints:*** Where the expansion joints are provided in the slabs, the joints and their cover slabs shall be suitably treated with water proofing. A typical sketch of an expansion joint with the RCC slabs on either side of the joint turned vertically up and covered with precast RCC cover slabs as given in Fig. 22.7. The cover slabs shall cover the vertical turned up dwarf walls by not less than 7.5 cm and are provided with throatings on their underside along their length. The water proofing treatment shall be taken up the sloping junction fillets and the vertical faces of the walls to the underside of the cover slabs. The cover slabs are given the water proofing treatment like the roof slabs, after the cross joints between adjacent cover slabs are first sealed with 15 cm width of roofing felt struck to them with bitumen. The water proofing treatment shall be carried down the sides of the cover slabs to their full thickness. Care shall be taken to see that overlaps if any in the roofing over the cover slabs stagger with the joints between cover slabs.

The formation of the expansion joints and provision of cover slabs shall be the responsibility of the construction agency. The formation of the junction fillets and the water proofing treatment of the joint and cover slabs shall be carried out by the water proofing agency. No extra shall be paid for the junction fillers or for the sealing of the cross joints in the cover slab with 15 cm width of bitumen strips.

22. 8.6.9 ***Pipes:*** Where vertical pipe outlets are met with 7.5 x 7.5 cm fillets of lime or cement concrete of the type and section shown in Fig. 22.7 shall be provided and flashing of four or six course treatment, same as for the roofing treatment shall be laid.

The upper edge of the flashing shall be laid sloping down forward and butted against the pipe and annular depression so formed shall be filled with hot bitumen. A circular metal collar in the shape of an inverted truncated cone shall be fixed on the pipe to throw off the rain water clear of the flashing and this shall be paid for separately.

22.8.6.10 ***Terrace:*** Where roof surfaces are expected to be used precast cement concrete tiles or 40 mm thick cement concrete shall be laid on the water proofing treatment. In such cases, the final course of stone grit or pea sized gravel shall not be laid in the water proofing treatment. Suitable adjustment in the rates will be effected for not providing the stone grit or pea sized gravel layer. Cement concrete in situ flooring shall be laid in panel not exceeding 0.4 square metres each. Precast tiles or in situ concrete flooring where laid shall be paid for separately unless included in the description of the water proofing item.

22.8.7 Measurements

22.8.7.1 Length and breadth shall be measured correct to a cm. The area shall be calculated in square metres correct to two places of decimal.

22.8.7.2 Measurements shall be taken over the entire exposed area of roofing and flashing treatment including flashing over low parapet walls, low dividing walls and expansion joints and at pipe projections etc. Overlaps and tucking into flashing grooves shall not be measured.

22.8.7.3 Vertical and sloping surfaces of water proofing treatment shall also be measured under the four or six course treatment as the case may be, irrespective of the fact that the final course of grit or pea sized gravel is replaced by bitumen primer.

22.8.7.4 Primer or saturated felt underlay, where provided, shall also be measured in the same manner as the water proofing treatment and paid for separately. No deduction in measurements shall be made for either openings or recesses for chimney stacks, roof lights and the like, for areas upto 40 square decimetre (0.4 sqm) nor anything shall be paid for forming such openings.

For similar areas exceeding 40 sq. decimetre deductions will be made in measurements for full opening and nothing extra shall be paid for forming such openings.

22.8.8 Rate

The rate shall include the cost of all labour and materials involved in all the operations described above and the particular specifications given under the different items, with the corrections noted in the relevant sub-paras.

22.9 GRADING ROOF WITH CEMENT CONCRETE 1:2:4

22.9.1 Materials

Cement, coarse sand and graded stone aggregate 20 mm nominal size, shall be used as specified in the item.

The specifications for the materials and method of preparation of concrete shall conform in general to the specification described in sub-head 4.0 of CPWD Specifications.

22.9.1.1 ***Laying:*** Before laying cement concrete for grading, the level markings to the required slope/gradient shall be made only with cement concrete on the surface of the slab at suitable spacing with the help of string and steel tape (Measuring tape) so that the mason can lay the concrete to the required thickness, slope / gradient easily in between the two level markings.

On getting the level marking approved by the Site Engineer the surface should be sprinkled with thick cement slurry and the concrete should be laid carefully, without throwing from height, in predetermined strips.

The concrete should be consolidated by specially made wooden tamping. After the tamping is done the surface should be finished to required slope/gradient with wooden trowels without leaving any spots of loose aggregates etc.

The mixed cement concrete must be laid in position, within half an hour of its mixing. In case any quantity of concrete remains unused for more than half an hour the same should be rejected and removed from the site.

22.9.1.2 ***Finishing:*** The slope of finished terrace shall not be more than 1 in 120 unless a steeper slope is desired by the Engineer-in-Charge.

The minimum thickness of the concrete at its junction with Khurra or parapets shall be 5 cm. The concrete shall be rounded at the junction of roof slab and parapet. It is desirable to provide a haunch/ gola/filler at the junction of the parapet wall and the roof slab as shown in Fig. 22.8.

The finished concrete surface shall present a smooth surface with correct slopes and uniform rounding. The concrete should be free from cracks. Excess trowelling shall be avoided.

22.9.1.3 ***Thickness:*** Average thickness shall be as per clause 22.9.1.2 as shown in Fig. 22.8.

22.9.1.4 ***Curing:*** Curing shall be done either by spreading straw/Hessian cloth over the graded surface, keeping the same wet for full 10 days or flooding the graded area with water by making kiaries with weak cement mortar, for 10 days. Occasional curing by simply spraying water now and then shall not be permitted under any circumstances.

22.9.1.5 ***Measurement:*** Length and breadth shall be measured correct to a cm. Area shall be worked out to nearest 0.01 sqm. and the cubical contents shall be worked out to nearest 0.001 cum.

No deduction shall be made for either opening or recesses for chimney stacks, roof lights etc., Khurra for area upto 0.1 sqm. Nothing extra shall be paid either for any extra material or labour involved in forming such opening or recess or in rounding the concrete function of roof with parapet walls, chimney stack, khurra etc.

22.9.1.6 ***Rate:*** The rate shall include the cost of all the materials and labour involved in all the operations described above.

22.10 GRADING ROOF WITH CEMENT MORTAR

22.10.1 Materials

Cement and coarse sand shall be as specified in the item of work or as described in sub-head 3.0 of CPWD Specifications.

22.10.1.1 ***Cement Mortar :*** Cement mortar 1:3 (1 cement: 3 coarse sand) /1:4(1 cement: 4 coarse sand) specified in the item of work shall conform to the specification described in sub-head 3.0 of CPWD Specifications.

22.10.1.2 ***Preparation of the Surface:*** The surface shall be cleaned properly with brooms bruch, cloth to remove all dirts, dust, mortar droppings.

22.10.1.3 ***Laying:*** Same as described in clause 22.9.1.1, except that cement mortar shall be tamped with wooden and steel trowels and surface finished with steel trowel.

22.10.1.4 ***Finishing***

(i) The slope of finished surface shall not be more than 1 in 120 unless a steeper slope is specified in the item of work.

(ii) The finished surface of the grading shall present a smooth surface with correct slopes and uniform roundings wherever they are provided. The mortar surface shall be free of cracks. Excess trowelling shall be avoided.

22.10.1.5 ***Thickness:*** The minimum thickness of cement mortar grading at the junction with khurra or parapet wall shall be 20 mm. The cement mortar shall be rounded at the junction of roof slab and parapet. It is desirable to provide a haunch/gola/filler at the junction of parapet wall and the roof slab. The maximum thickness that shall be adopted for grading with cement mortar shall be 50 mm. It is not at all desirable to lay the cement mortar grading for greater thickness and in that case it is advised to go in for grading with Cement Concrete. The average thickness shall be as shown in Fig. 22.9 and 22.10.

22.10.1.6 ***Curing:*** Curing for the grading with cement mortar shall be done exactly as described in clause 22.9.1.4.

22.10.1.7 ***Measurement:*** Same as specified in clause 22.9.1.5.

22.10.1.8 ***Rate:*** The rate shall include the cost of all the labour and material involved in all the operations described above.

22.11 Clause shifted to Sub Head 14 (Repairs to Buildings) as clause no. 14.49

22.12 Clause shifted to Sub Head 14 (Repairs to Buildings) as clause no. 14.50

22.13 Clause shifted to Sub Head 14 (Repairs to Buildings) as clause no. 14.51

22.14 WATER PROOFING TREATMENT WITH INTERGRAL CRYSTALINE ADMIXTURE

22.14.0 General

One method that can simplify the protective process is to make concrete with Integral Crystalline Admixtures that reduce its permeability in effect to make the concrete itself waterproof. Apart from the regular workability admixtures, Integral Crystalline durability admixtures shall be added to all concrete, structural and otherwise, to waterproof & enhance the Concrete Durability. The Crystalline Admixture shall be added either at the time of batching at the batching plant or in the drum of the transit mixer, when the concrete arrives the point of pouring.

The concrete water proofing industry redefined their terminology a short time ago. American Concrete Institute (ACI) 212-3R-10 “Report on Chemical Admixture for Concrete” documents devoted chapter 15 / page 46 to permeability reducing admixtures (PRA’s) that outlines PRAH & PRAN classification or differentiates between those suitable for concrete exposed to Non Hydrostatic Conditions (PRAN) and concrete exposed to Hydrostatic Conditions (PRAH). Besides reducing permeability some PRA’s impart other beneficial characteristics such as reduced drying shrinkage, reduced chloride-ion penetration, improved freeze thaw resistance and enhanced autogenous sealing.

22.14.1 Material

Integral crystalline water-proofing admixture is one part cementitious powder added to the concrete mix at the time of batching. Integral crystalline water-proofing admixture consists of **hydrophilic chemicals** such as Portland cement, very fine treated silica sand and various active, proprietary chemicals. These active chemicals react with moisture in fresh concrete and with the by-products of cement hydration to cause a

catalytic reaction, which generates a non-soluble crystalline formation throughout the pores and capillary tracts of the concrete. Thus, the concrete becomes permanently sealed against the penetration of water or liquids from any direction. The concrete is also protected from deterioration due to harsh environmental conditions. Integral crystalline water-proofing admixture is specially formulated to meet varying project and temperature conditions. This reaction continuous over the life of the concrete serving to seal not only initial shrinkage cracks, but also cracks that occur over time.

22.14.2 Technical Specifications / Parameters

The specifications of the materials should match or exceed the requirements as mentioned in nomenclature of the item.

The water proofing compound used in integral crystalline water proofing treatment shall satisfy all the requirements indicated in relevant standards or as specified in concerned relevant codes etc. and the same shall be got tested and get approved from the Engineer-in-charge before its use at site of work.

The integral crystalline waterproofing admixtures of **hydrophilic in nature** shall confirm to the following requirements:

1. Dosage as specified in the nomenclature of item or higher as recommended by manufacturer's specification. The material shall fulfill the requirements of American Concrete Institute Guidelines ACI-212- 3R-10 Chapter 15 or European norms EN 934-2-T2 and fall under PRAH (Permeability reducing Admixtures for HYDROSTATIC conditions) and shall be capable of withstanding/resistant to 16 bar hydrostatic pressure and reduce Coefficient of Permeability of concrete by more than 90, when compared to controlled concrete and tested as per DIN 1048 Part 5 or EN 12390-8 by carrying out 4 cycles each of 5 bar hydrostatic pressure for 72 hours and drying for 48 hours between the cycles. The co-efficient of Permeability calculated as per Darcy's Formula/ Valenta equation by incorporating penetration values obtained at the end of fourth cycle pressure.

2. The crystalline admixture shall be compatible with any other concrete admixture confirming to ASTM C494, EN 934-2 or IS 9103.

3. The performance of the crystalline admixture must not be restricted by water-cement ratio of concrete mix. In other words, the crystalline admixture must perform at any water-cement ratio of the concrete mix.

4. The integral crystalline admixture shall possess CE approval as per EN934-2 and shall be procured from CE approved manufacturing unit. It shall also possess approval certificate from any national apex institution mandated to issue design codes. The product has no corrosion effect on reinforcement steel according to test norm DINV18998. The maximum chloride content less than 0.1% and maximum alkali content less than 9.3%.

5. In addition to recognizing the use of Integrate Crystalline Admixtures. ACI 212-3R-10 has also provided some guideline in para 15.3-"Selection and Evaluation" to select the best quality PRAH's materials as maximum permeability reducing admixtures at maximum Hydrostatic Pressure. Para 15.3 stated that the effect of the admixture can be evaluated by testing the permeability of concrete both directly and indirect methods. The US Army Corps of Engineers CRC C48-92 (1992) test method is a direct measurement of concrete permeability resistance during exposure to water under **200 psi or 13.8 bars or 1.38 MPa of hydrostatic pressure.**

6. The integral crystalline admixture must reduce Chloride diffusion Co-efficient by minimum 45% when tested as per ASTM C 1556-4 and compared with the controlled concrete, thereby prolonging the durability & service life of the treated concrete structure.

7. The integral crystalline admixture must be capable of self-healing of cracks up to a width of 0.5mm.

8. The integral crystalline admixture performance shall not be affected by wear abrasion of the treated concrete surface and crystalline treated concrete shall not require protection layer.

9. The integral crystalline admixture shall be non-toxic and shall confirm to NSF-61 USA or any other similar certification from reputable international or local third party or declaration of performance certificate supervised by a reputable European/US third party.

10. The integral crystalline admixture when used in the concrete will have no detrimental side effect interms of Alkali Silica Reaction (ASR) and corrosion of steel reinforcement etc.

11. The manufacturer shall submit guarantee in respect of crystalline admixture performance for 10 years against any leakage.

Note: The manufacturer shall submit test certificates in respect of all above said specification/ parameters of Integral Crystalline Admixture Material from reputed National/International laboratories as per relevant codes. To support the claim of crystal formation, national/ international test report of scanning electrons microscopic (SEM) photographs dandified and mature crystal formation to plug all the capillary track and pores of the concrete shall be provided.

Total quantity of Integral Crystalline Admixture Material required shall be arranged at site of work only after obtaining the prior approval of the Engineer-in-Charge in writing. Proper account of water proofing compound used in the work shall be maintained. It shall be ensured that the consumption of the compound is as per specified requirements. The contractor shall associate himself with anyone of the applicator of water proofing compound duly approved by the Engineer-in-Charge before start of work relating to the water proofing treatment.

22.14.3 Recommended uses

Foundations/Rafts
Sewage and Water Treatment Plants
Tunnels and Subway Systems
Parking Structures
Pre-Cast, Cast-in-situ and Shotcrete applications
Reservoirs, Bridges and Dams
Secondary Containment Structures
Underground Vaults
Swimming Pools and water tanks
Basement Retaining Walls

22.14.4 Dosage

0.8% (minimum) to the weight of cement content per cubic meter of concrete or higher dosage as recommended by the manufacturer's specification in reinforcement cement concrete at site of work.

22.14.5 Mixing

The integral crystalline admixture shall be used @ 0.8% (minimum) to the weight of cement content per cum of concrete or higher as recommended by the manufacturer's specification desired to meet water proofing and durability criteria. Integral crystalline Admixture must be added to the concrete at the time of batching at the batching plant or in the drum of the transit mixer, when the concrete arrives the point of pouring.

The sequence of procedures for addition will vary according to the type of batch plant operation and equipment. The mixing shall be followed as below unless & until specified otherwise. For any detailing and mixing guidelines the manufacturer's specifications should be followed.

22.14.5.1 Ready mix plant- Dry batch operation

Add integral crystalline admixture in powder form to the drum of the ready-mix truck under the batch plant and add 60%- 70% of the required water, along with required aggregate. Mix the materials for 2-3 minutes to ensure that the integral crystalline admixture is distributed evenly throughout the mix water. Add the balance of materials to the ready-mix truck in accordance with standard batching practices.

22.14.5.2 Ready mix plant- Central mix operation

Mix integral crystalline admixture with water to form a very thin slurry (e.g. 18kg of powder mixed with 22.7 litre of water) or recommended by the manufacturers specification. Pour the required amount of material into the drum of the ready-mix truck. The aggregate, cement, sand and water should be batched and mixed in the plant in accordance with standard practices (taking into account the quality of water that has already been placed in the ready-mix truck). Pour the concrete into the truck and mix for at least 5 minutes to ensure even distribution of integral crystalline admixture throughout the concrete.

22.14.5.3 Precast batch plant

Add integral crystalline admixture to the aggregate and sand, then mix thoroughly for 2-3 minutes before adding the cement and water. The total concrete mass should be blended using standard practices.

It is important to obtain a homogeneous mixture of integral crystalline admixture with the concrete. Therefore dry integral crystalline admixture powder should never be mixed directly to wet concrete as this may cause clumping and hence thorough dispersion in the concrete mix may not occur.

22.14.5.4 Setting time and strength

The setting time of concrete mix is directly affected by the chemical and physical composition of ingredients, temperature of the concrete and prevailing climatic conditions. Retardation of set may occur when using integral crystalline admixture. The amount of retardation will depend upon the concrete mix design and the dosage rate of integral crystalline admixture. However, under normal conditions, integral crystalline admixture will provide a normal set concrete. Concrete containing integral crystalline admixture may develop higher ultimate strengths than plain concrete. Trial mixes of the concrete should be carried out under project conditions to determine setting time and strength of the concrete.

22.14.6 Precaution / Special Consideration

When incorporating Integral Crystalline Admixture, the temperature of the concrete mix should be above 6ºC for at least 24 hours from casting.

22.14.7 Storage / Shelf Life

Integral Crystalline Admixture must be stored dry at a minimum temperature of 7º C and its self life is one year when stored under proper conditions. The product/material should be stored under dry condition. The self life of the integral crystalline admixture shall be treated as one year when stored under normal conditions.

22.14.8 Measurement

The quantity i.e. weight of Integral Crystalline Admixture will be measured in kilogram correct to two places of decimal.

22.14.9 Rate

The rate shall include the cost of all labour and materials involved in all the operations described above.

22.15 FIBRE REINFORCED ELASTOMERIC LIQUID WATER PROOFING MEMBRANE WITH RESILIENT ACRYLIC POLYMERS

22.15.1 Material

Fibre reinforced elastomeric liquid water proofing membrane is a ready-to-use waterproofing, white product, with high solar reflectance and Sun Reflectivity Index (SRI) of 105, for external applications. This is made from resilient acrylic polymers and synthetic resins in water dispersion, and when dry forms a continuous, flexible waterproofing membrane. This is resistant to all atmospheric conditions and UV rays, and guarantees long-lasting protection for the substrate.

22.15.2 Technical Specification/ Parameters:

1. Fibre reinforced elastomeric liquid water proofing membrane with fibers in water emulsion with high reflectance and emissivity with a solar reflectance index SRI of 105 should comply with the requirements of EN 1504-9 (“Products and systems for protecting and repairing concrete structures:

definitions, requirements, quality control and conformity assessment. General principles for the use of products and systems") EN 1504-2 coating (C) principles PI, MC and IR ("Concrete surface protection systems").

2. This should posses a paste like consistency having highly reflective white colour.

3. This should have density of 1.35 with dry solid content of 61.4%.

4. This should have minimum tensile strength of 1.0N/mm^2 as per ISO 37 or ASTM D-412.

5. This should confirm to results after testing as per EN1062-11 for exposure to artificial weather conditions.

6. The Sun Reflectivity Index when tested as per ASTM E1980 should be 105 minimum.

7. Elongation at break (% age) of 150 % minimum as per ASTM D-412.

8. Adhesion strength is more than 1.0 N/mm^2 as per ASTM D-4541.

22.15.3 Applications

It is to be applied using a long-haired roller, brush or spray on any horizontal, sloping or vertical surfaces to form a string, flexible, tack-free dry surface, suitable for occasional light foot traffic. This can with stand normal expansion and contraction stresses caused by temperature variations due to its flexibility. This also helps lower the working temperature of roofs and guarantees good energy performance properties of all the layers of the roof.

22.15.4 Preparation of Surface

All the substrates, whether they are new or old, must be sound, clean, dry and free of all traces of oil, grease, old paint, rust, mould and nay other material which could compromise the bond. Application temperature may be from 7^{0}C to 40^{0}C.

Concrete and in general mineral substrates must be sound and dry with no rising damp. Any loose parts must be removed with wire brushes. All wax, water-repellent treatments, etc. must be removed from the surface of ceramic substrates with a suitable detergent and/ or by sanding. Any hollows and gaps in the surface must be repaired properly with appropriate material as described and instructed by the manufacturer of this product. The tools to be used must be properly cleaned.

22.15.5 Application Procedure

All the area of operation shall be thoroughly cleaned as described in para 22.15.3 above. Mix the content in such a manner that they are perfectly blended into a homogenous state of liquid which can be applied by long haired roller or airless spray. The fibre reinforced elastomeric liquid water proofing membrane with resilient acrylic polymers shall be applied on top of concrete roof in three coats @ 10.76 litre/10 sqm or more as recommended by manufacturer specification. One coat i.e. first coat of self priming elastomeric water proofing liquid. The material shall be diluted with water in the ratio of 3:1 (3 parts of elastomeric water proofing liquid and 1 part of water). Wait until the first coat is completely dry and becomes slightly darker in colour. After the first coat has dried completely apply second coat with undiluted elastomeric water proofing liquid in a cross direction to the previous coat. After the drying of second coat completely apply the final coat of undiluted elastomeric water proofing liquid in a direction perpendicular to previous coat. The overall dry film thickness should not be less than 500 microns or more as specified in manufacturer specification. Protect the membrane from rain unless it is completely dry. The overall consumption of the material should be as per nomenclature of the item and should also adhere to the specifications detailed in the approved schedule of the manufacturer.

22.15.6 Measurement

The length and breadth/ height shall be measured in running metre correct to two places of decimal and the area of applications should be measured in sqm correct to two places of decimal.

22.15.7 Rate

The rate shall be include the cost of all the labour and material involved in all the operations described above.

22.16 WATER PROOFING TREATMENT WITH INTEGRAL CRYSTALINE WATER PROOFING COATING / SLURRY

22.16.0 General

This Integral crystalline water proofing coating / slurry of **hydrophilic in nature** is applied to surface of the concrete to water proof and protect the concrete in-depth. It consists of Portland cement, specially treated quartz sand and a compound of active chemicals. Integral crystalline water proofing coating material needs only to be mixed with water prior to application.

When integral crystalline water proofing material is applied to a concrete surface, the active chemicals react with moisture and the by-products of cement hydration to cause a catalytic reaction that generates an insoluble, crystalline structure. These crystals fill the pores and minor shrinkage cracks in the concrete to prevent any further water ingress (even under pressure). However, integral crystalline water proofing material will still allow the passage of vapor through the structure (i.e. the concrete will be able to "breathe"). Even after the concrete has cured, integral crystalline water proofing material remains dormant in the concrete and will reactivate in the presence of moisture to seal capillary tracts and hairline cracks.

In addition to water proofing the structure, integral crystalline water proofing slurry protects concrete against seawater, wastewater, aggressive groundwater and many other aggressive chemical solutions. Integral crystalline water proofing material is approved for use in contact with potable water and is therefore suitable for use in water storage tanks, reservoirs, water treatment plants, etc.

22.16.1 Material:

This Integral crystalline water proofing material consists of Portland cement, specially treated quartz sand and a compound of active chemicals.

The water proofing compound used in integral crystalline water proofing treatment shall satisfy all the requirements indicated in relevant standards or as specified in concerned relevant codes etc. and the same shall be got tested and get approved from the Engineer-in-charge before its use.

Technical Specification/ Parameters:

The integral crystalline slurry / coating material of **hydrophilic in natural** shall confirm to the following requirements:

1. Dosage as specified in the nomenclature of item or higher as recommended by manufacturer's specification. The material shall fulfill the requirements of American Concrete Institute Guidelines ACI-212- 3R-10 Chapter 15 or European norms EN 934-2-T2 and fall under PRAH (Permeability reducing Admixtures for HYDROSTATIC conditions) and shall be capable of withstanding/resistant to 16 bar hydrostatic pressure and reduce Coefficient of Permeability of concrete by more than 90, when compared to controlled concrete and tested as per DIN 1048 Part 5 or EN 12390-8 by carrying out 4 cycles each of 5 bar hydrostatic pressure for 72 hours and drying for 48 hours between the cycles. The co-efficient of Permeability calculated as per Darcy's Formula/ Valenta equation by incorporating penetration values obtained at the end of fourth cycle pressure.

2. It shall confirm to EN1504-3 (For structural repairs-R3, Compressive Strength >25MPa) supplied from an approved manufacturing unit having CE approval confirming to EN1504-3R3.

3. The product has no corrosion effect on reinforcement steel according to test norm DINV18998. The maximum chloride content less than 0.1%.

4. The Integral Crystalline Slurry must be capable of self-healing of cracks up to a width of 0.5mm.

5. The crystalline water proofing coating/slurry, when used in the concrete, will have no detrimental side effects in terms of Alkali Silica Reaction (ASR), corrosion of Steel Reinforcement etc.

6. The product performance shall not be affected by wear abrasion of the treated concrete surface and crystalline treated concrete shall not require protection layer.

7. The crystalline water proofing coating/slurry shall be non toxic and suitable for use in potable water facilities- NSF listed as per ANSI 61 listing or DVGW-W347, Germany or equivalent and a declaration of performance certificate supervised by a reputed European/US third party.

8. The manufacturer shall submit guarantee in respect of crystalline water proofing coating/slurry performance for 10 years against any leakage.

Note: The manufacturer shall submit test certificates in respect of all above said specifications/ parameters of Integral Crystalline water proofing slurry material from reputed National/International laboratories as per relevant codes.

Total quantity of the Integral Crystalline water proofing slurry material required shall be arranged at site of work only after obtaining the prior approval of the Engineer-in-Charge in writing. The proper account of water proofing compound used in the work shall be maintained. It shall be ensured that the consumption of the compound is as per specified requirements. The Contractor shall associate himself with anyone of the applicator of water proofing compound duly approved by the Engineer-in-Charge before start of work relating to the water proofing treatment.

22.16.2 Recommended uses

Foundations/Rafts	Reservoirs, Bridges and Dams
Sewage and Water Treatment Plants	Secondary Containment Structures
Tunnels and Subway Systems	Underground Vaults
Parking Structures	Swimming Pools and water tanks
Pre-Cast, Cast-in-situ and Shotcrete applications	Basement Retaining Walls

22.16.3 Preparation of surface

All concrete to be treated with integral crystalline water proofing slurry material must be clean and have an “open” capillary surface. Remove laitance, dirt, grease, etc. by means of high pressure water jetting, wet sand blasting or wire brushing. Faulty concrete in the form of cracks, honeycombing, etc. must be chased out, treated with the same material and filled flush with the mortar mixture as specified by the manufacturer. Surface must be carefully pre-watered prior to the application of integral crystalline water proofing material. The concrete surface must be damp but with no wet sheen on the surface.

22.16.4 Mixing

Integral crystalline water proofing slurry / coating material should be mechanically mixed with clean water to a creamy consistency resembling to thick oil. Only that much material should be mix as can be used within 20 minutes and mixture should be stirred frequently. The mixture should not be allowed to set, it if happens, simply re-stir to restore workability but no more water should be added to it. The ratio of integral crystalline water proofing material with water should be as below

(i) **Vertical surface**: - For applying with brush the mixing ratio shall be 5 parts of integral crystalline water proofing coating material to 2 parts of water.

(ii) **Horizontal surface**: - The ratio should be 3 parts of Integral Crystalline water proofing coating material to 1 part of water. This should be applied by brush only.

22.16.5 Application Procedure

The slurry mix of the Integral Crystalline water proofing slurry material shall be applied in one or two coats as specified/ required according to work situation in the item. After preparation of surface as described in para 22.16.3, and making the surface saturated with water before application of Crystalline Slurry, then first coat of the slurry mix shall be applied by the brush or appropriate power spray equipment. The second coat as specified shall be applied while the first coat is still green.

The other method of application known as dry powder consistency can also be applied on horizontal surfaces only. The specified amount of integral crystalline water proofing material is distributed in powder form through a sieve or a semi mechanical barrow spreader and troweled into the freshly placed concrete as this reaches the initial set.

The integral crystalline water proofing material to be used shall be as following:-

(i) **Vertical surface**: - Two coats of integral crystalline water proofing material slurry coat shall be applied @ of 0.70 kg per sqm. per coat or more as specified by the manufacturer specification.

(ii) **Horizontal surface**: - One coat of integral crystalline water proofing material slurry coat shall be applied @ of 1.10 kg per sqm or more as specified by the manufacturer specification to harden concrete. Alternatively integral crystalline water proofing material mix can be dry sprinkled @ of 1.10 kg per sqm and trowel applied to fresh concrete when it has reached initial set.

(iii) **Construction joint**: - Integral crystalline water proofing material mix shall be applied either as slurry coat or dry powder consistency immediately prior to placing the next lift/ bay of concrete @ 1.60 kg per sqm. or more as specified by the manufacturer specification.

(iv) **Binding concrete**: - Integral crystalline water proofing material mix shall be applied either as slurry coat or dry powder consistency immediately prior to placing the overlying concrete slab.

22.16.6 Curing

The treated surfaces should be kept damp for a period of five days and must be protected against direct sun, wind and frost, by covering with polyethylene sheeting, damp burlap or similar material.

22.16.7 Precaution / Special Consideration

Do not apply Integral Crystalline Slurry at temperatures at or below freezing or to frozen or freezing surfaces. Integral Crystalline slurry cannot be used as an additive to concrete or plasters. (Integral Crystalline Admixture should be considered for these applications).

22.16.8 Storage / Shelf Life

When properly stored in a dry place in unopened and undamaged original packaging its self life is one year.

22.16.9 Measurement

The Length & breadth/height of the coated area by Integral Crystalline slurry shall be measured in metre correct to two places of decimal. Measurement shall be made in sqm of the area.

22.16.10 Rate

The rate shall include the cost of all the labour, material and equipments involved in all the operations described above.

22.17 POLYMER MODIFIED FLEXIBLE CEMENTATIOUS NEGATIVE SIDE WATERPROOFING COATING WITH ELASTIC WATERPROOFING POLYMERS

22.17.1 Material

Flexible cementatious negative side waterproofing coating with elastic waterproofing polymers is a one-component, concentrated liquid admixture used to enhance the performance of cementations repair mortars, plasters, stuccos, concrete mixes and toppings for restoration of horizontal, vertical and overhead concrete; concrete masonry units (CMU); and masonry surfaces.

22.17.2 Technical Specification/ Parameters:

1. Flexible cementations negative side waterproofing coating with elastic waterproofing polymer should have PH value of 7 and consist of liquid state.

2. This should have the density of 1.02 gm per ml.

3. This should posses the property of application in undiluted as well as diluted form.

4. This should be non-reemulsifiable.

22.17.3 Applications

It is to be applied using a long-haired roller, brush or spray on any horizontal, sloping or vertical surfaces to form a string, flexible, tack-free dry surface. This is easy to use and control in construction works for water proofing of the surface and optimizes bond to concrete substrates. It also improves resistance to abrasion and freeze/ thaw cycles.

22.17.4 Preparation of Surface

All substrates must be structurally sound, stable and solid, with all loose material removed. Thoroughly clean the surface of any substance that could interfere with the bond of the installation material, including dirt, paint, tar, asphalt, wax, oil, grease, latex compounds, from release agents, laitance, foreign substances pre existing paint film & loose particles till plaster is visible and any other residues. Concrete surfaces must be mechanically profiled and prepared by shotblasting, sandblasting, diamond-grinding, water-jetting, scarifying or other engineer-approved methods to obtain an acceptable profile. Concrete substrate and ambient room temperatures must be maintained between 45°F and 95°F (7°C and 35°C) before application. Temperatures must be maintained within this range for at least of 72 hours after the application coating. Application temperature varies from 7^0C to 40^0C.

22.17.5 Application Procedure

Apply the coating on to this sound and dry surface using a long-haired roller, brush or spray. The dilution of the compound the water should be done in a clean mixing pail. The polymer modified flexible cementatious negative side water proofing coating with elastic water proofing polymers shall be applied on interior wall plaster surface in three coats @ 14.35 kg/10 sqm or more as recommended by manufacturer specification. The ratio of mixing with water is to be done in accordance with the nomenclature of the item along with corresponding coats and manufacturer specifications. One coat i.e. first coat of self priming cementatious water proofing polymers shall be applied on to the properly prepared and dried surface (diluted with water in the ratio of 1:1). Another coat shall be applied when the coat below is still wet. Two coats of cementatious water proofing polymers (diluted with water in the ration of 3:1) over the first coat applied. All the coats shall be applied in perpendicular direction to each other. The final surface is to be protective from excessive heat or draft conditions during the first 24 to 72 hours. Final surface should be cured for at least 5 to 7 days. Use of damp burlap, polyethylene sheeting or water-based curing compound is also recommended to be used for curing.

22.17.6 Measurement

The length and breadth/ height shall be measured in running metre correct to two places of decimal and the area of applications shall be measured in sqm correct to two places of decimal.

22.17.7 Rate

The rate shall be include the cost of all the labour and material involved in all the operations described above.

22.18 WATER PROOFING TREATMENT WITH INTEGRAL CRYSTALINE WATER PROOFING DRY-SHAKE

22.18.0 General

Crystalline water proofing dry-shake of **hydrophilic in nature** is a unique Integral Crystalline chemical treatment for the waterproofing and protection of concrete. Crystalline water proofing dry-shake has been formulated for dry-shake applications on horizontal concrete surfaces where greater impact and abrasion resistance is required.

22.18.1 Material

Integral Crystalline water proofing dry-shake (dry powder) compound consists of Portland cement, various active proprietary chemicals, and a synthetic aggregate hardener that has been crushed and graded to particle sizes suitable for concrete floors.

Crystalline water proofing dry-shake becomes an integral part of the concrete surface, thereby eliminating problems normally associated with coatings (e.g. scaling, dusting, flaking and delaminating). The active chemicals react with the moisture in the fresh concrete causing a catalytic reaction that generates a non-soluble crystalline formation within the pores and capillary tracts of the concrete.

Technical Specification/ Parameters:

The Integral Crystalline dry shake material of hydrophilic in nature shall confirm to the following requirements:

1. Dosage as specified in the nomenclature of item or higher as recommended by manufacturer's specification. The material shall fulfill the requirements of American Concrete Institute Guidelines ACI-212- 3R-10 Chapter 15 or European norms EN 934-2-T2 and fall under PRAH (Permeability reducing Admixtures for HYDROSTATIC conditions) and shall be capable of withstanding/resistant to 16 bar hydrostatic pressure and reduce Coefficient of Permeability of concrete by more than 90, when compared to controlled concrete and tested as per DIN 1048 Part 5 or EN 12390-8 by carrying out 4 cycles each of 5 bar hydrostatic pressure for 72 hours and drying for 48 hours between the cycles. The co-efficient of Permeability calculated as per Darcy's Formula/Valenta equation by incorporating penetration values obtained at the end of fourth cycle pressure.

2. It shall confirm to EN1504-3 (For structural repairs-R3, Compressive Strength > 25 MPa) supplied from an approved manufacturing unit having CE approval confirming to EN 1504-3R3.

3. The product has no corrosion effect on reinforcement steel according to test norm DINV18998. The maximum chloride content less than 0.1%.

4. The Integral Crystalline dry shake shall be capable of self-healing of cracks up to a width of 0.5mm.

5. The integral crystalline dry shake, when used in the concrete, will have no detrimental side effects in terms of Alkali Silica Reaction (ASR), corrosion of Steel Reinforcement etc.

6. The integral crystalline dry shake performance shall not be affected by wear abrasion of the treated concrete surface and crystalline treated concrete shall not require protection layer.

7. The crystalline water proofing coating/slurry shall be non toxic and suitable for use in potable water facilities- NSF listed as per ANSI 61 listing or DVGW-W347, Germany or equivalent and a declaration of performance certificate supervised by a reputed European/US third party.

8. The manufacturer shall submit guarantee in respect of crystalline water proofing dry shake performance for 10 years against any leakage.

Note: The manufacturer shall submit test certificates in respect of all above specification/parameter as stated above of Integral Crystalline water proofing dry shake material from reputed National/International laboratories as per relevant codes.

Total quantity of the Integral Crystalline water proofing dry shake material required shall be arranged at site of work only after obtaining the prior approval of the Engineer-in-Charge in writing. The proper account of water proofing compound used in the work shall be maintained. It shall be ensured that the consumption of the compound is as per specified requirements. Contractor shall associate himself with anyone of the applicator of water proofing compound duly approved by the Engineer-in-Charge before start of work relating to the water proofing treatment.

22.18.2 Application Rate (Dose)

Crystalline water proofing dry-shake material to be used under normal conditions should cover the application surface sprinkled @ 0.60 kg per sqm or higher as recommended by the manufacturer specification over the lean concrete of structure depending upon the degree of abrasion resistance required.

If the surface is to be used under heavy traffic conditions or where greater abrasion resistance is required, the manufacturers recommendation should be taken into account while applying crystalline water proofing dry-shake on the concrete surface.

22.18.3 Application Procedure

(i) After fresh concrete is placed. Consolidated and levelled, wait until concrete can be walked on leaving an indentation of 6-8mm.

(ii) Concrete should be free of bleed water and be able to support the weight of a power trowel. Float open the surface.

(iii) Immediately after floating open the surface and within one hour of finishing the concrete, apply one-half of the Integral Crystalline water proofing dry-shake material by hand or mechanical spreader, in one direction only. The Integral Crystalline water proofing dry-shake material must be spread evenly.

(iv) As soon as the Integral Crystalline water proofing dry-shake material has absorbed moisture from the base slab, it should be power floated to the surface.

(v) Immediately after power floating, apply remaining Integral Crystalline water proofing dry-shake material at right angles to the first application.

(vi) Allow remaining Integral Crystalline water proofing dry-shake material to absorb moisture from the base slab and then power float the material into the surface. When concrete has hardened sufficiently, power trowel surface to the required finish.

22.18.4 Curing

Curing is important and shall begin as soon as final set has occurred but before surface starts to dry. Conventional moist curing procedures such as water spray, wet burlap or plastic covers may be used. Curing should continue for at least 48 hours. In hot dry sunny or windy conditions, it is advisable to use an evaporation retardant on the fresh concrete surface to prevent premature drying of the slab conditions due consultations should be made from the technical representatives of the manufacturer for specific instructions. In lieu or moist curing, concrete sealers and curing compounds may be used. In all cases, recommended guidelines for proper curing should be followed.

22.18.5 Recommended uses

Basement Rafts	Foundation slab
Water tank base slab	Sewage and Water Treatment Plants slab
Below Grade Structures	Warehouses Floors
Traffic Bearing Surfaces	Parking Structures

22.18.6 Precaution / Special Consideration

For the best results when applying Integral Crystalline dry shake materials, the air content of the concrete shall not exceed 3% (a high air content can make it difficult to achieve a proper application).

In hot, dry, or windy conditions, it is advisable to use an evaporation retardant on the fresh concrete surface to prevent premature drying of the slab.

22.18.7 Storage / Shelf Life

Integral Crystalline dry shake must be stored dry at a minimum temperature of 7º C and its self life is one year when stored under proper conditions.

22.18.8 Measurement

The quantity of Integral Crystalline dry shake sprinkled area shall be calculated in sqm. The Length & breadth/height of the Integral Crystalline dry shake sprinkled area shall be measured in metre correct to two places of decimal.

22.18.9 Rate

The rate shall include the cost of all the labour, material and equipments involved in all the operations described above.

22.19 CRYSTALINE WATER PROOFING MORTAR

22.19.1 Material

Crystalline water proofing mortar consists of Portland cement, specially treated quartz sand and a compound of active chemicals.

The active chemicals react with moisture and the by-products of cement hydration to cause a catalytic reaction, which generates an insoluble integral crystalline complex. These crystalline complexes grow in the presence of water and block the capillaries of the concrete and minor shrinkage cracks, thus water proofing the concrete. Chemicals activation begins when the power is mixed with water and may take several days to completely block the capillaries, depending on ambient temperature and environmental conditions. It can be applied to the positive or negative water pressure sides of a structure.

22.19.2 Technical Specification/ Parameters:

1. The crystalline water proofing mortar shall confirm to EN1504-3 having Compressive Strength Class R4 $\geq$ 45 MPa and adhesive bond strength Class R3 $\geq$ 1.5 MPa supplied from an approved manufacturing unit having CE approval confirming to EN 1504-3R3.

2. It has no corrosion effect on reinforcement steel according to test norm DIN V 18998. The maximum chloride content less than 0.1%.

3. The crystalline water proofing mortar, when used in the concrete, will have no detrimental side effects in terms of Alkali Silica Reaction (ASR), corrosion of Steel Reinforcement etc.

4. The crystalline water proofing mortar performance shall not be affected by wear abrasion of the treated concrete surface and crystalline treated concrete shall not require protection layer.

5. The crystalline water proofing mortar shall be non toxic and suitable for use in potable water facilities- NSF listed as per ANSI 61 listing or DVGW-W347, Germany or equivalent and a declaration of performance certificate supervised by a reputed European/US third party.

6. The manufacturer shall submit guarantee in respect of crystalline water proofing mortar performance for 10 years against any leakage.

   Note: The manufacturer shall submit test certificates in respect of all above said specification/parameters of Crystalline mortar from reputed National/International laboratories as per relevant codes.

Total quantity of the water proofing Crystalline Mortar material required shall be arranged at site of work only after obtaining the prior approval of the Engineer-in-Charge in writing. The proper account of water proofing compound used in the work shall be maintained. It shall be ensured that the consumption of the compound is as per specified requirements. Contractor shall associate himself with anyone of the specialist firms mentioned in approved list of applicator of water proofing compound only approved by Engineer-in-Charge before start of work.

22.19.3 Recommended Uses

RCC underground structure like basement, water tanks, bridge deck etc.

This material can be applied in conjunction with crystalline water proofing coating for :

(i) Installation of seal strips, reglets and coves at joints to assure water tightness

(ii) Patching and filling / sealing of routed out cracks.

(iii) Patching of tie holes and faulty construction joints.

(iv) Repairing of spalled and honeycombed area.

22.19.4 Preparation of Surface

All surfaces to be patched, repaired or sealed with crystalline water proofing mortar must be clean and sound. **Crack** should be routed out to a U-shaped groove, size 25 mm wide and 25 mm deep. **Tie holes** should be roughened prior to filling. **Spalled and honeycombed area** must be thoroughly cleaned and chiseled back to sound concrete prior to repair. Remove all dirt, cement laitance, form release agents, curing compounds, paints, coating, etc. by means of wet or dry sand blasting, high pressure water jet or other approved mechanical means. Surfaces must be well moistened to a dull dampness at the time of application. The concrete should be damp with no wet sheen on the surface.

22.19.5 Mixing

(i) **For routed cracks, coves and non-moving joints:** Add water to crystalline water proofing mortar powder until a medium stiff, trowelable consistency reached. The texture of the mix should be pliable enough to be trowelled into the cracks with some pressure, but not so pliable that it would run out or sag out of the crack.
Approximate mixing ratio (by volume) is 4.5 parts crystalline water proofing mortar powder to 1 part water. Alternatively, 450gm of crystalline water proofing mortar powder to 100 ml of water is to be mixed or as specified by the manufacturer specification.

(ii) **Tie holes and pointing applications:** Add only a small amount of water. Mixed consistency should be that of “dry earth,” holding a shape when squeezed in your hand but easily crumbled when pressed between fingers. Mix only as much material as can be used within 20 minutes.

22.19.6 Application Procedure

(i) **For sealing cracks and faulty construction joints**, routed out/making U-shape groove size 25x25mm and then priming the surface with integral crystalline slurry @0.05 kg per running meter and while the surface is tacky filled the groove upto surface crystalline mortar @1.50 kg per running meter. Once crystalline mortar is touch dry then finally applying two coats of integral crystalline slurry @0.05 kg per running meter per coat.

(ii) **For repairing spalled & honeycombed areas**, prepared the surface and chiesel back upto sound concrete and then primed the area with integral crystalline slurry @0.70 kg per sqm. and while the surface is tacky repair and level the honeycomb area with crystalline mortar @ 22.70 kg per sqm. for an average thickness of 10mm. Once crystalline mortar is touch dry then finally two coats of integral crystalline slurry @ 0.70kg per sqm. per coat.

(iii) **For patching of tie rod holes**, prepared tie rod hole surface and primed the area with integral crystalline slurry @ 0.07 kg per sqm and while the surface is tacky repair and filled the tie rod holes with crystalline mortar @ 0.040 kg per hole. The crystalline mortar shall be tightly rodded into tie rod holes or packed tightly. For 25x25x25 mm hole, use 0.040 kg per hole to fill the tie rod hole.

22.19.7 Curing

Provide protection against extreme weather conditions, such as heavy rain or freezing conditions, during the setting period. Curing is not normally required except during hot, low humidity weather. In these conditions, a light mist of water approximately 25 hours after the repair is completed will help to ensure a controlled cure. In extreme dry heat, water misting may be carried out at required intervals more frequently.

22.19.8 Precaution / Special Consideration

Crystalline mortar shall not applied at temperatures below 40ºF (4ºC), to a frozen substrate or if temperatures will drop below freezing during the curing period (approximately 24 hours). This product is not recommended for use in expansion or construction joints. Crystalline mortar can be applied in (13 mm) layers not exceeding 2.5 inch (approximately 6.5 cm) to prevent shrinkage cracks in the mortar.

22.19.9 Storage / Shelf Life

Crystalline mortar shall be stored in a dry enclosed area off the ground at a minimum temperature of 7ºC. Self life when stored in proper conditions in unopened, undamaged packaging is one year.

22.19.10 Measurement

Faulty construction joint will be measured by measuring the length in running meter correct to two places of decimal.

Repair of honeycombed area will be measured in square meter correct to two places of decimal by measuring the length and width of treated area correct to two places of decimal.

For repair of tie rod holes, the measurement shall be done for each number of hole.

22.19.11 Rate

The rate includes the cost of all the labour and material involved in all the operations described above.

22.20 SWELLABLE TYPE WATER STOP TAPE

22.20.0 General

Swellable type water stop tape of size 19 mm x 25 mm thick in linear metre (expansive nature) is a unique sealing compound designed to expand rapidly when exposed to moisture, making it a self-healing joint material for construction joint applications / treatment .

22.20.1 Material

This is a swellable type sealing compound which expand rapidly after coming in to contact or exposed to moisture. This acts as a self healing material and is used for applications in construction joints.

22.20.2 Physical Properties

(i) Specific gravity (ASTM D71): 1.35 ± 0.05 (ASTM D-71)

(ii) Volatile matter: 1% maximum (ASTM D-6)

(iii) Penetration, 150g cone at 25°C, 5sec : 40 ± 5mm (ASTM D-217)

(iv) Rate of Rapid Expansion:

(a) Fresh Water Exposure: 24 Hours-140%, 48 Hours- 175%, 72 Hours-190% & 120 Hours-210%.

(b) Salt Water Exposure: 24 Hours-7%, 48 Hours-12%, 72 Hours-14%, 120 Hours-18%

The water stop material should meet the requirements to EU REACH Regulation (EC) No 1907/2006.

22.20.3 Physical Properties of Swellable Water stop Primer

(i) % Solid : Min 20%

(ii) Flash Point: 93 deg C

(iii) Dry Time : 25 deg C:10 min

(iv) Dry Time : 4 deg C : 60 min

22.20.4 Recommended Uses

Typical applications for swellable type water stop tape include building foundations, raft slabs, retaining walls, water storage tanks, at the junction of raft slab with the retaining walls and similar non-moving cold construction joints etc.

22.20.5 Application

(i) The entire surface length where the water stop is to be applied is cleaned thoroughly by using blower and brush. Apply one coat of required primer throughout the length of the joint @ 3.78 litre per 240 running metre. Allow the primer to dry for 10 to 15 minutes at the temperature of 25°C. This should be allowed to dry for some longer time in the areas where the temperature are low.

(ii) By using the heel of the hand and moderate pressure, press the self expanding joint material firmly into the position on the structure on the entire area which has been primed and dried. Make sure that the product has bonded with the primed area.

(iii) Where required, splice ends to from a continuous, uninterrupted seal. For best results, cut each end at opposite 45deg. angles and tightly butt ends together. DO NOR OVERLAP ENDS. Gently knead the spliced ends creating an uninterrupted seal.

(iv) Peel the protective covering from the exposed side of the installed expandable joints sealing compound.

(v) Pour the matting structural member in position.

Notes:

The manufacturer shall submit guarantee in respect of swellable type water stop tape performance for 10 years against any leakage.

Always use swellable type water stop primer to avoid displacement of the swellable type water stop tape during concrete pouring. It may be necessary to utilize masonry nails or other mechanical means to hold the sealant in place on vertical surfaces.

Place swellable type water stop tape so that it is not closer than 5 cm away from the outer surface of poured structure. If a Key way is utilized, place the swellable type water stop tape into the bottom of the formed Keyway area.

22.20.5 Precaution / Special Consideration

Always use swellable type water stop primer to ensure tight adhesion and to aid in preventing swellable type water stop tape from moving during the concrete pour. For vertical surfaces, nails may be used to hold the product in place in conjunction with swellable type water stop primer. Swellable type water stop tape shall be used at a minimum depth of 50 mm inside the concrete. When used on pipes and other structural penetrations, swellable type water stop tape shall be cut to measured length and placed around the penetration with ends butted. In all cases, swellable type water stop tape shall be in direct contact with the substrate along the entire length of the installation. Swellable type water stop tape is not an expansion joint sealant and only suitable for non-moving concrete joints. Swellable type water stop tape should not be installed in standing water or on frozen or icy surfaces

22.20.6 Storage / Shelf Life

When stored in a dry enclosed area off the ground at a minimum temperature of 45°F (7°C) in unopened, undamaged cartons, its self life is unlimited.

22.20.7 Measurement

The measurement shall be taken by measuring the length of swellable type water stop tape in meter correct to two paces of decimal.

22.20.6 Rate

The rate shall include the cost of all labour and materials involved in all the operations described above.

APPENDIX A

BITUMEN FELTS (FIBRE HESSIAN BASE)
(Clause 22.8.1.1)

A-1 Weights

The weights of the ingredients used in the manufacture of bitumen felts per 10 sqm shall be not less than those specified in Table A-I

TABLE A-I
Minimum Weights of Bitumen Felts

S. No.	Type of felt	For 10 sqm				
		Untreated Base	Saturant	Coatant	Bitumen content	Total weight of the finished bitumen felt in dry condition with mica dusting powder Min.
		Kg	Kg	Kg	Kg	Kg
	Fibre Base					
(i)	Type 2 grade 1 Hessian Base	5.0	4.5	12.9	12	22.6
(ii)	Type 3 Grade 1	2.3	1.8	17.7	12.1	23
(iii)	Type 3 Grade 2	2.3	1.8	31.8	20.2	37.1

Notes:

1. The weight of the untreated base shall be taken as in the dry condition.
2. Includes allowance for 1.2 kg minimum mica dusting powder in dry condition.

A-2 Testing

A-2.1 Frequency of test shall be decided by the Engineer -in-charge depending on quantum of work. From each of the rolls one piece 3 m long and the full width of the felt shall be cut out for preparing test specimens. The first 2M. of the roll shall not be selected for this purpose. The lengths of felt so selected shall be free from abnormal defects and shall be truly representative of the whole consignment. The selected pieces of felt shall be dispatched without breakage or distortion, wrapped up in water proof paper or other similar materials so as to cause no damage to the material during transit. In case the material has stuck together, no heat shall be applied to separate the layer but the whole roll shall be sent for testing and the fact shall be reported.

The samples, when tested as per IS1322 shall conform to the requirements given in Table A-II.

TABLE A-II

Sl. No	Type of Felt	Breaking strength kg	Pliability Test	Storage sticking tests	Heat Resistance Test	Pressure head test	Water absorption test Max.
1	Type 2 (all grades)	95 / 60	(i) The roll shall not show cracks on unrolling (ii) Consider any surface rupture exceeding 5 mm in length as failure	The test pieces shall be examined after cooling After release of the load, the layers of felt shall be capable of being separated without damaging the coatant in any way	The test pieces shall show no sign of melting of the bitumen compound -	The test pieces shall show no sign of leakage -	5.0% -
2	Type 3 (all grades)	135/90	(i) The roll shall not show cracks on unrolling (ii) Consider any surface rupture exceeding 5 mm in length as failure	The test pieces shall be examined after cooling After release of the load, the layer of felt shall be capable of being separated without damaging the coatant in any way	The test pieces shall show no sign of melting of the bitumen compound -	The test pieces shall show no sign of leakage -	2.0% -

APPENDIX B

GLASS FIBRE BASE BITUMEN FELT
(Clause 22.8.1.1)

B-1 Weight

The weight of the ingredients used in the manufacture of glass fibre felts for 10 square metre shall be not less than those specified in Table B-I.

TABLE B-I
Minimum Weight of Bitumen Glass Fibre Base Felt

For 10 Square Metre

S. No.	Type of Felt	Untreated Base	Treated Base	Coatant	Total weight in dry condition including surfacing materials
		(kg)	(kg)	(kg)	(kg)
1	Type 2 Gr. I	--	0.4	15.3	18.0

B-2 Tests

The sample, when tested as per IS 7193 shall conform to the requirements given in Table B-II

TABLE B-II
Requirements of Glass Fibre Felts

S. No.	Properties	Requirements
(i)	Breaking strength, Min kg	(a) Warp 50 (b) Weft 30
(ii)	Pliability test	(a) Roll shall not show cracks on unrolling (b) Consider any surface rupture exceeding 5 mm in length as failure.
(iii)	Storage sticking	The test pieces shall be examined after cooling. After release of load, the layers of felt be capable of being separated without damaging.
(iv)	Pressure head	The test pieces shall show no sign of leakage.
(v)	Heat resistance	The test pieces shall show no sign of melting of bitumen compound.
(vi)	Water absorption	2 per cent

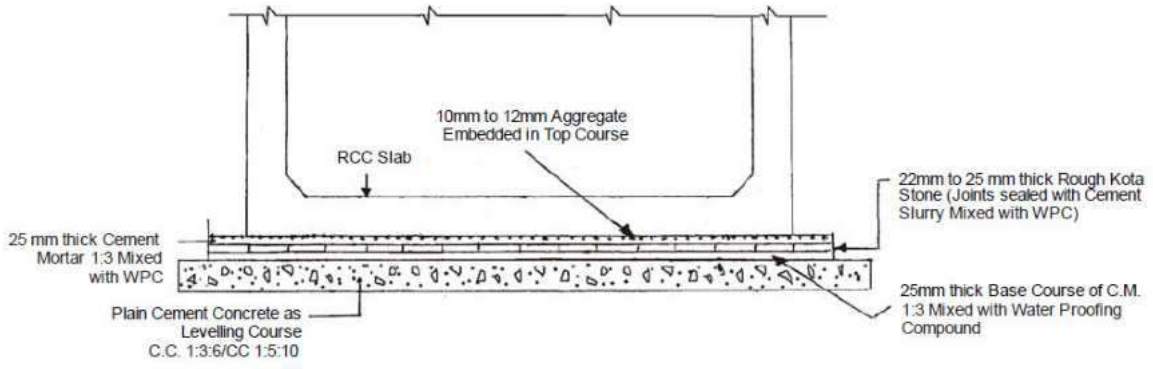


Fig. 22.1 : Waterproofing of Horizontal Surface of U.G. Structure

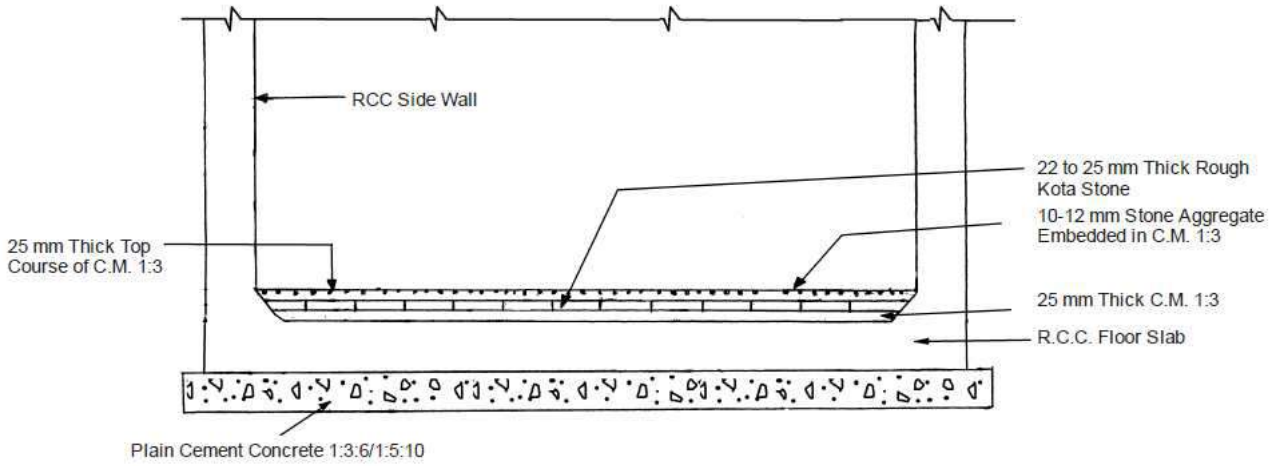


Fig. 22.2 : Water Proofing Horizontal Surfaces from Inside of a U.G. Structure

Sub Head : Water Proofing Treatment
Clause : 22.2

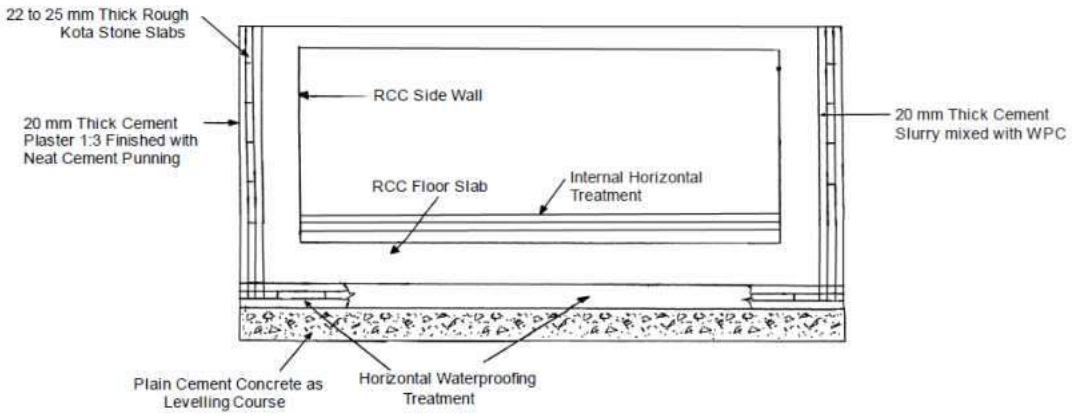


Fig. 22.3 : Waterproofing on Vertical Surfaces of Under Ground Structures

Sub Head : Water Proofing Treatment
Clause : 22.3

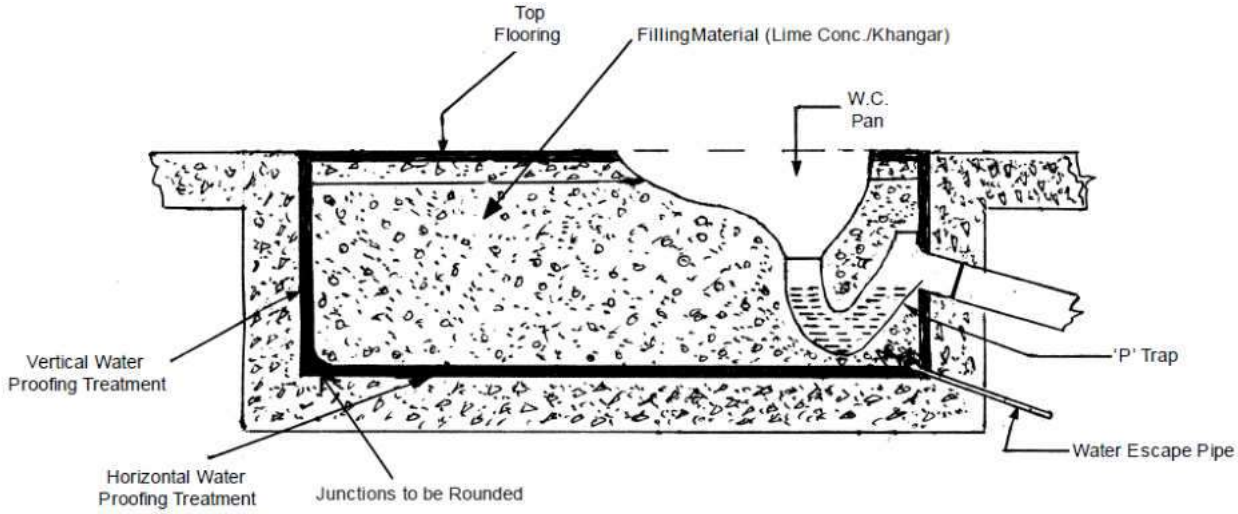
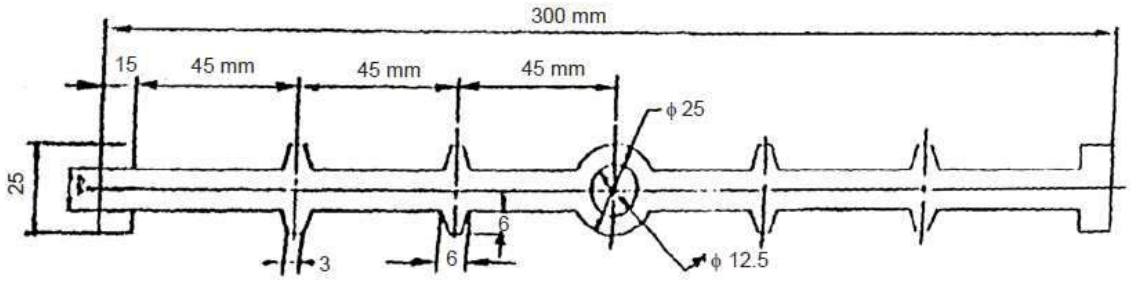


Fig. 22.4 : Position of Horizontal and Vertical Waterproofing Treatment in Sunken Portion of W.C./Kitchen and the like

Sub Head : Water Proofing Treatment
Clause : 22.4



All dimensions in millimeters

Fig. 22.5 : Typical Cross-Section of PVC Water-Stop

Sub Head : Water Proofing Treatment
Clause : 22.7

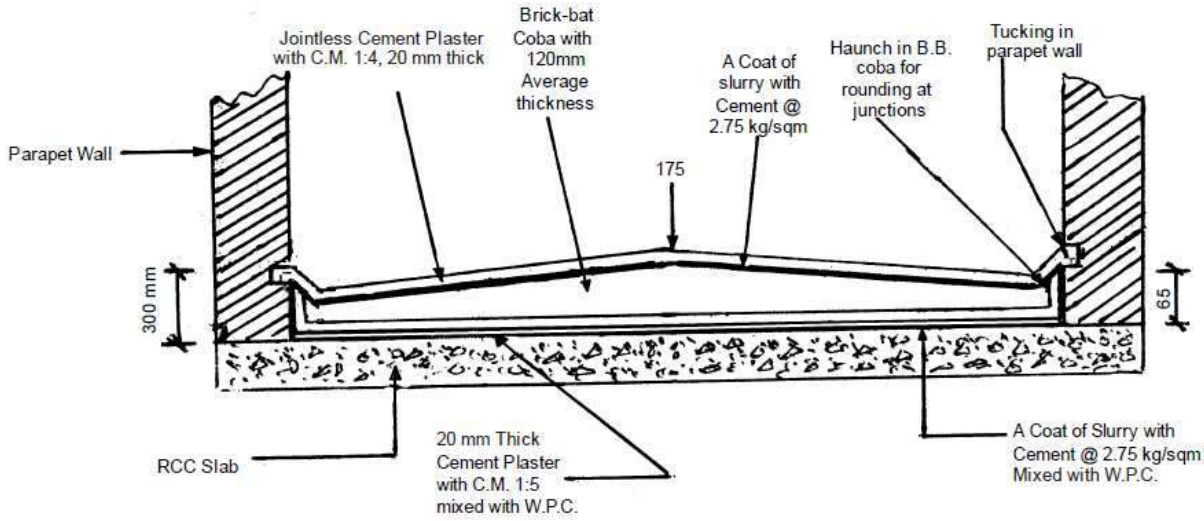
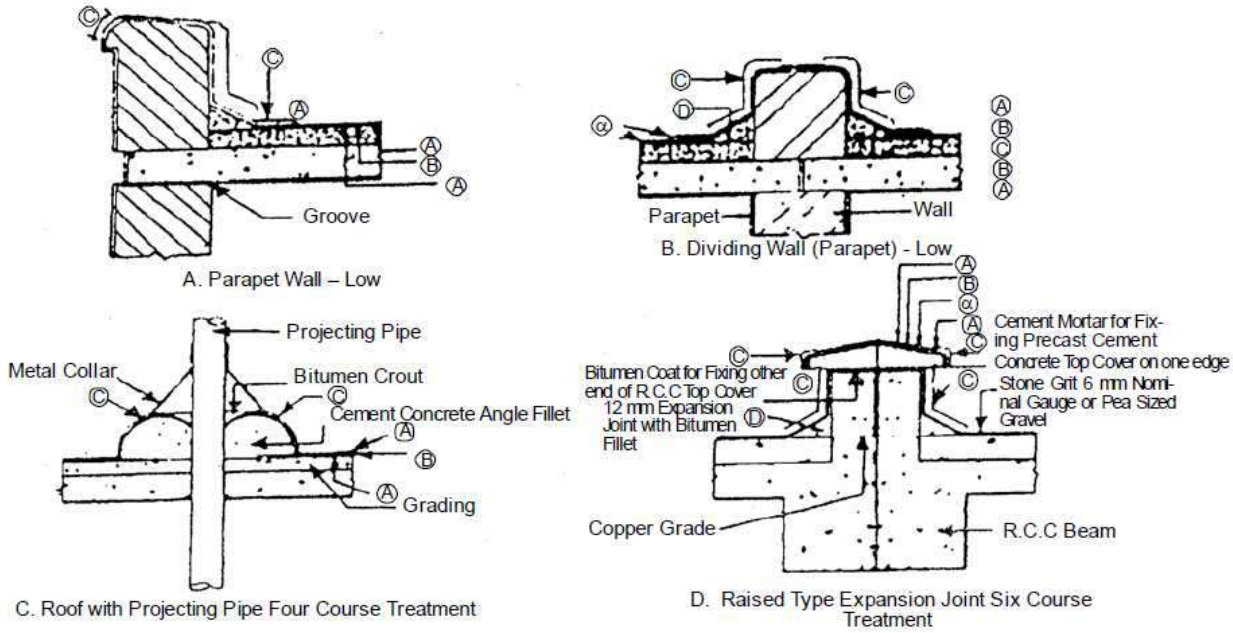


Fig. 22.6 : Integral Cement based Waterproofing Treatment with Brick-bat Coba Over a RCC Slab

Sub Head : Water Proofing Treatment
Clause : 22.8



Diagrams Not to Scale
All dimensions are in mm

Fig. 22.7 : Water Proofing

Sub Head : Water Proofing Treatment
Clause : 22.9

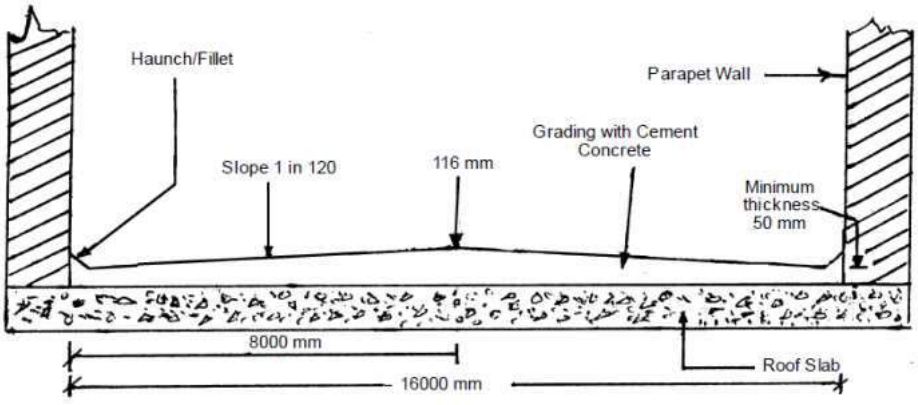


Fig. 22.8 : Grading Roof Slab with Cement Concrete

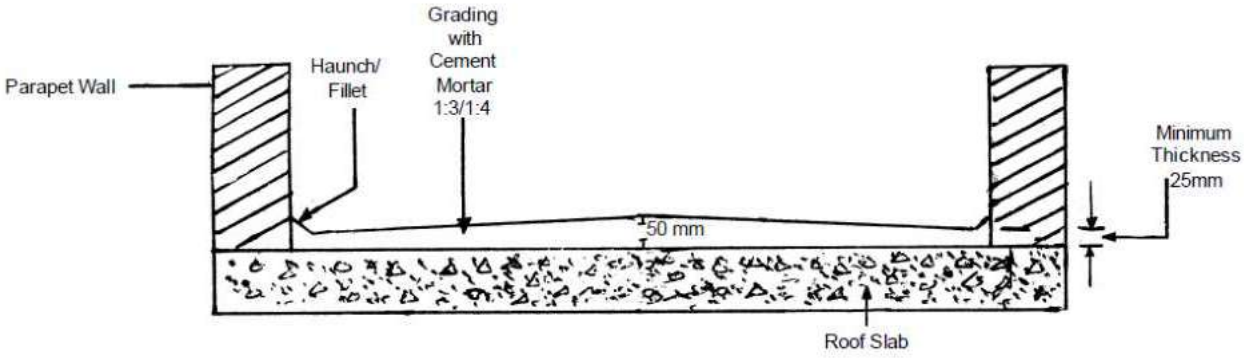


Fig. 22.9 : Grading Roof Slab with Cement Mortar 1:3/1:4

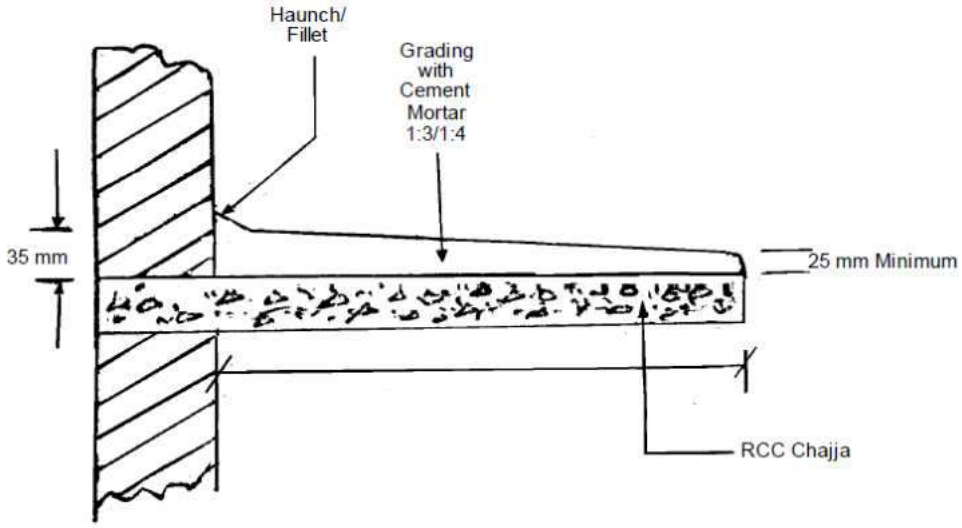


Fig. 22.10 : Grading Chajja with Cement Mortar 1:3/1:4

SUB HEAD : 23.0

RAIN WATER HARVESTING & TUBEWELLS

SUB HEAD : 26.0

NEW TECHNOLOGIES & MATERIALS

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LIST OF BUREAU OF INDIAN STANDARD CODES

S. No.	*BIS. No.*	*Subject*
1	IS 277-1992	Galvanized Steel Sheets (Plain And Corrugated)-Specification
2	IS 737	Wrought aluminium and aluminium alloy sheet and strip for general engineering purposes-Specification
3	IS : 801-1975	Code of Practice for Use of Cold Formed Light Gauge Steel Structural Members In General Building Construction
4	IS : 875-1987	Design Loads
5	IS 1254	Corrugated aluminium sheet
6	IS 1343	Prestressed Concrete - Code Of Practice
7	IS 2095:2011	Gypsum Plaster Boards - Specification
8	IS 2676	Dimension for wrought aluminium and aluminium alloy sheet and strip
9	IS 4671: 1984	Specification For Expanded Polystyrene For Thermal Insulation Purposes
10	ISO 4898:2008	Rigid cellular plastics -- Thermal insulation products for buildings -- Specifications
11	IS 4990: 2011	Plywood For Concrete Shuttering Works - Specification
12	IS 5688-1982	Method Of Test For Preformed Block-Type and Pipe-Covering Type Thermal Insulation
13	IS 8225:1987	Measurement Of Sound Absorption In A Reverberation Room
14	IS 10297-1982	Code of practice for design and construction of floors and roofs using precast reinforced prestressed concrete ribbed or cored slab units
15	IS 11447:1985	Code of practice for construction with large panel prefabricates
16	IS : 13958-1994	Bamboo mat board for general purposes -Specification
17	IS 14862:2000	Fibre Cement Flat Sheets - Specification
18	IS 14862: 2000	Fibre Cement Flat Sheets - Specification
19	IS 14867-1999	Falsework For Concrete Structures - Guidelines
20	IS : 15476-2004	Bamboo Mat Corrugated Sheets - Specification
21	IS 15916	Building Design and Erection Using Prefabricated Concrete-Code of Practice

26.0 NEW TECHNOLOGIES & MATERIALS

26.1 PHENOL BONDED BAMBOOWOOD FLOORING

26.1.1 MATERIAL

26.1.1.1 Frame: The base frame shall be of strong, dry concrete or as specified like plywood or wooden of treated and seasoned and frame shall be leveled and smooth. The Bamboowood flooring tiles shall be fixed with tongue and groove interlocking system, with underlayment of 4mm thick expanded poly ethylene foam sheets having density 40kg/cum, over prepared surface.

26.1.1.2 Flooring Tiles:

The Bamboowood flooring shall be of 14mm thick with tongue and groove inter locking system of micro beveled edges, eco-friendly bamboowood tiles high in density and hardness, made from bamboo grass, a renewable source of raw material.

The Flooring Tiles shall be of size 1800mm length (minimum) and 130mm wide (minimum of 14mm thickness. The Bamboowood planks shall have minimum density of 1000 Kg/m^3 & minimum Hardness 1000 Kgf. The Bamboowood flooring tiles shall have Eco friendly UV coating in approved colour, texture and factory finished, having Performance Appraisal Certificate (PAC) issued by Building Materials & Technology Promotion Council (BMTPC). The flooring tiles shall have necessary quarter round planks of size 1900mm x 18mm and door reducer of size 1900mm x 44mm, wherever required.

The Bamboowood flooring tiles characterized with density, hardness, modulus of rupture, modulus of elasticity, thermal conductivity as per IS: 3346-1980 $\leq$ 0.50 W/ m-K, termite resistant as per 6months termite mound test and borer resistant as per box test, scratch resistance as per Hamburger test of $\geq$ 20 N, abrasion resistance as per DIN EN 438-2 of > 100cycle & ASTM D 4060 of >6000 cycle & ISO 15184 of $\geq$ 1H, impact resistance as per DIN EN 438 P2–12 of $\geq$ 2 Newton, Indentation Resistant DIN EN 438 P –14 of $\geq$ 1 Newton, Chemical Resistance DIN 68861 Part 1 of 5, In flammability DIN 4102 Part 14 of B1, Heat Resistance DIN 68861 Part 6 of 6A.

26.1.1.3 Base Material:

Expanded polyethylene foam sheets of 4mm thickness and having density 40kg/m^3.

26.1.2 Fixing of base work and tiles:

The expanded poly ethylene foam sheets of 4mm thickness and having density 40kg/m3 of available width and running length as underlayment. Place the foam sheet and seal joints with min. 50 mm width masking tape so that it should not overlap. This foam will take undulation and act as cushion for flooring tiles. Open the boxes of tiles and keep tiles in room for normalizing for 72hrs prior to installation. First check the dimensions with meter tape to calculate the expansion gap to be left for sides. For standard room 12ft x 12ft, the expansion gap shall be 15mm and above to this add 0.5mm for each layer; for width above 25ft gap shall be 30mm. Ends shall have standard 15mm expansion gap all times. Make a right angle along the longer side of area where flooring to be laid by placing marking line and use guide strips as specified above. Then start laying down flooring tiles one after another end to end. Place them against the guide strips along with right angle marking line. Take D-3 category water resistant glue and apply above tongue with a conical shape glue applicator for even layer. And place second line of tiles and push in with first layer from sides and match end to end of this layer. If last tile is longer; then trim the excess and take that to first piece in next layer. Repeat same again and again till complete laying of flooring in whole area. Keep cleaning the excess glue coming up on tile surface with moist cloth. Use Silicon based joint sealant of approved quality for the joints of the tiles. Place door reduce at entrance in last.

26.1.3 Precautions:-

(a) Base concrete must be strong, levelled and dried prior to flooring tiles installation work.

(b) Bamboowood flooring tiles are ready to use as factory finished hence should be the last job to be carried out in new or under renovation area.

(c) All wet trades such as plastering, conducting, and painting, walling, Ceiling, Air Conditioning duct work, Electrical chasing or drawing lines & cables, etc should be completed prior to start the flooring works.

(d) No unauthorized work shall be carried out after flooring is laid.

26.1.4 Maintenance Guidelines

Bamboowood flooring shall be maintained by hardwood floor cleaners as recommended to ensure that floor stays looking good. It shall be ensured that hardwood floor cleaners are water based, nontoxic cleaners which have been designed for finished hardwood floors. Cleaner shall be used as per manufacturer's instructions.

Types of Drying Methods for the Floors are as follows:

Dry mop: Dirt and grit shall always be removed prior to cleaning Bamboowood floors with an electrostatic dust control mop/ soft mop/ vacuum cleaner. Bristle broom shall be avoided.
Dry spray: The area of floor or the cleaning pad shall be mist with the hardwood floor cleaner.

Wipe: The floor shall be cleaned with a microfiber cloth or mop using a back and forth motion until it is dry. Soiled mop or cloth shall be replaced once it becomes soiled to avoid streaking.

Do's and Don'ts: Do's

(i) The floor shall be cleaned regularly. Recommendations for cleaning the floor as a guide shall be as follows:
Low frequented area (residential) – about every 2-4 weeks
Medium frequented area (offices) – about every 1-2 weeks
High frequented area (public places) – about every 1-2 days

(ii) Spills shall be removed promptly

(iii) Mats at exterior and interior doors shall be placed to trap sand 13 and grit from incoming traffic

(iv) Heavy furniture or appliances shall always be picked rather than sliding them across the floor

(v) Any minor scratches or damage shall be repaired using hardwood flooring cleaners

Don'ts

(i) Do not steam mop or wet mop floor surface area after installation. Excess water can cause swelling

(ii) Do not let sand, dirt or grit build up. They act like sandpaper and actually abrade and dull the floor finish

26.1.5 Measurements: Length & breadth of the finished flooring shall be measured correct to a centimeter from wall to wall. The area shall be calculated in square meter correct to two decimal places. Expansion joint area shall not be deducted. No deduction will be made of openings of area upto 0.40 sqm nor shall extra payment be made either for any extra material or labour involved in forming such openings. For opening exceeding 0.40sqm in area , deduction in measurements shall be made but extra will be payable for any extra material or labour involved in making such opening.

26.1.6 Rates: The rate shall include cost of all the materials and labour involved in all the operation described above, including.

26.2 PHENOL BONDED BAMBOO WOOD IN WALL SKIRTING

26.2.1 MATERIAL

26.2.1.1 Frame: The base frame shall be of strong, dry concrete or as specified like plywood or wood treated and seasoned, frame leveled and smooth. The Bamboowood Wall Skirting tiles shall be fixed with SS screws including rawl plug, with underlayment of 4mm thick expanded poly ethylene foam sheets having density 40kg/cum, over prepared surface.

26.2.1.2 Wall Skirting Tiles:

The Bamboowood Wall Skirting shall be of 14mm thick with one side quarter rounded of micro beveled edges, eco-friendly bamboowood high in density and hardness, made from bamboo grass, a renewable source of raw material.

The Wall Skirting Tiles shall be of size 1900mm length (minimum) and 85mm wide (minimum of 14mm thickness. The Bamboowood planks shall have minimum density of 1000 Kg/m3 & minimum Hardness 1000 Kgf. The Bamboowood Wall Skirting tiles shall have Eco friendly UV coating in approved colour, texture and factory finish, having Performance Appraisal Certificate (PAC) issued by Building Materials & Technology Promotion Council (BMTPC).

The Bamboowood wall skirting tiles shall be characterized with density, hardness, modulus of rupture, modulus of elasticity, thermal conductivity as per IS: 3346-1980 $\leq$ 0.50 W/ m-K, termite resistant as per 6months termite mound test and borer resistant as per box test, scratch resistance as per Hamburger test of $\geq$ 20 N, abrasion resistance as per DIN EN 438-2 of > 100cycle & ASTM D 4060 of >6000 cycle & ISO 15184 of $\geq$ 1H, impact resistance as per DIN EN 438 P2–12 of $\geq$ 2 Newton, Indentation Resistant DIN EN 438 P –14 of $\geq$ 1 Newton, Chemical Resistance DIN 68861 Part 1 of 5, Inflammability DIN 4102 Part 14 of B1, Heat Resistance DIN 68861 Part 6 of 6A.

26.2.1.3 Base Material:

Expanded poly ethylene foam sheets of 4mm thickness and having density 40kg/m3 of available with and running length.

26.2.2 Fixing of base work and tiles:

Place the foam sheet and seal joints with masking tape so that it should not overlap. This foam will take undulation and act as cushion for skirting tiles. Open the boxes of tiles and keep tiles in room for normalizing for 72hrs prior to installation. Place the wall skirting 2mm above the bamboowood tiles flooring surface. Use drill machine to make suitable holes in tiles at both ends and accordingly make holes for rawl plug in wall. Place the rawl plug and then foam and over that place wall skirting tiles and held in place by 50mm SS screws at both ends. Repeat same for entire area. Wall Skirting used to cover the small area expansion gaps. For larger area expansion gaps need quarter round as shoe to cover the expansion gap on all sides. Use Silicon based joint sealant of approved quality for the joints of the tiles.

26.2.3 Precautions:-

(a) Base concrete must be strong, leveled and dried prior to flooring tiles installation work.
(b) Bamboowood wall skirting tiles are ready to use as factory finished hence should be the last job to be carried out in new or under renovation area.
(c) All wet trades such as plastering, conduting, and painting, walling, Ceiling, Air Conditioning duct work, Electrical chasing or drawing lines & cables, flooring, wall cladding etc should be completed prior to start of skirting works.
(d) No unauthorized work shall be carried out after flooring laid.

26.2.4 Measurements:

Length &breadth of the finished Wall Skirting shall be measured correct to a centimeter. The length & breadth shall be calculated in running meter correct to two decimal places. All sides length & breadth where wall skirting is installed shall be measured. No deduction will be made for openings of areas upto 0.40 sqm nor shall extra payment be made either for any extra material or labour involved in forming such openings. For opening exceeding 0.40sqm in area , deduction in measurements shall be made but extra will be payable for any extra material or labour involved in making such opening.

26.2.5 Rates: The rate shall include cost of all the materials and labour involved in all the operation described above.

26.3 PHENOL BONDED BAMBOOWOOD WALL CLADDING

26.3.1 MATERIAL

26.3.1.1 Frame: The frame shall be made of second class teak wood of treated and seasoned of size 20x15mm in centre of each tile and bottom and top of work height, 40x15mm placed at ends of each tile. The frame shall be fixed to wall with 50mm SS screws and raw plug. The Bamboowood wall cladding shall be laid over back layment of 1.00mm thick expanded poly ethylene foam of density 40kg/cum in two layers first layer on wall surface before fixing wooden frame and second layer on frame under cladding.

26.3.1.2 Wall Cladding Tiles:

The Bamboowood Wall Cladding tiles shall be of 10mm thick with profiled edges. Eco friendly bamboowood wall cladding tiles high in density and hardness, made from bamboo grass, a renewable source of raw material.

The Wall Cladding Tiles shall be of size 1800mm length (minimum) and 130mm wide (minimum) of 10mm thickness. The Bamboowood planks shall have minimum density of 1000 Kg/m3 & minimum Hardness 1000 Kgf. The Bamboowood wall cladding tiles shall have Eco friendly UV coating in approved colour, texture and factory finish, having Performance Appraisal Certificate (PAC) issued by Building Materials & Technology Promotion Council (BMTPC). The wall cladding tiles shall have necessary threshold of size 1900mm x 44mm and T mold of size 1900mm x44mm wherever required.

The Bamboowood wall cladding tiles shall be characterized with density, hardness, modulus of rupture, modulus of elasticity and thermal conductivity as per IS: 3346-1980 $\leq$ 0.50 W/ m-K, termite resistant as per 6months termite mound test and borer resistant as per box test, scratch resistance as per Hamburger test of $\geq$ 20 N, abrasion resistance as per DIN EN 438-2 of > 100cycle & ASTM D 4060 of >6000 cycle & ISO 15184 of $\geq$ 1H, impact resistance as per DIN EN 438 P2–12 of $\geq$ 2 Newton, Indentation Resistant DIN EN 438 P –14 of $\geq$ 1 Newton, Chemical Resistance DIN 68861 Part 1 of 5, In flammability DIN 4102 Part 14 of B1, Heat Resistance DIN 68861 Part 6 of 6A.

26.3.1.3 Base Material:

Expanded poly ethylene foam sheets of 1mm thickness and having density 40kg/m3 and second class teak wood of treated and seasoned.

26.3.2 Fixing of base work and tiles:

The expanded poly ethylene foam sheets of 1mm thickness and having density 40kg/m^3 of available width and running length as backlayment. Place the foam sheet and seal joints with masking tape so that it should not overlap. The frame shall be made of second class teak wood of treated and seasoned of size 20x15mm in centre of each tile and bottom and top of work height, 40x15mm placed at ends of each tile. The frame shall be fixed to wall with 50mm SS screws and

rawl plug. The frame shall be laid over first layer of foam. Open the boxes of tiles and keep tiles in room for normalizing for 72hrs prior to installation. Make a right angle along the length and height of wall by keeping a 10mm gap with all. The Bamboowood wall cladding shall be laid over backlayment of 1.00mm thick expanded poly ethylene foam of density 40kg/cum on frame under cladding. Use pneumatic installation gun and tools of pressure 7bar and use BR18G nails. Place wall cladding tile and hit in head and toe and in centre to pace it. Keep a gap of minimum 3.00mm between two wall cladding tiles and continue laying as explained above. One can increase gap between tiles as per their requirement as well. Use T-mold to join two tiles at the ends and threshold in top and bottom of wall cladding to give a pleasing looks.

26.3.3 Precautions:-

(a) Base concrete must be strong, leveled and dried prior to flooring tiles installation work.

(b) Bamboowood wall cladding tiles are ready to use as factory finished hence should be the last job to be carried out in new or under renovation area.

(c) All wet trades such as plastering, conducting, and painting, walling, Ceiling, Air Conditioning duct work, Electrical chasing or drawing lines & cables, etc should be completed prior to start of cladding works.

(d) No unauthorized work shall be carried out after wall cladding installation.

26.3.4 Measurements:

Height & breadth of the finished Wall cladding shall be measured correct to a centimeter from wall to wall. The area shall be calculated in square meter correct to two decimal places. Expansion area shall not be deducted. No deduction will be made of openings of area upto 0.40 sqm nor shall extra payment be made either for any extra material or labour involved in forming such openings. For opening exceeding 0.40sqm in area, deduction in measurements shall be made but extra will be payable for any extra material or labour involved in making such opening.

26.3.5 Rates: The rate shall include cost of all the materials and labour involved in all the operation described above, including Frame work mentioned in para above including material & hardware consumed /utilized.

26.4 PHENOL BONDED BAMBOOWOOD PANELLED OR PANELLED AND GLAZED SHUTTERS FOR DOORS WINDOWS, CLERESTOREY WINDOWS

26.4.1 MATERIAL

26.4.1.1 Frame: The door frame (chowkhat) shall be of wooden of treated and seasoned or Bamboowood or as specified material. The opening for Shutter of door shall be levelled and smooth. The Shutter for door shall have profiled interlocking system and be fixed with bamboo pins in position. The Shutter shall fix to door frame with SS hinges and screws.

26.4.1.2 Shutters of doors:

The Bamboowood Shutters of doors shall be of 30mm thick with pre - molded planks having inter locking system of micro bevelled edges, eco-friendly bamboowood of high in density and hardness, made from bamboo grass, a renewable source of raw material.

The Shutters of doors shall be of 30mm thick bamboowood planks. The Bamboowood planks shall have minimum density of 1000 Kg/m3 & minimum Hardness 1000Kgf. The bamboowood shutters of doors shall have approved coating in approved colour, texture and factory finished. The bamboowood shall have Performance Appraisal Certificate (PAC) issued by Building Materials & Technology Promotion Council (BMTPC). The shutter of doors shall have necessary profile to fit in panelling as required.

The Bamboowood planks pre - molded into shutters of doors characterized with density, hardness, modulus of rupture, modulus of elasticity, thermal conductivity as per IS: 3346-1980 $\leq$ 0.50 W/ m-K, termite resistant as per 6months termite mound test and borer resistant as per box test.

26.4.1.3 Base Material:

Door frame of wood or metal or Bamboowood or aluminum or others as specified.

26.4.2 Fixing of Shutter of doors:

The pre-molded planks of Bamboowood shutters of doors shall have 10mm wide and 25mm deep grooves to fit in panels. These planks shall be in vertical and horizontal (middle, top n bottom) rails. The panels shall fit in rails and all these planks shall fixed together and held in place by bamboo pins. Doors accessories shall be of adequate metal such as stainless steel butt hinges of size 125x65x1.9mm and minimum 4nos with minimum 4 screws per hand, making 8screws per hinge to be used. Another fittings like door handle, lock and bolts etc as specified. Normalize doors prior to installation for 72hrs. First check the dimensions of door frame opening with meter tape and match same with shutter of door at site; accordingly take installation of shutters of door in frame forward. There should be a movement gap left between shutter and door frame. Trained carpenter can work easily on Bamboowood shutters of doors. The carpenter shall use modern hand tools and machines for better results.

26.4.3 Precautions:-

(a) Frame of Door shall be fixed properly with concrete and must be strong, levelled and dried prior to shutter door installation work.

(b) Bamboowood shutters of doors are ready to use as factory finished hence precautions should be carried out in new or under renovation area.

(c) All wet trades such as plastering, conducting, and painting, walling, Ceiling, Air Conditioning duct work, Electrical chasing or drawing lines & cables, etc should be completed prior to installation of doors works.

(d) No unauthorized work shall be carried out after shutter of doors in place at that area.

26.4.4 Measurements:

Length & breadth of the shutters of doors shall be measured correct to a centimeter in fixed position (overlapping not to be measured in case of double leaved shutters) and the area calculated in square meter corrected to two place of decimal. No deduction shall be made to form panel openings or louvers . No extra payments shall be made for shape, joints and labours included in all operation describe above.

26.4.5 Rates: The rate shall include cost of all the materials and labour involved in all the operation described above, including Frame work mentioned in para above including material & hardware consumed /utilized.

26.5 PHENOL BONDED BAMBOO WOOD PANELING

26.5.1 MATERIAL

26.5.1.1 Frame: The shutters of doors shall be of Bamboowood planks. The shutter of door shall have 10mm grooves for panelling to fit in and be leveled and smooth. The panelling for shutters of doors shall have profiled interlocking system and be fixed with shutters of doors.

26.5.1.2 Panelling for shutters of doors:

The Bamboowood panelling for shutters of doors shall be of 10mm thick with pre - molded planks having inter locking system of micro beveled edges, eco-friendly bamboowood, high in density and hardness, made from bamboo grass, a renewable source of raw material.

The panelling for shutters of doors shall be of 10mm thick bamboowood planks. The Bamboowood panel tiles shall have minimum density of 1000 Kg/m3 & minimum Hardness 1000Kgf. The bamboowood panel tiles for shutters of doors shall have approved coating in approved colour, texture and factory finished. The bamboowood panels shall have Performance Appraisal Certificate (PAC) issued by Building Materials & Technology Promotion Council (BMTPC). The shutter of doors shall have necessary profile to fit in paneling as required.

The Bamboowood panels pre - molded to fit in shutters of doors characterized with density, hardness, modulus of rupture, modulus of elasticity, thermal conductivity as per IS: 3346-1980 $\leq$ 0.50 W/ m-K, termite resistant as per 6months termite mound test and borer resistant as per box test.

26.5.1.3 Base Material:

Shutters of door shall be made of Bamboowood to fit in panelling.

26.5.2 Fixing of Panelling for shutter of doors:

The pre-molded panels of Bamboowood shutters of doors shall have 10mm thickness. The shutters of doors shall have 10mm wide and 25mm deep grove to fit in panelling. The panels shall fit in rails and all these panels shall be fixed together to smooth level and whole shutter of door with panel locked in and held in place by bamboo pins. Normalize doors prior to installation for 72hrs. First check the dimensions of door frame opening with meter tape and match same with shutter of door at site; accordingly take installation of panelled shutters of door to fix in frame of door. There should be a movement gap left between shutter and door frame. Trained carpenter can work easily on Bamboowood panelled shutter doors. The carpenter shall use modern hand tools and machines for better results.

26.5.3 Precautions:-

(a) Frame of Door shall be fixed properly with concrete and must be strong, leveled and dried prior to shutter door installation work.

(b) Bamboowood panelled shutters of doors are ready to use as factory finished hence precautions should be carried out in new or under renovation area.

(c) All wet trades such as plastering, conducting, and painting, walling, Ceiling, Air Conditioning duct work, Electrical chasing or drawing lines & cables, etc should be completed prior to installation of doors works.

(d) No unauthorized work shall be carried out after panelled shutter of doors in place at that area.

26.5.4 Measurements:

For paneling of shutters of door, length & width of panels shall be measured correct to a centimetre and the area shall be calculated to the nearest 0.01sqm. The portion of panels insert or glazed panel inside the grooves or rebates shall be measured for payment.

26.5.5 Rates: The rate shall include cost of all the materials and labour involved in all the operation described above.

26.6 FACTORY MADE DOOR FRAME OF PHENOL BONDED BAMBOOWOOD

26.6.1 MATERIAL

26.6.1.1 Frame: The door frame (chowkhat) opening shall be of strong, or as specified and leveled and smooth. The Bamboowood frame for doors shall have 10mm gap between concrete and frame. The frame shall have interlocking system of rails and gap filling foam as back lament, over prepared surface.

26.6.1.2 Frame for doors:

The Bamboowood frame for doors shall be 65mm thick with pre - molded planks having inter locking system of micro beveled edges, eco-friendly bamboowood high in density and hardness, made from bamboo grass, a renewable source of raw material.

The Frames shall be of 65mm thick bamboowood planks. The Bamboowood planks shall have minimum density of 1000 Kg/m3 & minimum Hardness 1000Kgf. The bamboowood frames shall have approved coating in approved colour, texture and factory finished. The bamboowood shall have Performance Appraisal Certificate (PAC) issued by Building Materials & Technology Promotion Council (BMTPC).

The Bamboowood planks pre - molded into frame for doors characterized with density, hardness, modulus of rupture, modulus of elasticity, thermal conductivity as per IS: 3346-1980 $\leq$ 0.50 W/ m-K, termite resistant as per 6months termite mound test and borer resistant as per box test.

26.6.1.3 Base Material:

Strong, dry concrete or as specified and smooth and leveled.

26.6.2 Fixing of Frames:

The pre-molded planks of Bamboowood frames shall have interlocking provisions between vertical and horizontal rails. The frame shall be fixed to strong, dry concrete with jamb. The jamb shall fixed on both sides of frame with 2nos of 100mm GI screws per jamb and 3nos of jamb each side first and then insert other end of jamb into concrete hole and locked bamboowood frame in place by concrete. There shall be a air gap of 10mm all around to bamboowood frame and this gap to be filled with PU foam and covered with architraves.

26.6.3 Precautions:-

(a) Concrete must be strong, leveled and dried prior to installation of bamboowood frame of door.

(b) Bamboowood frame ready to use as factory finished hence precautions should be carried out in new or under renovation area.

(c) Jamb should be fixed to sides of frame at equal interval and jamb hole should be made in advance in concrete prior to installation work.

(d) All wet trades such as plastering, conducting, and painting, walling, Air Conditioning duct work, Electrical chasing or drawing lines & cables, etc should be completed prior to installation of frame works.

(e) No unauthorized work shall be carried out after installation of frame at place.

26.6.4 Measurements:

Length & breadth of the frame shall be measured correct to a centimeter as per approved drawings and prior to installation work. Rails of verticals and horizontal shall be measured with pre-molded profiles. Inserts of rails shall be measured as thickness of top rail as 65mm. These inserts shall be

taken into account of measurements. The volume shall be calculated in cum correct to four decimal places. No deduction shall be made inserts. Installation of frame of doors and fitting of accessories shall be extra payment and be made for labour involved in making such openings.

26.6.5 Rates:

The rate shall include cost of all the materials and labour involved in all the operation described above.

26.7 BAMBOO MAT CORRUGATED SHEET (BMCS)

26.7.1 MATERIAL

Material and testing criteria as per IS 15476:2004 (upto amendment No.-4)

26.7.2 Fixing Procedure:-

1. The roof slope should be minimum 20° OR maximum 45°.
2. (a) For 2440mm long BMCS, the purlin spacing should be @ 1145mm centre to centre.
   (b) For 2140mm long BMCS, the purlin spacing should be @ 995mm centre to centre.
   (c) For 1830mm long BMCS, the purlin spacing should be @ 840mm centre to centre.
   (d) In the same Horizontal Plan, the purlin level (Elevation) at all points must be same to avoid concave / convex formation of BMCS's surface which will obstruct the proper flow of water on the BMCS, as shown in the figure no. 26.1
   (e) The rafter (1), (2), (3), (4) etc. as shown in figure 26.1, must be perfectly straight otherwise it will give concave / convex surface of BMCS which will obstruct the proper flow of water.
3. Minimum 6" (150mm) end lap to be provided while fitting the BMCS on Purlins. See figure no. 26.2
4. The Standard width of BMCS is 1050mm. There are 9 nos. of Crown and 8 nos. of Valley in One BMCS of standard width of 1050mm. See figure no.26.3
5. One Corrugation side lap of 110mm to be provided while fitting the BMCS on Purlins. See figure no. 26.4 below:
6. BMCS & BMRC to be fitted with Self-Drilling Screws with Stainless Steel EPDM bonded washers compete (See figure no. 26.5) OR 8mm diameter J Hooks / L Hooks, Bolts, nuts, bitumen washer, galvanized washers complete. (See figure no. 26.6). NAIL should never be used for fitting the BMCS & BMRC.
7. For fitting the Self-Drilling Screws OR J Hooks / L Hooks, Bolts, nuts etc., the correct size hole in the BMCS & BMRC must be made with Drill Machine only. The holes should never be made by PUNCH, as it will crack the BMCS & BMRC.
8. The holes for fixing the Self-Drilling Screws OR J Hooks / L Hooks, Bolts, nuts etc. to be made on the APEX (Crest) only and NOT in the Valley. See figure no. 26.5 & 26.6.
9. At least one of the fixing Self-Drilling Screws OR J Hooks / L Hooks, Bolts, nuts etc. to pass through the end lap of BMCS / BMRC. If it is not possible, extra Self-Drilling Screws OR J Hooks / L Hooks, Bolts, nuts etc. to be provided. The end lap of BMCS / BMRC to be jointed together. The edges of the BMCS & BMRC should be straight when fixed end to end and the surface to be plain and parallel to the general plan of the roof. See figure no. 26.7 below:

10. Free overhanging of BMCS to be not more than 300mm.

11. The BMRC Ridge purlin to be fitted at a distance of 200mm from the Apex of the Truss / Roof.See figure no. 26.7.

12. Polyurethane (PU) Coating Green colour / any other colour coated side must face the SUN to resist severe Heat & Rain.

13. Polyurethane (PU) Coating Green colour / any other colour of Exterior quality to be applied after every five years for longer life of the BMCS / BMRC.

26.7.3 Precautions:-

BMCS / BMRC cutting should be done with Fine Teeth Carpenter hand saw / electric hand cutting machine and after cutting, the edges to be sealed with any of the following sealants available in the markets:

(i) Exterior Grade quality Varnish

(ii) Polyurethane Coating of Exterior Grade quality

(iii) Bituminized Rubber sealant.

(iv) Silicon Based sealant.

The products should be handled with care and the product should not fall on edges during handling, unloading and loading process.

The BMCS / BMRC procured from must be stored in a covered shed/ location at site with sufficient cross ventilation inside the covered shed/ location. The BMCS / BMRC must also be stacked on elevated wooden pallets which are not touching the ground level.

26.7.4 Finish:-

The complete roof shall present a neat and uniform appearance and be leak proof.

26.7.5 Measurements:- (for DSR'18 item 26.6A)

Length and breadth shall be measured correct to a cm and its area shall be calculated in square metres correct to two place of decimal.

The superficial area of roof covering shall be measured on the flat without allowance for laps and corrugations. Portion of roof covering overlapping the ridge etc. shall be included in the measurements of the roof.

No deduction in measurements shall be made for the opening upto 0.4 sqm and nothing extra shall be allowed for forming such opening. For any opening exceeding 0.40 sqm in area, deduction in measurements for the full opening shall be made and in such case the labour involved in making these openings shall be paid separately. Cutting across corrugation shall be measured on the flat and not grithed.

26.7.6 Rates:

The rate shall include cost of all the materials and labour involved in all the operation described except otherwise stated. This includes the cost of roof sheets, L hook, bolts and nuts, bituminous and galvanized iron washers.

26.7.7 Measurements:- (for DSR'18 item 26.6B)

The measurement for ridges and hips shall be taken for the finished work along the centre line of the ridge and hip lines in length , correct to a cm . the laps in adjacent ridges pieces shall not be measured. The underlay of ridges under expansion joint pieces where the latter are provided shall however be measured.

26.7.8 Rates:-

The rates shall included the cost of all material and labour specified above , but does not include (a) the cost of required hook, bolt nuts and screws and their washers, (b) the cost of supplying and fixing expansion joint pieces, (c) the cost of closing the gaps between plain ridge and the sheet roofing corrugation. Item(a) above will be covered by the rate of BMCS roofing while item (b) & (c) will be paid for separately unless specifically included in the description of item of the BMRC.

26.8 PHENOL BONDED BAMBOO MAT BOARD FOR FALSE CEILING

26.8.1 Material

Material and testing criteria as per IS:13958-1994 (upto amendment No.-4)

26.8.1.1 Frame

The frame work shall consist of GI Tee sections for main runners of size 30x25x0.3 mm thick and for cross runners of size 25x25x0.3 mm thick and parameter wall angle of GI section of size 25x25x0.4 mm thick fixed to the wall with dash hold fastner 12.5 mm dia and 50 mm long . The frame work shall be executed in a manner so as to form a grid of 600 mm x 600 mm as specified in the item. The frame work shall be suspended from ceiling by level adjusting hangers made of 4 mm dia. GI rods fixed to slab by means of GI ceiling cleats. The ceiling cleats shall be fixed to the slab by means of mechanical dash fasteners12.5 mm dia and 50 mm long. MS hangers and ceiling cleats shall be painted with a coat of yellow zinc chromate primer and two coats of synthetic enamel paint.

26.8.1.2 Ceiling Tiles

Ceiling tiles shall be of 4 mm thick phenol bonded Bamboo mat board bound confirm to IS 13958-1994 of required size.

26.8.2 FIXING OF CEILING TILES

The ceiling tiles shall be placed over the GI frame.

26.8.3 Measurements

Length & breadth of the finished ceiling shall be measured correct to a centimetre. The area shall be calculated in square metre correct to two decimal places. No deduction shall be made for making openings for electrical, air conditioning, fire fighting fixtures nor shall extra payment be made either for extra materials or labour involved in making such openings.

26.8.4 Rate

The rate shall include the cost of all the materials and labour involved in all the operation described above including frame work, scaffolding etc.

26.9 BAMBOO MAT BOARD FOR PARTITION TO FRAME

26.9.1 MATERIAL

Material and testing criteria as per IS:13958-1994 (upto amendment No.-4)

26.9.1.1 Frame

The base frame work to be executed as per items specified and as per direction of Engineer-in-Charge

26.9.2 Fixing Procedure:-

(a) Sawing of Bamboo mat board shall be truly straight and square. The Bamboo mat board shall be planed smooth and accurate to the full dimensions, rebates, roundings, and mouldings as shown in the drawings made, before assembly. Patchings or plugging of, any kind shall not be permitted except as provided

(b) Bamboo mat board can be screwed or nailed as per the requirement on the existing frame work.

(c) The screws used for fixing the mat board shall be sunk into the wood work and their tops covered with putty.

(d) When the Bamboo mat board is cut, the edges has to be sealed by using any of the following sealants available in the market.

(i) Exterior Grade quality Varnish

(ii) Polyurethane Coating of Exterior Grade quality

(iii) Bituminized Rubber sealant.

(iv) Silicon Based sealant.

(e) Bamboo mat board, if used for outside (exterior) a waterproofing coating to be provided on the board for each longer life against weathering effects.

(f) Cutting should be done with fine teeth carpenter hand saw/ electric hand cutting machine.

(g) The ornament work shall be made if required in true and accurate to the dimensions shown in the working drawings.

(h) The fixing shall be done true to line and levels.

26.9.3 Precautions:-

The Bamboo mat board must be stored in a covered shed/ location with sufficient cross ventilation inside the covered shed/ location. The Bamboo mat bard must also be stacked on the elevated wooden pallets which are not touching the ground level. The product should be handled with care and the product should not fall on edges during handling, unloading and loading process.

26.9.4 Measurements:

Length and breadth shall be measured correct to a cm. Bamboo mat board used for partition work shall be measured in square metre nearest to two places of decimal. The moulded work shall be measured in cm running metre i.e. in running metres stating the girth in cm. The sectional periphery (girth) of moulding excluding the portion in contact with wall shall be measured in cm correct to 5 mm and length in metre correct to a cm. No deduction will be made of openings of area upto 0.40 sqm nor shall extra payment be made either for any extra material or labour involved in forming such openings. For opening exceeding 0.40sqm in area, deduction in measurements shall be made but extra will be payable for any extra material or labour involved in making such opening.

26.9.5 Rates:

The rate includes the cost of materials and labour required for all the operation described above but excluding the cost of backing or studding.

26.10 WALL PANELLING WITH PHENOL BONDED BAMBOO MAT BOARD

26.10.1 MATERIAL

Material and testing criteria as per IS:13958-1994 (upto amendment No.-4)

26.10.2 Grounds

Grounds shall be provided where so specified. These shall consist of first class hard wood plugs or the class of wood used for fabricating the frames, of trapezoidal shape having base of 50 × 50 mm and top 35 × 35 mm with depth of 5.0 cm and embedded in the wall with cement mortar 1:3 (1 cement : 3fine sand) and batten of first class hard wood or as specified of size 50 × 25 mm or as specified, fixed over the plugs with 50 mm long wood screws. The plugs shall be spaced at 45 to 60 centimeters centre to centre, depending upon the nature of work. The battens shall be painted with priming coat, of approved wood primer before fixing.

26.10.3 Fixing Procedure:-

(a) Sawing of Bamboo mat board shall be truly straight and square. The Bamboo mat board shall be planed smooth and accurate to the full dimensions, rebates, roundings, and mouldings as shown in the drawings made, before assembly. Patchings or plugging of, any kind shall not be permitted except as provided

(b) Bamboo mat board can be screwed or nailed as per the requirement on the existing frame work.

(c) The screws used for fixing the mat board shall be sunk into the wood work and their tops covered with putty.

(d) When the Bamboo mat board is cut, the edges has to be sealed by using any of the following sealants available in the market.

(i) Exterior Grade quality Varnish

(ii) Polyurethane Coating of Exterior Grade quality

(iii) Bituminized Rubber sealant.

(iv) Silicon Based sealant.

(e) Bamboo mat board, if used for outside (exterior) a waterproofing coating to be provided on the board for each longer life against weathering effects.

(f) Cutting should be done with fine teeth carpenter hand saw/ electric hand cutting machine.

(g) The ornament work shall be made if required in true and accurate to the dimensions shown in the working drawings.

(h) The fixing shall be done true to line and levels.

26.10.4 Precautions:-

The Bamboo mat board must be stored in a covered shed/ location with sufficient cross ventilation inside the covered shed/ location. The Bamboo mat bard must also be stacked on the elevated wooden pallets which are not touching the ground level. The product should be handled with care and the product should not fall on edges during handling, unloading and loading process.

26.10.5 Measurements:

Length and breadth shall be measured correct to a cm. Bamboo mat board used for paneling work shall be measured in square metre nearest to two places of decimal. The moulded work shall be measured in cm running metre i.e. in running metres stating the girth in cm. The sectional periphery (girth) of moulding excluding the portion in contact with wall shall be measured in cm correct to 5 mm and length in metre correct to a cm. No deduction will be made of openings of area upto 0.40 sqm nor shall extra payment be made either for any extra material or labour involved in forming such openings. For opening exceeding 0.40sqm in area, deduction in measurements shall be made but extra will be payable for any extra material or labour involved in making such opening.

Where only plugs are required to be fixed for the ornamental work, the cost for the same shall be deemed to be included in the rate of ornamental work and no separate payment shall be made for plugs.

26.10.6 Rates:

The rate includes the cost of materials and labour required for all the operation described above but excluding the cost of backing or studding.

The testing of bamboowood products and the criteria as listed in Table No.26.1

TESTING CRITERIA OF MATERIAL

Table No. 26.1

Sl no.	Characteristic	Test Method	Criteria
I. Bamboowood (General Test)			
Sl no.	Characteristic	Test Method	Criteria
1	Density	IS: 1708 (Part 2)1986	≥ 1000Kg /m^3
2	Modulus of Rupture (MOR)	IS: 1708 (Part 5)1986	≥ 150 N /mm^2
3	Modulus of Elasticity (MOE)	IS: 1708 (Part 5)1986	≥ 17500 N /mm^2
4	Hardness Test	IS :1708 (Part 10), ASTM D 1037	≥ 800 kg
5	Moisture Content	IS: 1708 (Part-1)1986 ASTM D 4442	≤12% (oven dry method)
II. Bamboowood (Specialized Test)			
1	Thermal Conductivity	IS: 3346-1980	≤ 0.50W/m-k
2	Volatile organic compound	IS; 13745-1993	≤8.00mg/100gm (oven dry method)
3	Termite Test	Laboratory Test	6 month in Termite Mound
4	Borer Test	Laboratory Test	6 month in Borer Box
5	Flame penetration	IS: 1734 (part-3) 1983	≥30 min
6	Water Absorption	IS 2380-1981	≤ 4% (2 hrs), ≤ 8% (24 hrs)
7	Swelling due to general absorption	IS 2380-1981	≤ 8%
8	Swelling due to surface absorption	IS 2380-1981	≤ 4% (2 hrs), ≤ 8% (24 hrs)
9	Flammability	IS: 1731 (Part-3) 1983	≥ 5 min (time taken for second ignition)
10	Rate of burning	IS 2380-1981	≥ 10 min (time taken to lose weight from 70% to 30%)
11	Screw withdrawal Resistance	IS: 2380-1981	≥ 250 Kg (Flat Face)
12	Screw withdrawal Resistance	IS: 2380-1981	≥ 200 Kg (Edge)
III. Flooring/ Wall Cladding Finish (General Test)			
1	Gloss Value	DIN EN ISO 2813	30 $\pm$ 5%
2	Scratch Resistance Coin Test	Coin Test	No Scratch
3	Heat Resistance (Cigarette Test)	DIN 68861 Part 6	6A
II. Material : Flooring/ Wall Cladding Finish (Specialized Test)			
1	Cross cut test	DIN EN ISO 2409	≤ GT 2
2	Scratch Resistance Coin Test	Hamburger planner	≥ 20 Newton
3	Abrasion Resistance	DIN EN 438-2 (500g load per wheel S 33	Initial Point > 100 cycle
4	Abrasion Resistance	ASTM D 4060 (500g load per wheel CS 17)	Initial point > 6000 cycle
5	Scratch Resistance pencil Hardness	ISO 15184	≥ 1H
6	Scratch Resistance surface	Steel wool test, type 2	No scratch
7	Impact Resistance	DIN EN 438 part2 – 12	≥ 2 Newton
8	Resistance to indentation	DIN EN 438 part2 – 14	≥ 1 Newton
9	Chemical Resistance	DIN 68861 part 1	5
10	In flammability	DIN 4102 part 14	B1
IV. Bamboo Mat Corrugated Sheets(BMCS)			
Sl no.	Characteristic	Test Method	Criteria
1	Density, gm/cm^2	IS :15476:2004	0.75 Min
2	Load bearing capacity. N/mm		
a	Dry state	IS :15476:2004	4.0 Min
b	Wet state	IS :15476:2004	3.0 Min
3	Impermeability	IS :15476:2004	The lower surface shall not show any formation of drop of water except for traces of moisture

4	Water absorption, Percent (after 24 h soaking)	IS :15476:2004	15, Max
5	Cycle test	IS :15476:2004	No delamination
6	Resistance to falling weight.		The test piece shall not break or show any crack or tear.
7	Resistance to fire		
a	Flame penetration	IS :15476:2004	Not less than 10 min
b	Rate of burning	IS :15476:2004	Not less than 20 min
c	Surface spread of flame maximum area of char in mm^2	IS :15476:2004	4500
V. Bamboo Mat Board for general purpose			
1	Internal Bond Strength Test		
a	In Dry State		
i	An average of six test specimen	IS:2380(Part 5):1977	0.70 N/mm^2
ii	Minimum	IS:2380(Part 5):1977	0.50 N/mm^2
b	In Wet State		
i	An average of six test specimen	IS:2380(Part 5):1977	0.50 N/mm^2
ii	Minimum	IS:2380(Part 5):1977	0.30 N/mm^2
c	Mycological Test		
i	An average of six test specimen	IS:2380(Part 5):1977	0.50 N/mm^2
ii	Minimum	IS:2380(Part 5):1977	0.30 N/mm^2
2	Surface Strength Test		
a	In Dry State		
i	An average of six test specimen	IS:2380(Part 22):1981	4.50 N/mm^2
ii	Minimum	IS:2380(Part 22):1981	3.00 N/mm^2
b	In Wet State		
i	An average of six test specimen	IS:2380(Part 22):1981	3.00 N/mm^2
ii	Minimum	IS:2380(Part 22):1981	2.00 N/mm^2
c	Mycological Test		
i	An average of six test specimen	IS:2380(Part 22):1981	3.00 N/mm^2
ii	Minimum	IS:2380(Part 22):1981	2.00 N/mm^2

26.11 EXTRUDED POLYSTYRENE RIGID INSULATION BOARD

26.11.1 MATERIALS

50mm thick extruded polystyrene rigid insulation board of required size between cavity wall, complying with ISO 4898:2008 & ASTM C 578-08b-type VI, having thermal conductivity of 0.0289 W/mk as per ASTM C 578 (Measured as per IS 3346), Compressive strength of > 350 KPA listed as per ASTM D 1621, density of 34-36 kg/Cum as per ASTM D 1622, Water absorption < 1% by Volume as per ASTM D 2842, Oxygen Index of 24.1 to 28.1 listed as per ASTM D 2863, cell size 0.4mm of dia (max) as per ASTM D 3576. Fire retardant property as per DIN 4102 Part 1 of class B2 and as per ASTM E 84 Class A.

26.11.2 Installation Process

1. The Cavity Wall Insulation system has to be installed by the Trained and authorized Applicator Only.

2. The insulation board has to be installed from Inside of the wall and should be firmly struck with the help of water based adhesive applied on all the four sides of the Insulation Board.

3. The Struck insulation board should further be fixed with the help pf PVC fasteners, which has be fastened on all the four corners in such a way that it should hold adjoining insulation sheets as well.

26.11.3 Requirement for extruded polystyrene rigid insulation board (See Fig No.26.8)
Since this product of performance based product, the third Party testing is Mandatory and should be done from any NABL approved laboratory or from any NYLAP approved international laboratory. The requirements of tests as mentioned in table no.26.2

Table 26.2

Sr. No	Requirement	Test Standard	Remarks
1	Thermal Conductivity Having 180 days aged thermal conductivity of 0.0289 W/mk.	ASTM C 578	Mandatory
2	Compressive strength of > 350 KPA.	ASTM D 1621	Mandatory
3	Density of 34-36 kg/Cum.	ASTM D 1622	Mandatory
4	Water absorption < 1% by Volume.	ASTM D 2842	Mandatory
5	Oxygen Index of 24.1 to 28.1	ASTM D 2863	Mandatory
6	Cell size 0.4mm of dia (max).	ASTM D 3576	Mandatory
7	Fire retardant property as per DIN , Part 1 of Class B2	------	Mandatory
8	Fire retardant property.	ASTM E 84 CLASS A	Mandatory

26.11.4 Measurements
Length and breadth of the wall insulation shall be measured correct to a cm and the surface area worked out in square metre of the finished work.

26.11.5 Rate
The rate shall include the cost of all materials and labour involved in all the operations described above including scaffolding if any required

26.12 UNDER DECK INSULATION SYSTEM
26.12.1 MATERIALS
50mm thick extruded polystyrene rigid insulation board of required size for Underdeck Insulation System, complying with ISO 4898:2008 & ASTM C 578-08b-type VI, having thermal conductivity of 0.0289 W/mk as per ASTM C 578 (Measured as per IS 3346), Compressive strength of > 350 KPA listed as per ASTM D 1621, density of 34-36 kg/Cum as per ASTM D 1622, Water absorption < 1% by Volume as per ASTM D 2842, Oxygen Index of 24.1 to 28.1 listed as per ASTM D 2863, cell size 0.4mm of dia (max) as per ASTM D 3576. Fire retardant property as per DIN , Part 1 of Class B2 and as per ASTM E 84 Class A.

26.12.2 Installation Process
1. The specified Under Deck Insulation System shall be applied by an Authorized applicator only.
2. The level of the slab should be checked and kept within permissible limit of variation of 3 to 5mm.
3. The Substrate/Roof Underdeck on which the insulation system needs to be installed must be free from all waste products such as petroleum, grease, oil, solvents, vegetable or mineral oil, **a**nimal fat etc.
4. The Insulation board must be fixed to the concrete slab from inside with the help of water based adhesive and Fasteners with PVC Capping. This has to be ensured that the PVC screws are embedded in the concrete with a minimum distance of 50mm from the edges and have a pull out strength of 0.3 kN.

26.12.3 Requirement for extruded polystyrene rigid insulation board (Fig.26.9)

Since this product is a performance based product, the third Party testing is Mandatory and should be done from any NABL approved laboratory or any other accreditation body which operates in accordance with test ISO/IEC 17011 and accredits labs as per ISO/IEC-17025 for testing. The test requirements as listed in table 26.3.

Table 26.3

Sr. No	Requirement	Test Standard	Remarks
1	Thermal Conductivity Having 180 days aged thermal conductivity of 0.0289 W/mk.	ASTM C 578	Mandatory
2	Compressive strength of > 350 KPA.	ASTM D 1621	Mandatory
3	Density of 34-36 kg/Cum.	ASTM D 1622	Mandatory
4	Water absorption < 1% by Volume.	ASTM D 2842	Mandatory
5	Oxygen Index of 24.1 to 28.1	ASTM D 2863	Mandatory
6	Cell size 0.4mm of dia (max).	ASTM D 3576	Mandatory
7	Fire retardant property as per DIN , Part 1 of Class B2	------	Mandatory
8	Fire retardant property	ASTM E 84 CLASS A	Mandatory

26.12.4 Measurements

Length and breadth of the roofing insulation shall be measured correct to a cm and the surface area worked out in square metre of the finished work.

No deduction shall be made for openings of areas upto 0.40 square metre. No extra payment will be made for any extra material or labour involved in forming such openings. For openings exceeding 0.40 square metre in area, deduction for the full opening will be made, but no extra will be paid for any extra material or labour involved in forming such openings.

26.12.5 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above including scaffolding if any required.

26.13 FACTORY MADE SOLID FOAM UPVC PROFILE FOR KITCHEN CABINET FRAME AND SHUTTER/PARTITION

26.13.1 Material

uPVC (un-plasticised polyvinyl chloride) is PVC resin blended with acrylic modifier, titanium dioxide and other chemicals. Then it is processed through machine and mould to produce required solid Foam uPVC multi-chambered profiles.

The factory made solid Foam uPVC white colour doors and windows shall be comprising of approved solid Foam uPVC make multi-chambered frames, sash and mullion duly reinforced with appropriate thickness of galvanised iron section of required length, an appropriate dimension of solid Foam uPVC glazing beads, EPDM gasket according to frame/sash profile and specified hardware and fittings of approved make having dimensions as per nomenclature of items. There are two type of solid Foam uPVC extruded profile series which are used depending upon the size and design of kitchen cabinet frame. Depth and width of the profile mentioned in the nomenclature of the item is as following.

(i) **Depth of a profile (D)-** Dimension which is measured at right angles to the glazing plane, between the front and back face surfaces of a profile.

(ii) **Width of a profile (W)**-Dimension, measured in the direction of the glazing plane, and perpendicular to the longitudinal axis of the profile.

Tolerance in profile dimension

For solid Foam uPVC frame, sash and mullion extruded profile minus 5 % tolerance in dimension. i.e in depth and width of profile shall be accepted. Variation in profile dimension in higher side shall be accepted but no extra payment on this account shall be made.

26.13.2 Terminology

(a) Frame

Non movable or fixed portion of the kitchen cabinet frame and shutter/Partition attached to the wall and to which the sash is assembled.

(b) Sash

Movable part in a kitchen cabinet frame and shutter/Partition.

(c) Glazing Bead

Profile which holds the glass or any other partition materials.

(d) Transom (or Mullion)

Profile used within the frame, vertically or horizontally in a frame and/ or sash.

26.13.3 Marking

Solid Foam uPVC profiles shall be legibly and visibly marked in an unobtrusive position not visible when the window is closed at least once every one meter along the length of the profile and it should be visible when the window is open as well as shall contain the following minimum information on the main profile such as frame, sash and mullion/transom.

(i) The name of the trade mark or brand name of the manufacturer

(ii) Date of manufacturing and profile code

26.13.4 Testing (Criteria for conformity)

The Solid Foam uPVC extruded hollow profiles use in kitchen cabinet frame and shutter/ Partition shall conform to the specification as per EN 12608 and other standards as mentioned in table 26.4

Table 26.4

S.No	Name of the test	Test Method	Specified Parameter
i)	Vicat Softening Temperature	EN ISO – 306	Shall not be <750C
ii)	Charpy Impact Strength	EN ISO – 179-2	Shall not be <20KJ/m^2
iii)	Flexural Modulus Elasticity	EN ISO – 178	Shall not be <2200 N/mm2
iv)	Tensile Impact Strength	EN ISO – 8256	Shall not be <600 KJ/m2
v)	Mean Breaking Stress for welded corner a) For the tensile bending test or b) For the compression bending test	EN – 514	 Shall not be <25 N/mm2 Shall not be<30N/mm2
vi)	Heat Reversion Test	IS:4985-2000	Shall not be> 2.0 %

For the determination of the weld ability of profiles, welded corners shall be tested for tests as mentioned above. The sample subjected to weld test shall not be finished by grooving and knifing etc. except for the outside edge of 90 degree angle, which shall be cleaned to permit the sample to sit fully on to the support.

Minimum percentage of titanium dioxide content in Solid Foam uPVC profiles shall not be less than 7.00 percent and calcium carbonate content shall not be more than 10.00 percent.

The Solid Foam uPVC kitchen cabinet frame and shutter/Partition shall be factory fabricated by the approved manufacturer and installation work shall be carried out by them or their authorised vendor duly approved by the Engineer -in -charge.

26.13.5 Configuration

Indicative size and configuration of kitchen cabinet frame and shutter/Partition to be provided, same shall be specified in the item and figure included in the tender document.

26.13.6 Fabrication

(i) According to the drawing, the required dimension and length of Solid Foam uPVC frame, sash and mullion profiles shall be mitred cut and reinforced with galvanised iron section of required length and thickness.

(ii) All frame and sash profiles of kitchen cabinet frame and shutter/Partition shall be fusion welded at all corners. Mullion and Transom profiles shall also be fusion welded as per window / door design so as to prevent any ingress of water or air in the reinforcement chamber.

(iii) Each corner and joints shall be neatly cleaned by removing all excess material. The weld shall be finished by grooving, knifing etc. at exposed welded portion only.

(iv) The kitchen cabinet frame and shutter/Partition shall be designed and provided water drainage/ventilation slots in profile of frame, sash, transom or mullion in order to permit the escape of entrapped water, moisture from the system. A minimum of 2 nos slots shall be provided at least at every 500 mm. The drainage shall be so designed as not to puncture the reinforcement chamber and prevent water running through the reinforcement chamber. The holes and slots shall offset between the inner and outer walls so as to prevent any back flow.

26.13.7 Reinforcement

(i) The reinforcement material should be non-hygroscopic and should have no adverse effect of the performance of the kitchen cabinet frame and shutter/Partition and it shall confirm to any grade of IS 1079 or IS 513.

(ii) Mild steel section reinforcement made from Roll forming process and shall be hot dip zinc galvanised in accordance with IS 277 with a minimum coating mass of 120 gm/sqm.

(iii) The thickness of reinforcement shall be as such that the Solid Foam uPVC kitchen cabinet frame and shutter/Partition meet the design wind pressure in accordance with IS 875 (Part-3) and design of the reinforcement should be as per Solid Foam uPVC profile manufacturer recommendation and fix to ensure adequate fastener retention.

(iv) Galvanised mild steel reinforcement section is to be inserted in Solid Foam uPVC frame, sash and mullion profile of required length with in 6 to 15 mm distance from the face of the weld and then shall be screwed at 150mm from the end at every 400 mm (maximum) pitch to Solid Foam uPVC profile so that it does not move or rattle.

26.13.8 Kitchen cabinet frame and shutter/Partition Hardware and Fittings

Materials for all hardware except for fixing shall have at least the equivalent corrosion resistance of EN 1670-1988 grade 4 (240 hrs) when subjected to natural salt spray testing in accordance with EN ISO 9227. Testing shall be carried out on complete hardware items and also duly approved by the Engineer - in - charge before use at the site of work.

Hardware like hinges, rollers and locking devices which have been life cycle tested in accordance with EN 199 (Windows and Doors - Resistance to repeated opening and closing - Test method) and have achieved at least 10,000 operating cycles (i.e. opening and closing) without deterioration, failure or excessive wear.

These shall be provided as per nomenclature of item of approved make and duly approved by Engineer-in-Charge before fixing at site of work. Hardware / fittings such as handle, roller, touch lock, multipoint locking, 3D hinges, friction hinges etc. shall be directly screwed not pre-drilled or hammered.

26.13.9 For kitchen cabinet frame and shutter/Partition

Approved quality stainless steel friction hinges (SS 304 grade) with SS screws shall be provided as per nomenclature of item and length of friction hinges should cover more than 60 percent width of the shutter and two number friction hinges required for each shutter one at top and one at bottom.

26.13.10 Tolerance

The tolerance in dimensions of finished kitchen cabinet frame and shutter/Partition in size shall not be more than + 5mm from the approved drawing dimension.

26.13.11 Installation

(i) There shall be a maximum gap of 3 to 5mm in between Solid Foam uPVC door / window frame and finished opening and the plastic packers shall be provided to maintain the level.

(ii) To maintain the exact dimension of door or window, the opening shall be checked for dimension and orthogonally using a prefabricated template. Any defect shall be made good by the agency at his own cost before fixing of door or window**.**

(iii) The Solid Foam uPVC frames are to be fixed in prepared opening in the walls. kitchen cabinet frame and shutter/Partition shall be fixed into the aperture by drilling through the outer frame to the existing structure and shall use 100 x 8mm fasteners of approved make.

(iv) The gap between Solid Foam uPVC kitchen cabinet frame and shutter/Partition and adjacent RCC/Brick/Stone cladding work shall be filled with weatherproof Silicon sealant of approved make to maximum 5mm depth and 5mmin width to allow expansion/contraction of Solid Foam uPVC profiles. Silicon sealant of matching colour of Solid Foam uPVC profile shall be applied over backer rod.

26.13.12 Precautions taken before installation of Solid Foam uPVC kitchen cabinet frame and shutter/Partition

(i) Jambs, sills and soffits of the opening shall be finished with plaster / stone / tiles according to agreement where Solid Foam uPVC kitchen cabinet frame and shutter/Partition to be fixed.

(ii) Aperture shall be smooth in line and level as well as in plumb.

(iii) Flooring (where kitchen cabinet frame and shutter/Partition is to be installed should be complete before installation of door).

(iv) Installation of Solid Foam uPVC kitchen cabinet frame and shutter/Partition should be done before the last coat of the paint on the wall where window jambs, sills and soffits to be finished by paint. Atleast one coat of paint should be done before installation begins.

(v) The colour of the profile shall be same and uniform on any surfaces or part of the surfaces which may be visible after installation of the kitchen cabinet frame and shutter/Partition fabricated from the profile, when viewed by the normal vision.

(vi) The Solid Foam uPVC profiles manufacturer shall provide warranty of 10 years for colour fastness and any manufacturing defects in respect of Solid Foam uPVC profiles as well as water and air tightness in case of casement Solid Foam uPVC kitchen cabinet frame and shutter/Partition unit.

(vii) Solid Foam uPVC kitchen cabinet frame and shutter/Partition hardware and fittings manufacturer shall provide warranty of 10 years for any manufacturing defects.

26.13.13 Mode of Measurement

The length and width of the kitchen cabinet frame and shutter/Partition shall be measured from outer to outer face of the Solid Foam uPVC frame correct to a centimetre. Area shall be calculated in square meter nearest to 0.01 square metres.

26.13.14 Rate

The rate includes the cost of all labour, material and T&P involved in all the operations described above at all heights of the building. The cost of glass panes, wire mesh and silicon sealant shall be paid separately.

26.14 REINFORCED SOIL RETAINING WALLS USING GEOGRIDS

26.14.1 General

The work shall include the design and construction of reinforced soil structures using geogrids. Geogrids are defined as ***a geosynthetic reinforcement material consisting of connected parallel sets of polymeric tensile ribs with apertures of sufficient size to allow strike-through of surrounding soil, aggregate or other particulate matter.*** The ribs are called *longitudinal* and *transverse* respectively, depending on the direction of major stress. The connection points of the longitudinal and transverse ribs are called *junctions / nodes*. The openings in the geogrids, which are usually, square, rectangular or oval, are called apertures.

The primary function of geogrid is soil reinforcement. In those applications where the direction of major stresses are known, like reinforced walls & embankments, reinforced slopes, etc. *unidirectional* or *uniaxial geogrids* are used. In applications where the stresses comefrom random directions in the plane of the geogrid, *bidirectional or biaxial* grids are used. In addition, geogrids having three sets of ribs, at 120° to each other, where strength is balanced along the three rib directions, are also available, These are called triaxial geogrids, and may be used if the situation so demands.

In essence geogrids are of three types from the point of view of manufacturing process :

(a) Extruded Polyethylene (PE)or Polypropylene (PP) (uniaxial, biaxial or triaxial)

(b) Coated yarn of Polyester (polyethylene terephthalate-PET)or Polyvinyl Alcohol (PVA) coated with PVC or latexor Bitumen or any such similar coating for purpose ofenvironmental protection). The entanglement of the yarn at the nodes is an important parameter which varies from product to product (unidirectional or bidirectional)for providing dimensional stability to the product.

(c) High tenacity PET or PP straps or rods are overlapped longitudinally and transversely and the junctions are ultrasonically or laser bonded to form stable geogrids (unidirectional or bidirectional).

This specification does not cover the soil reinforcement works executed with metallic reinforcement, or with geotextiles as reinforcement or natural fibre (coir or jute or bamboo) reinforcement materials or with Geowebs / geocells.

It also does not cover 'Hybrid' systems, where multiple/ more than one type of reinforcement product /system is used within the same structure.

Geogrids are used in the following applications :

(a) Sub-base / Foundation reinforcement

(b) Erosion control

(c) Reinforced Soil Walls and Slopes

(a) Sub-base / Foundation reinforcement :

Geogrids for use as reinforcement of sub-base of pavements or foundations shall be biaxial grids and shall meet the requirements listed in Table 26.5 :

Table 26.5

Property	Unit	Stipulation	Test Method
Stiffness @0.5% strain	kN/m	≥ 350; both in MD and X-MD	ISO 10319
Tensile strength @2% strain	kN/m	≥ 15% of T_{ult}; both in MD and X-MD	ASTM D 6637
Tensile strength @5% strain	kN/m	≥ 20% of T_{ult}; both in MD and X-MD	ASTM D 6637
Junction efficiency for extruded	%	≥ 90% of rib ultimate tensile strength	ASTM WK 14256
Ultra-violet stability	%	≥ 70% after 500 hrs exposure	ASTM D 4355

Note : MD – Machine direction during manufacture

X-MD – Cross Machine direction during manufacture

All numerical values in the above Table represent MARV in the specified direction.

Minimum Average Roll Value (MARV) :

At least 6 sample rolls are taken from each lot of supply. "Lot" is defined by each quantum of continuous supply or each quantum of continuous manufacture, whichever is less OR as agreed between Engineer-in-Charge and contractor. From each of the rolls of material, at least 8 specimen are taken and tested for the required property. The arithmetic average over all specimen are calculated for each roll (average roll value). The minimum of the averages denotes MARV.

Statistically, MARV is 2 standard deviations less than the mean of average roll values. If the lot comprises more than 216 rolls, the number of samples should be ?(No. of rolls).

(b) *Erosion control:*

Detailed specifications for erosion control systems with geogrids shall be worked out as per manufacturer's specifications for the system adopted.

(c) Reinforced Soil Walls and Slopes :

Structures with faces steeper that 70° are considered as reinforced soil walls (RSW) (or mechanically stabilized earth walls) and structures with face inclinations < 70° are considered to be reinforced soil slopes (RSS). Some kind of facia system will be required for walls and slopes steeper that 45°

All reinforced soil walls or slopes shall be executed based on approved designs and drawings by the technical sanction authority. In case of EPC contracts, all generic specifications for reinforced soil walls or slopes, to the extent deemed fit by NIT approving authority, shall be made part of the tender document.

All reinforced soil walls and slopes having facia elements require connections between reinforcing elements and facia. The design of facia including architectural / aesthetic considerations shall be made part of the tender documents. Similarly, different manufacturers / vendors /solution providers propose different forms of soil reinforcement to facia connectors. The strength, elongation at load and durability of the connection shall be ascertained and generic requirements made part of the tender document. The performance guarantee of the system as a whole shall inter alia include the performance of facia and connectors.

In case of geonet or geocomposite drainage system provided in reinforced soil retaining walls or slopes, the specifications for the same shall be provided separately as per the drainage requirement and system adopted, based on manufacturer's specifications. Guidance may be taken from ASTM STP 1390 "Testing and Performance of Geosynthetics in Subsurface Drainage". The different patterns of Geo grids as shown in Fig 26.10, 26.11 and 26.12.

Reference may be made to IRC: SP:102-2014 "Guidelines for Design and Construction of Reinforced Soil Walls" for guidance on design principles, construction issues, quality control and common causes of failure of reinforced soil walls.

26.14.2 Physical and Mechanical Properties of Geogrids

26.14.2.1 General Requirements

The physical dimensional properties of the reinforcing elements like type of structure, rib/strap dimensions, junction type, spacing between rib/strap, thickness of reinforcement elements, which vary from product to product, can be readily measured for compliance with manufacturer's specifications / data sheet. Some physical properties like mass per unit area, roll width and length, weight of roll, etc. impact the logistical issues like truckability, wastage, etc.

The manufacturers of geogrids shall have ISO – 9001 certification for manufacturing process and quality control.

The product proposed to be used in the work shall have certification for use as soil reinforcing material from an agency accredited for certifying geosynthetic reinforcement product.

The polymers used in the manufacture of soil reinforcing geogrids shall be virgin material.

The manufacturer shall provide third party test reports from NABL (or Geosynthetic Accreditation Institute – Laboratory Accreditation Program [GAILAP]) accredited laboratories in India for quantity of geogrids beyond a limit to be specified in the Notice Inviting Tender. The said limit will depend on quantum of work, its location, urgency, availability of accredited laboratories, etc. For all quantities less than that, manufacturer's test certificate shall suffice. Test reports from IITs shall also be acceptable. In case of one laboratory not having the entire gamut of facilities, different tests may be got done from separate tests facilities.

26.14.2.2 Physical Properties

Density of the PE, PP, PET or PVA material of extruded geogrids or bonded strap geogrids can be measured using ASTM D 792 or ASTM D 1505. Coated PET yarn geogrids shall have molecular weight (ASTM D 4603) not less than 25000 gm/mol (minimum) and Carboxyl End Group Content (ASTM D 7409) which should not exceed 30 mmol/kg (maximum).

26.14.2.3 Engineering Properties of Geogrid

The following engineering properties are required to be provided for all types of geogrids intended to be used in the work :

(i) Wide width tensile strength (ASTM D 6637 or ISO 10319) : This is the Short term strength or characteristic strength (T_{CHAR}) or ultimate tensile strength (T_{ULT}). It is taken as the MARV strength i.e. mean strength less two standard deviations. Test for the ultimate tensile strength shall be carried out for each grade of reinforcement. The test results shall be accompanied by stress – strain curves showing strength at 2 % and 5% strain and strain elongation at failure.

(ii) Endurance properties denoted by the various reduction factors : The manufacturer shall provide third party test reports from above mentioned laboratories / IITs for all the tests needed to establish all the reduction factors listed below :

RF_{CR} - Reduction factor for creep

RF_{ID} - Reduction factor for installation damage

RF_{W} - Reduction factor for weathering

RF_{CH} - Reduction factor for chemical / environmental effects

f_S - Factor for the extrapolation of data. It caters to the statistical variation in the reduction factors but does not consider the uncertainties of soil structure and calculation of loads.

All the above factors shall be determined in accordance with the provisions of ISO/TR 20432 – "Guide to the determination of long term strength of geosynthetics for soil reinforcement".

The Long Term design strength (LTDS)is determined as :

$T_D = T_{CHAR} / R$; where $R = RF_{CR} \times RF_{ID} \times RF_{W} \times RF_{CH} \times f_S$

(iii) Junction efficiency is defined as a percentage of junction strength determined in accordance with ASTM D 7737 and single rib failure strength as per ASTM D 6637. It varies between 90 to 100% for extruded biaxial grids, 10 to 25% for woven or knit grids and 40 to 70% for bonded strap grids.

For extruded biaxial or triaxial geogrids, the junction efficiency shall be 95% ± 2%

26.14.2.4 Project Specific Tests :

Annual average Daily Temperatures (AADT) / design temperature of the project site shall be worked out and values of reduction factor for creep RF_{CR} and for RF_{CH} shall be provided as per procedures given in ISO / TR -20432.

Also Tests shall be carried out to provide the following parameters for all grades of geogrids used in the project :

(a) Pull-out coefficient as per ASTM D 6706 "Standard Test Method formeasuring Geosynthetic pullout Resistance in Soil" and;

(b) Coefficient of interaction between reinforced fill soil and geogrids as per ASTM D 5321 – " Standard Test Method for Determining the coefficient of soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method" or as per IS :13326 : Part 1 – 1992 " Method of test for the evaluation of interface friction between Geosynthetic and soil : Part 1 Modified direct shear technique".

One set of project specific tests shall be conducted at field or hird party accredited laboratory or at any reputed institute like IITs, which may be mentioned in the tender.

26.14.3 Engineering Properties of Earth Fill

The fill material in the reinforced soil zone shall have drained or effective angle of friction not less than 30^0, measured in accordance with IS :2720 (Part 13), by conducting a drained direct shear test. In case the fill material has 25 percent or more particles of 4.75 mm or larger, drained shear test using large shear box may be conducted (IS :2720 : Part 39 : Section 1).

The Plasticity Index of the fill material shall be $\leq$6.

The gradation of fill soil shall be as per limits specified in Table 26.6

Table 26.6

Sieve Size	Percentage Passing
75 mm	100%
425 micron	0 – 60%
75 micron	< 15%

Materials with more than 15 percent passing 75 micron sieve, but less than 10 percent of particles smaller than 15 microns are acceptable provided Plasticity Index (PI) is less than 6 and angle of internal friction (∅) is not less than 30°.

Where Geosynthetic reinforcement material used is polyester yarn, the pH value of the fill material shall be between 3 and 9. For Geosynthetic reinforcement material manufactured from PVA, PP and HDPE, the pH value of the fill material shall be greater than 3. The pH value of the soil fill shall be determined as per IS : 2720 (Part 26) – 1987 (Reaffirmed 2016)

Fly ash may be used as fill materials in reinforced soil walls provided its angle of internal friction (∅) is not less than 30° and PI is less than 6. Reference may be made to IRC Guide lines on Use of Fly ash in Road Embankments (IRC:SP-58).

Fly ash shall also satisfy requirements concerning pH values as above.

The fill materials used in the reinforced soil zone shall be free from organic or other deleterious materials and shall not react adversely (chemically, electrically or biologically) with the reinforcement material and / or facia material.

Properties of fill soil in the reinforced zone, unreinforced zone (or retained / back fill) soil and the foundation soil shall be determined accurately during the construction phase, as per quality assurance plans and directions of Engineer-in-Charge so as to ensure that these are the same as those considered in the design.

The fill soil in the unreinforced zone shall also conform to the requirements specified in the design.

26.14.4 Identification, Transportation, Storage and Handling

Geogrids shall be procured in roll form of width as per design requirement and with the prior approval of the Engineer-in-Charge. All rolls shall have a protective cover with a label or tag (at multiple locations and inside the core of the rolls in accordance with ASTM D 4873) specifying name of the product, name of the manufacturer, roll number, date of manufacture and roll dimensions.

Material shall be protected from sunlight, mud, dirt, debris, any other harmful substances or mechanical damage during transportation.

Rolls shall be stored in a secured area sufficiently elevated above the ground and adequately covered to protect them from the following: Construction site damage, precipitation, prolonged exposure to ultraviolet radiation including sunlight, chemicals that are strong acids or strong bases, flames including welding sparks, high temperatures, and any other environmental conditions that may damage the physical property values of the Geogrid.

Any material, which is damaged during transportation, handling or storage and do not meet the minimum requirements of the specifications, rendering it unsuitable for use in the specific application, is liable for rejection by the Engineer-in-Charge.

26.14.5 Failure Definition, System Responsibilty and Performance Bond

The design life, performance criteria and failure definitions shall be as per FHWA-NHI-10-024 and IRC : SP : 102-2014. The design of reinforced soil wall or slope shall spell out the design life, performance criteria and failure definitions. For example, the deformations of the wall / slope or any component thereof exceeding the design values, any visible structural distress in any wall element, any subsidence of the top surface of reinforced soil leading to distress in the infrastructure which is structurally dependent on the reinforced soil wall or slope or foundation system, etc. are some conditions to be watched.

The decision of the Engineer-in-Charge as to the failure or otherwise of the reinforced soil wall or slope or foundation system shall be final and binding on the contractor.

In case of failure, approved retrofitting measures may be adopted, duly vetted by expert institutions like IITs, at the risk and cost of the contractor. The retrofitting measure shall be approved by the Engineer-in-Charge.

Alternatively, and as a last resort, the whole or part of the structure, which has failed, shall be dismantled and redone to the entire satisfaction of the Engineer-in-Charge.

If specified in the contract, the reinforced soil system performance shall be covered under performance guarantee of the entire work, and no separate defect liability period or bond need be specified for the reinforced soil structure. However, corporate guarantee for system performance for a period covering the Defect Liability Period or more may be sought from the contractor.

26.14.6 Installation & Measurement for Payment

26.14.6.1 Site Preparation

The site shall be prepared by clearing, grubbing, and excavation or filling the area to the design grade. This includes removal of topsoil and vegetation.

26.14.6.2 Foundation:

The foundation shall be aleveling pad of minimum 100mm width over and above the width of the facia element, and 150mm thick M10 grade plain concrete, provided at a depth not less than 1000mm to receive the facia elements and / or bottom most layer of reinforcement. The designer may provide higher specifications if the situation at site so demands.

26.14.6.3 Laying of Geogrid

The geogrid shall be laid perpendicular to the face of the wall with greater cross sectional dimension in the horizontal plane. The geogrid shall be laid stretched and smooth without wrinkles or folds on the prepared subgrade (or within the granular subbase / base course if shown in the drawings) with the machine direction oriented in the direction of major stress or as shown in the drawings. It shall be held taut by suitable arrangement at site.

Geosynthetic uniaxial reinforcement shall be placed in continuous longitudinal rolls in the direction of the main stress. Joints parallel to the wall shall not be permitted, except as shown on the working drawings. Reinforcement coverage shall be a given percent of embedment area to be mentioned in the design / working drawings, as per the type of reinforcement being used. Adjacent sections of geosynthetic reinforcement need **not**be overlapped or mechanically connected. In case of biaxial / triaxial reinforcement applications, overlap / connections shall be as per manufacturer's requirements.

On curves, the geogrid may be folded or overlapped to conform to the curves. The fold or overlap shall be in the direction of construction and held in place by pins, staples, etc.

Prior to placing sub base / base course material the installed geogrid shall be inspected and approved by the Engineer-in-Charge. Any minor damages shall be repaired by covering the damaged location with a geogrid patch, which shall be mechanically connected to the parent reinforcement, as directed by the Engineer-in-Charge.

26.14.6.4 Placing and Compacting Sub base/base course

The sub base or base shall be placed by end dumping onto the geogrid from the edge of the geogrid or over previously placed sub base or base aggregate. The dumper shall move in reverse direction over the spilled material.

Movement of construction equipment directly over the geogrid shall not be permitted. The grid shall have a minimum compacted thickness of 150 mm over the grid before allowing movement of vehicles, the speed of which shall be limited to 10 km/hr.

Sudden breaking and sharp turning of construction equipment shall be avoided on the first lift of earth over the geogrid.

26.14.6.5 Specifications for Facia

The facing system shall be one of the following :

(a) **Precast reinforced concrete panels:**

The minimum thickness of precast concrete panels shall be 180 mm including facing textures, logos and embellishments. The grade of concrete shall be minimum M35. The concrete shall conform to the requirements of IS 456-2000.

Facia panel systems shall have provision of both horizontal and vertical gaps to prevent concrete to concrete contact. The horizontal gap between the facing elements shall be maintained by provision of Ethylene Propylene Diene Monomer (EPDM) pad.

The joints between the panels shall be covered from inside (inner face side)with non – woven geotextile strips glued to the facing element ensuring full coverage of joints, to prevent loss of aggregate filter material. Synthetic glue shall be used for this purpose. The width of the geotextile strip shall not be less than 100 mm. This provision of covering of panel joints with geotextile strips need not be followed if Geocomposite filter is used in place of aggregate filter media.

All dimensions of the RCC panel facia elements shall be within ± 5mm, except thickness for which tolerance shall be (+)5mm & (-) 0mm. Additionally, the evenness of the front face shall be ± 5mm over 1500 mm length. The difference between length of the two diagonals shall not be more than 5mm.

(b) **Precast concrete interlocking blocks or Precast concrete hollow blocks:**

Precast concrete blocks are dry cast and shall be manufactured from fully automatic block making machines. The minimum grade of concrete shall be M 35 for all kinds of modular blocks. In case of hollow blocks, the hollow area shall not exceed 40 percent of the cross sectional area of the block. The outer side of the block shall have minimum thickness of 100mm.The hollow area shall however be filled with filter media.

The dimensional tolerance for length and width shall be ±2.5mm and for height ±1.5mm.

(c) **Gabion facing:**

Where gabion facia is used, it shall conform to the provisions of BS – 1:2010 and EN 14475 and made of mechanically fabricated double twisted hexagonal mesh. Wire used for the double twisted mesh and selvedges shall be hot dip galvanized as per IS : 4826 – heavily coated and soft type, with wire and mesh properties in accordance with EN – 10223 with minimum Zn + alloy coating as per EN – 10244 and 0.5 mm thick PVC coating as per EN – 10245 and ISO – 527.

(d) **Wrap around facia using geotextiles:**

Where geosynthetics, including geogrids are used as wrap around facia, these shall form a part of the reinforcing element. The wrap around shall have adequate length to resist pull out and the wrap around length shall be calculated on the basis of safety in pull out. Wrap around facia shall be protected by suitable means, against adverse effects of UV and other elements of nature.

(e) Other proprietary and proven systems at the discretion of NIT approving authority

The facing material as well as the connections between facia and reinforcement shall be sufficiently flexible to withstand any deformation of the fill and foundations.

The facia shall have an inward batter as shown in the drawings so that the tendency of the facia panels to bulge outwards is countered.

Facia type adopted shall be given in the design and shown with complete details in the drawings. The system supplier shall provide any test data to satisfy the Engineer-in-Charge regarding the properties and suitability of the facia system adopted, if so required.

Where facia such as wrap around or gabion or welded wire and woven steel wire mesh facings have been used and where climate conditions are appropriate, a green finish may be provided where specified.

26.14.6.6 Connection between the Facia And Reinforcement

Connection between the facia panels and the reinforcing element shall be by using either nut or bolt, HDPE inserts with bodkin joint, hollow embedded devices, polymeric/galvanized steel strips , / rods,/pipes, / loop & toggle , fiber glass dowels or any other material shown in the drawings. The connection between the panel and the reinforcement shall provide for 100 percent of the long term design strength of the reinforcing element in continuity. Proprietary connections systems may be provided as per design, subject to the condition that they are compliant with the design requirements and durable.

In case of modular block facia and other type of facia such as gabion facia, where the reinforcement is held by friction between the facia block and the reinforcement, the connection strength shall be determined as per ASTM D 6638 :Standard Method of Test for Determining Connection Strength between Geosynthetic Reinforcement and Segmental Concrete Units".

The available connection strength shall satisfy the design requirements and shall not be less than the maximum possible tensile force that the reinforcement layer under consideration may be subjected to.

26.14.7 Measurement for Payment & Rates

(i) Reinforced Soil Wall :

The measurement for payment for reinforced soil wall shall be in square meters of finished work of each face and shall be measured in the plane of final inclination specified in the drawings. The measurement of length shall be the finished work along the length of the road. The measurement of height along the slope shall be done from the top level of the footing on which the facia element is placed to the top of the capping beam.

Measurement for friction slab and crash barrier shall be made separately.

(ii) Reinforced Soil Slope :

The measurement for payment for reinforced soil slope shall be in square meters of finished work of each face and shall be measured in the plane of final inclination specified in the drawings. The measurement of height along the slope shall be done from the top of the leveling pad, where provided, to the top of the embankment. Where leveling pad is not provided, the height shall be measured, in the final plane of inclination specified in the drawings, from the bottom of the slope faceto the top of topmost facing element provided.

Measurement and payment of friction slab and crash barrier if provided shall be made separately.

(iii) Rates:

The rate shall include cost of material, labour, plant and machinery, royalties, handling, storage and transportation expenses, leveling pad, facia elements, coping beam, connectors, reinforcing elements, scaffolding, all inclusive EXCEPTSupply and installation of the specified filter media material, bed block, supply of soil fill for the reinforced as well as unreinforced zone of the quality specified in the contract, placing, spreading and compaction through mechanical means, which shall be measured separately.

No separate measurements for overlaps, wastages, or on any other account shall be admissible, unless specifically provided for in the tender.

The rate shall include full compensation for design, drawings and testing of materials, as per tender conditions.

The rate shall NOT include the cost of investigations, design and construction of ground improvement measures, if required. The same shall be provided and paid as per NIT.

The payment for friction slab and crash barrier shall be made separately.

26.14.8 Design and Drawings:

The design of reinforced soil structure, the same shall be carried out in accordance with the following standards as applicable :

(i) BS:8006-1-2010 “Code of Practice for Strengthened /Reinforced Soils and other Fills”.

(ii) IRC:SP:102-2014 “Guidelines for Design and Construction of Reinforced Soil Walls”.

(iii) FHWA – NHI-10-024 and FHWA – NHI-10-025 – “ Design and Construction of

Mechanically Stabilized Earth Walls and Reinforced Soil Slopes”

The design shall include the design of drainage system for the reinforced soil wall or slope or foundation system.

26.14.9 Quality Control and Testing

The quality management system of the manufacturer shall conform to the requirements of ISO 9001:2015.

Manufacturer shall issue a test report stating minimum average roll values of material properties, at the time of shipment from factory.

CE-certification should be required for supply of polymer geogrid material.

Manufacturer shall submit proof of having supplied to –

(i) One project in India having at least 80% of the tender quantity, OR

(ii) Two projects in India having at least 60% of the tender quantity, OR

(iii) Three projects in India having at least 40% of the tender quantity

The manufacturer shall submit project references if required by the Engineer-in-Charge.

In addition, at least one of the above qualifying projects shall have performed satisfactorily for at least a 5-year period. Owner / Engineer’s certificate to that effect shall be submitted.

The NIT approving authority may, for recorded reasons, alter the above specifications due to exigencies of work.

26.15 ALUMINUM PROFILE INDUSTRIAL TROUGHED SHEET ROOFING

26.15.1 MATERIALS

26.15.1.1 Aluminum profile industrial troughed sheet

These shall be made of alloy 31500/ 31000/40800 of thickness specified in the description of the item and Chemical Composition of Wrought Aluminium and Aluminium Alloy Sheet and Strip shall conform to IS 737. The weight of the sheet shall not be less than the value as per table 26.7.

Table 26.7

Thickness (mm)	Weight of Sheet (Kg)		
	Per Sqm. Sheet	Per metre Length	
		920mm wide	1044mm wide
0.91	3.23	2.96	3.36
0.71	2.50	2.31	2.62

The sheets shall be free from cracks, split edges, twists, surface flaws etc. They shall be clean, bright and smooth. The sheets shall not show signs of rust or white powdery deposits on the surface. The corrugations shall be uniform in depth and pitch and parallel with the side.

26.15.1.2 Purlins

Purlins of the specified material or M.S. rolled sections of requisite size shall be fixed over the principal rafters. These shall not be spaced at more than the following distances. (Table 26.8)

Table 26.8

Thickness of sheet	Maximum spacing of purlins (intermediate)	Maximum spacing of purlins (ends)
0.71 mm	0.80 metre	0.55 metre
0.91 mm	1.20 metre	0.80 metre

The unsupported overhang sheets should not be more than 100mm and 150mm for the sheet thickness of 0.71mm and 0.91mm respectively. The top surfaces of the purlins shall be uniform and plane. They shall be painted before fixing on top. Embedded portions of wooden purlins shall be coal tarred with two coats.

26.15.2 Slope

Roof shall not be pitched at a flatter slope than 1 vertical to 6horizontal. The normal pitch adopted shall usually be 1 vertical to 4horizontal.

26.15.3 Laying and Fixing

The sheets shall be laid and fixed in the manner described below, unless otherwise shown in the working drawings or directed by the Engineer-in-Charge.

The sheets shall be laid on the purlins to a true plane, with the lines of corrugations parallel or normal to the sides of the area to be covered unless otherwise required as in special shaped roofs.

The sheets shall be laid with a minimum lap of 15 cm at the ends and 2 ridges of corrugations at each side. The above minimum end lap of 15 cm shall apply to slopes of 1 vertical to 2 horizontal and steeper slopes. For flatter slopes the minimum permissible end lap shall be 20 cm. The minimum lap

of sheets with ridge, hip and valley shall be 20 cm measured at right angles to the line of the ridge, hip and valley respectively. These sheets shall be cut to suit the dimensions or shapes of the roof, either along their length or their width or in a slant across their lines of corrugations at hips and valleys. They shall be cut carefully with a straight edge chisel to give a smooth and straight finish.

Sheets shall not generally be fixed into gables and parapets. They shall be bent up along their side edges close to the wall and the junction shall be protected by suitable flashing or by a projecting drip course, the later to cover the junction by at least 7.5 cm.

The laying operation shall include all scaffolding work involved.

Sheets shall be fixed to the purlins or other roof members such as hip or valley rafters etc. with fixed using self drilling/ self tapping SS screw (See Fig 26.13A & 26.13B) of size 5.5x65mm with EPDM seal complete upto required pitch in horizontal, vertical or curves surfaces.

When fastening with self-drilling fasteners, it is imperative that the screw point has cleared the substrate before the threads engage or the driller will actually pull the threads through the substrate faster than it can be drilled, thereby breaking the fastener.

The bolts shall be sufficiently long so that after fixing they project above the top of the nuts by not less than 10 mm. There shall be a minimum of three self drilling / self tapping placed at the ridges of corrugations in each sheet on every purlin and their spacing shall not exceed 30 cm.

The self drilling/ self tapping SS screw shall be continuous and free from defects such as blisters, flux stains, drops, excessive projections or other imperfections which would impair serviceability.

26.15.4 Finish

The roof when completed shall be true to lines, and slopes and shall be leak proof.

26.15.5 Measurements

The length and breadth shall be measured correct to a cm. Area shall be worked out in sqm correct to two places of decimal.

The superficial area of roof covering shall be measured on the flat without allowance for laps and corrugations. Portion of roof covering overlapping the ridge or hip etc. shall be included in the measurements of the roof.

Roof with curved sheets shall be measured and paid for separately. Measurements shall be taken on the flat and not girthed.

No deduction in measurement shall be made for opening upto 0.4 sqm and nothing extra shall be allowed for forming such openings. For any opening exceeding 0.4 sqm in area, deduction in measurements for the full opening shall be made and in such cases the labour involved in making these openings shall be paid for separately. Cutting across corrugation shall be measured on the flat and not girthed. No additions shall be made for laps cut through.

26.15.5 Rate

The rate shall include the cost of all the materials and labour involved in all the operations described above including all screws, seal, ridge, scaffolding, machinery for fixing and approved sealant where required etc. but excluding the cost of purlins, rafters and trusses.

26.16 ECO FRIENDLY LIGHT WEIGHT CALCIUM SILICATE FALSE CEILING (TEGULAR EDGED)

26.16.1 Materials

26.16.1.1 Tiles

Eco **f**riendly **l**ight weight **c**alcium silicate tiles shall be made from Non-cementitious hydrated wet moulded calcium silicate slurry/mixture, reinforced with fibers and natural fillers. Free from formaldehyde and other harmful materials. Does not contain any toxic ingredients. Shall have appropriate recycled material contents.

The Ceiling Tiles shall be of appropriate class and of finished thickness as specified in the description of the item .Only selected tiles of uniform width shall be used. Unless otherwise specified in the description of the item or shown in the drawings, the width of tiles selected for use shall not be less than 595 X 595 mm in size and shall be 15 mm thick integral densified tegular edged type, light weight wet moulded calcium silicate.

Where width of room/ corridor is in multiple of standard width of tiles, same pattern shall be maintained throughout the length. Where the width of rooms/ corridor is not in multiple of standard width of tiles, borders with appropriate width and material of boards shall be provided in design approved by the Engineer-in-charge and maintained uniformly throughout of the length/ width of room/ corridor. Eco Friendly Light Weight Calcium silicate tiles shall have the following properties:

(a) **Surface:** All tiles are prime coated on both sides. Standard finish in two coats white dispersion type, solvent free paint.

(b) **Dimensions:**
595mmx595mmx15mm thick tegular edged. Size referred to are always module sizes. The nominal panel size may differ depending on the suspension system used.

(c) **Thickness**: 10 mm thick in the center and 15mm thick all around on edge resting portion with integral densified edge.

(d) **Density of material:** 350 kg per cum in the central 10 mm thick portion and 450 kg cum on the edges, (Average 370 kg per cum as per ECBC Code 2007).

(e) **Relative humidity:** 100% RH resistant.

(f) **Fire resistance:** Non-combustible as per BS:476 Part-4. Fire performance: as per BS:476 (Part-6) for fire propagation and BS 476 (Part 7) for Surface spread of flame.

(g) Thermal conductivity: 0.048 W/m- K - 0.052 W/m- K as per ECBC Code 2007 and ASTM 518-1991.

(h) **Recycled Content:** Shall have 46-50% recycled content out of which 18-20% should be FLYASH.

(i) **Acoustic control:** Sound Attenuation 30-32dB
Noise reduction coefficient (NRC)

Plain & Designer tile: 0.10-0.15.

For Pin Hole/Texture pattern tiles: 0.20-0.30.

Pin hole/Texture fully perforated tile: 0.30-0.40.

For 5mm fully perforated 0.40-0.50.

For 5mm fully perforated with 50mm/48gsm glass wool 0.65-0.85.

(J) Light reflectance: >85%.

(k) Weight: 5 - 5.5Kg/m^2.

(l) Suspension system: Suspension system shall be made of roll-formed hot-dipped galvanized steel.

26.16.1.2 Frame

Frame is made up of interlocking metal T-grid of hot dipped galvanized steel sections of 0.33mm thick (Galvanized @ 120 gms/m^2 including all sides) comprising of main T runners of size 24 x 38mm of length 3000mm, cross T of size 24 x 32 mm of length 1200mm and secondary intermediate cross T of size 24 x 32mm of length 600mm to form grid modules of size 600 x 600mm. This grid shall be suspended from ceiling using galvanized mild steel members (Galvanized @ 80 gms/m^2 including all sides) i.e. 12x50mm long dash fasteners, 6mm dia fully threaded hanger rod upto 1000 mm length and L-shaped level adjuster of size 76 x 25 x 25x 1.6mm fixed with grid and Z cleat of size 25x37x25x1.6mm thick with precut hole on both 25mm flange to pierce into 12x50mm or even bigger dash fastener if require. Frame also consist of galvanized iron perimeter wall angle of size 24 x 24 x 0.40mm of length 3000mm to be fixed on periphery wall/ partition with the help of plastic rawl plugs at 450mm centre to centre and 40mm long dry wall SS screws.

The bottom surface of the frame shall be checked and corrected to true plans and slopes.

26.16.2 Fixing

Outer wall angle shall be fixed accurately and truly at required height and level, parallel and close to the wall. Thereafter all the T members shall be placed and fixed carefully to form the grid. The grid comprises of main T-runners at 1200mm centres securely fixed to the structural soffit by approved and adjustable hanger rods at 1200mm maximum centres and not more than 150mm from spliced joints of main T-runners. The last hanger at the end of each runner should not be greater than 600mm from the adjacent wall. Similarly, cross T-runners of 1200mm length shall be placed at 600mm centre to centre. 600x600mm modules to be formed by fitting 600mm long flush fitting cross Tees (secondary cross T) centrally between 1200mm cross T-runners. The tiles shall then be placed properly in the grids as per required pattern, texture and design/ drawing and as per directions of the Engineer-in-Charge. If required, level of the false ceiling grid shall be checked after placing of calcium silicate tiles and necessary adjustment shall be made wherever required through level adjuster.

26.16.3 Precaution:

(a) All wet trades such as plastering, conduting and painting etc, be completed prior to start of false ceiling works.

(b) Air conditioning duct work is to be completed preferably even before the suspension of the grid section.

(c) Electrical chasing or drawing lines & cables, etc are to be in place before start of false ceiling work.

(d) No unauthorized weight is put on false ceiling. Lighting fixtures, diffusers are to be suspended independently with proper chain/wire & dash fasteners as directed by Engineer In Charge/ manufacturer guide line.

(e) The area is dry prior to ceiling installation work.

26.16.4 Finishing

Care should be taken while placing Light Weight calcium silicate tiles into the grid so that there will be no displacement to grid and stains/ dirty marks put by the workers. (worker should preferably wear clean soft cotton gloves while placing tile).

26.16.5 Measurements

Length and breadth shall be measured correct to a cm. Areas shall be worked out to nearest 0.01sqm. The superficial area of the finished work ceiling shall be measured in square meters. No deduction in measurements shall be made for openings of areas upto0.36 Sqm. Nothing extra shall be payable either for any extra material or labour involved in forming such openings. For openings exceeding 0.36 sqm in area, deductions in measurements for the full opening in multiple of area of each tile (0.36 Sqm) will be made.

26.16.6 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above.

26.16.7 MTC: Manufacturers test certificate/ report of invoice to be submitted for every delivery challan by suppliers.

26.17 ECO FRIENDLY LIGHT WEIGHT CALCIUM SILICATE FALSE CEILING (MICRO LOOK EDGE) (Fig . 16)

26.17.1 Materials

26.17.1.1 Tiles

Eco friendly light weight calcium silicate tiles shall be made from Non-cementitious hydrated calcium silicate slurry/mixture, reinforced with recycled material and natural fillers. Free from formaldehyde and other harmful materials. does not contain any toxic ingredients.

Tiles shall be appropriate class and of finished thickness as specified in the description of the item. Only selected tiles of uniform width shall be used. Unless otherwise specified in the description of the item or shown in the drawings, the width of tiles selected for use shall not be less than 595 x 595mm in size and of approved texture, design and patterns and patterns and shall be 15mm thick integral densified micro-edged type light weight calcium silicate.

Where width of room/ corridor is in multiple of standard width of tiles, same pattern shall be maintained throughout the length. Where the width of rooms/ corridor is not in multiple of standard width of tiles, borders with appropriate width and material of boards shall be provided in design approved by the Engineer-in-charge and maintained uniformly throughout of the length/ width of room/ corridor. Calcium silicate tiles shall have the following properties:

(a) **Surface:** All tiles are prime coated on both sides. Standard finish in two coats white dispersion type, solvent free paint.

(b) **Dimensions:**

595mm x 595mm x 15mm thick integral densified micro-edge. Size referred to are always module sizes. The nominal panel size may differ depending on the suspension system used.

(C) **Thickness**: 10 mm thick in the center and 15mm thick all around on edge resting portion with micro look integral densified edge.

(d) **Density of material:** 350 kg per cum in the central 10 mm thick portion and 450 kg cum on the edges, (Average 370 kg per cum as per ECBC Code 2007).

(e) **Relative humidity:** 100% RH resistant.

(f) **Fire resistance:** Non-combustible as per BS:476 Part-4. Fire performance: as per BS:476 (Part-6) for fire propagation and BS 476 (Part 7) for Surface spread of flame.

(g) Thermal conductivity: 0.048 W/m- K - 0.052 W/m- K as per ECBC Code 2007 and ASTM 518-1991.

(h) Recycled Content: Shall have 46-50% recycled content out of which 18-20% should be FLYASH.

(i) Acoustic control: Sound Attenuation 30-32dB

Noise reduction coefficient (NRC)

Plain & Designer tile: 0.10-0.15.

For Pin Hole/Texture pattern tiles: 0.20-0.30.

Pin hole/Texture fully perforated tile: 0.30-0.40.

For 5mm fully perforated 0.40-0.50.

For 5mm fully perforated with 50mm/48gsm glass wool 0.65-0.85.

(j) Light reflectance: >85%.

(k) Weight: 5 - 5.5Kg/m^2.

(l) Suspension system: Suspension system shall be made of roll-formed hot-dipped galvanized steel.

26.17.1.2 Frame

Frame is made up of interlocking metal pre coated T-grid of hot dipped galvanized steel sections of 0.40mm thick on Silhouette profile comprising of main T runners of size 15 x 42mm of length 3000mm, cross T of size 15 x 42mm of length 1200mm and secondary intermediate cross T of size 15 x 42mm of length 600mm to form grid modules of size 600 x 600mm. This grid shall be suspended from ceiling using galvanized mild steel members (Galvanized @ 80 gms/m^2 including all sides) i.e. 12x50mm long dash fasteners, 6mm dia fully threaded hanger rod upto 1000 mm length, L-shaped level adjuster of size 76 x 25 x 25x 1.6mm fixed with grid and Z cleat of size 25x37x25x1.6mm thick with precut hole on both 25mm flange to pierce into 12x50mm or even bigger dash fastener if required Frame also consist of galvanized iron perimeter wall angle of size 22 x 19 x 0.40mm of length 3000mm to be fixed on periphery wall/ partition with the help of plastic rawl plugs at 450mm centre to centre and 40mm long dry wall SS screws.

The bottom surface of the frame shall be checked and corrected to true plans and slopes.

26.17.2 Fixing

Outer wall angle shall be fixed accurately and truly at required height and level, parallel and close to the wall. Thereafter all the T members shall be placed and fixed carefully to form the grid. The grid comprises of main T-runners at 1200mm centres securely fixed to the structural soffit by approved and adjustable hanger rods at 1200mm maximum centres and not more than 150mm from spliced joints of main T-runners. The last hanger at the end of each runner should not be greater than 600mm from the adjacent wall. Similarly, cross T-runners of 1200mm length shall be placed at 600mm centre to centre. 600x600mm modules to be formed by fitting 600mm long flush fitting cross Tees (secondary cross T) centrally between 1200mm cross T-runners. The tiles shall then be placed properly in the grids as per required pattern, texture and design/ drawing and as per directions of the Engineer-in-Charge. If required, level of the false ceiling grid shall be checked after placing of calcium silicate tiles and necessary adjustment shall be made wherever required through level adjuster.

26.17.3 Precaution:

a. All wet trades such as plastering, conduting and painting etc, be completed prior to start of false ceiling works.

b. Air conditioning duct work is to be completed preferably even before the suspension of the grid section.

c. Electrical chasing or drawing lines & cables etc are to be in place before start of false ceiling work.

d. No unauthorized weight is put on false ceiling. Lighting fixtures, diffusers are to be suspended independently with proper chain/wire & dash fasteners as directed by Engineer In Charge/ Manufacturer guide line

e. The area is dry prior to ceiling installation work.

26.17.4 Finishing

Care should be taken while placing Light Weight calcium silicate tiles into the grid so that there will be no displacement to grid and stains/ dirty marks put by the workers. (worker should preferably wear clean soft cotton gloves while placing tile).

26.17.5 Measurements

Length and breadth shall be measured correct to a cm. Areas shall be worked out to nearest 0.01sqm. The superficial area of the finished work ceiling shall be measured in square meters. No deduction in measurements shall be made for openings of areas upto0.36 Sqm. extra shall be payable either for any extra material or labour involved in forming such openings. For openings exceeding 0.36 sqm in area, deductions in measurements for the full opening in multiple of area of each tile (0.36 Sqm) will be made.

26.17.6 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above.

26.17.7 MTC: Manufacturers test certificate/ report of invoice to be submitted for every delivery challan by suppliers.

26.18 ECO FRIENDLY LIGHT WEIGHT CALCIUM SILICATE WALL PANELLING (FULLY PERFORATED SQUARE/ BUTT EDGED) (Fig . 17)

26.18.1 Materials

26.18.1.1 Tiles

Eco Friendly Light Weight Calcium silicate tiles shall be made from Non-cementitious hydrated calcium silicate slurry/Mixture, reinforced recycled material with fibers and natural fillers. Free from formaldehyde and other harmful materials. Does not contain any toxic ingredients.

Tiles shall be appropriate class and of finished thickness as specified in the description of the item. Only selected tiles of uniform width shall be used. Unless otherwise specified in the description of the item or shown in the drawings, the width of tiles selected for use shall not be less than 595 x 595mm in size and of approved texture, design and patterns and patterns and shall be 15mm thick fully perforated square/ butt edged type.

Where width and height of room is in multiple of standard width of tiles/panels, same pattern shall be maintained throughout the length. Where the width and height of rooms is not in multiple of standard width of tiles, cut tile of same design shall be used, material of tile shall be provided in design approved by the Engineer-in-charge and maintained uniformly throughout of the length / height of room.

Calcium silicate tiles shall have the following properties:

(a) **Surface:** All tiles are prime coated on both sides. Standard finish in two coats white dispersion type, solvent free paint.

(b) **Dimensions:** 595mmx595mm Butt look Edged. The nominal panel size may differ where cut tile are used to make similar pattern

(c) **Density of material:** 350 kg per cum in the central 10 mm thick portion and 450 kg cum on the butt edge, (Average 370 kg per cum as per ECBC Code 2007).

(d) **Relative humidity:** 100% RH resistant.

(e) **Fire resistance:** Non-combustible as per BS:476 Part-4. Fire performance: as per BS:476 (Part-6) for fire propagation and BS 476 (Part 7) for Surface spread of flame.

(f) **Thermal conductivity:** 0.048 W/m- K - 0.052 W/m- K as per ECBC Code 2007 and ASTM 518-1991.

(g) **Recycled Content:** Shall have 46-50% recycled content out of which 18-20% should be FLYASH.

(h) **Acoustic control:** Sound Attenuation 30-32dB

Noise reduction coefficient (NRC)

For 5mm fully perforated 0.45-0.65.

For 5mm fully perforated with 50mm/48 kg^3 density glass wool 0.65-0.85.

(i) **Light reflectance:**>85%.

(j) **Weight:** 5 - 5.5Kg/m^2

(k) **Glass Wool: (to be procured separately by installer** 50mm thick of density 48 Kg/m^3 shall be inserted uniformly before laying the tiles/panels.

(l) **Framing system:** Framing system shall be made from especially fabricated galvanized mild steel sheet of 0.50mm thick pressed sections.

26.18.1.2 Frame

Framing system shall be made from especially fabricated galvanized mild steel sheet of 0.50mm thick pressed sections having hot dipped galvanizing @120gms/m^2 including all sides. Framing system comprising of vertical studs of size 48 x 34 x 36mm, ceiling channel section of size 50 x 32mm fixed to the floor and soffit at 600mm centres and the channel section of size 50 x 32mm is then to be fixed in horizontal direction at 600mm centre to centre so as to form a grid of 600 x 600mm. .

The surface of the frame shall be checked and corrected to true verticality and slopes if any.

26.18.2 Fixing

Framing system shall be made from especially fabricated galvanized mild steel sheet of 0.50mm thick pressed sections having hot dipped galvanizing @120gms/m^2 including all sides. Framing system comprising of vertical studs of size 48 x 34 x 36mm placed at 600mm centre to centre in a floor and

ceiling channel section of size 50 x 32mm fixed to the floor and soffit at 600mm centres using 12mm dia, 50mm long wedge type expanded zinc alloy dash fastner with 10mm bolt. This channel is then to be fixed in horizontal direction at 600mm centre to centreso as to form a grid of 600 x 600mm.Glass wool of 50mm thickness and of density 48 Kg/m^3 is then to be inserted in the slot. Finally, calcium silicate tile/ panels are to be screw fixed with self-tapping pan head nickel coated M S screws of size 13 x 3.2mm on the grid leaving an even groove of 1mm between the panels/ tiles as per required pattern, texture and design/ drawing, preferably start from 2.5/4.0ft/window sill height or as per directions of the Engineer-in-Charge. Joint between the tiles/ panels are then be jointed and finished using recommended jointing calcium silicate based compound and fibre joint tape roll of 50 mm wide and two coats of primer suitable for paneling.

26.18.3 Finishing

Care should be taken while fixing Calcium Silicate Wall Panels / Butt edge tiles on the framing system, so that these are even surface, and no undulations are seen, nor the paint remains visible in the perforations, and no dirt marks are visible, (worker should preferably wear clean soft cotton gloves while placing tile).

26.18.4 Measurements

Length and breadth shall be measured correct to a cm. Areas shall be worked out to nearest 0.01sqm. The superficial area of the finished work paneling shall be measured in square meters. No deduction in measurements shall be made for openings of areas upto0.36 Sqm. Nothing extra shall be payable either for any extra material or labour involved in forming such openings. For openings exceeding 0.36 sqm in area, deductions in measurements for the full opening in multiple of area of each tile (0.36 Sqm) will be made.

26.18.5 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above.

26.18.6 MTC: Manufacturers test certificate/ report of invoice to be submitted for every delivery challan by suppliers.

26.19 CALCIUM SILICATE FALSE CEILING (TEGULAR EDGED- FIXED TO EXISTING T-FRAME)

26.19.1 Materials

26.19.1.1 Tiles

Eco friendly light weight calcium silicate tiles shall be made from Non-cementitious hydrated wet moulded calcium silicate slurry/mixture, reinforced with fibers and natural fillers. Free from formaldehyde and other harmful materials. Does not contain any toxic ingredients. Shall have appropriate recycled material contents.

The Ceiling Tiles shall be of appropriate class and of finished thickness as specified in the description of the item .Only selected tiles of uniform width shall be used. Unless otherwise specified in the description of the item or shown in the drawings, the width of tiles selected for use shall not be less than 595 x 595 mm in size and shall be 15 mm thick integral densified tegular edged type, light weight wet moulded calcium silicate.

Where width of room/ corridor is in multiple of standard width of tiles, same pattern shall be maintained throughout the length. Where the width of rooms/ corridor is not in multiple of standard width of tiles, borders with appropriate width and material of boards shall be provided in design approved by the Engineer-in-charge and maintained uniformly throughout of the length/ width of room/ corridor. Calcium silicate tiles shall have the following properties:

(a) **Surface:** All tiles are prime coated on both sides. Standard finish in two coats white dispersion type, solvent free paint.

(b) **Dimensions:**
595mmx595mmx15mm thick tegular edged. Size referred to are always module sizes. The nominal panel size may differ depending on the suspension system used.

(c) **Thickness**: 10 mm thick in the center and 15mm thick all around on edge resting portion with integral densified edge.

(d) **Density of material:** 350 kg per cum in the central 10 mm thick portion and 450 kg cum on the edges, (Average 370 kg per cum as per ECBC Code 2007).

(e) **Relative humidity:** 100% RH resistant.

(f) **Fire resistance:** Non-combustible as per BS:476 Part-4. Fire performance: as per BS:476 (Part-6) for fire propagation and BS 476 (Part 7) for Surface spread of flame.

(g) **Thermal conductivity:** 0.048 W/m- K - 0.052 W/m- K as per ECBC Code 2007 and ASTM 518-1991.

(h) **Recycled Content:** Shall have 46-50% recycled content out of which 18-20% should be FLYASH.

(i) **Acoustic control:** Sound Attenuation 30-32dB

Noise reduction coefficient (NRC)

Plain & Designer tile: 0.10-0.15.

For Pin Hole/Texture pattern tiles: 0.20-0.30.

Pin hole/Texture fully perforated tile: 0.30-0.40.

For 5mm fully perforated 0.40-0.50.

For 5mm fully perforated with 50mm/48gsm glass wool 0.65-0.85.

(j) **Light reflectance:** >85%.

(k) **Weight:** 5 - 5.5Kg/m^2.

26.19.1.2 Frame

Frame is already exists at site. The bottom surface of the frame shall be checked and corrected to true plans and slopes.

26.19.2 Fixing

The tiles shall be placed properly in the grids already exists at site, as per required pattern, texture and design/ drawing and as per directions of the Engineer-in-Charge/manufacturer guide line. If required. level of the false ceiling grid shall be checked after placing of calcium silicate tiles and necessary adjustment shall be made wherever required through level adjuster.

26.19.3 Finishing

Care should be taken while placing Light Weight calcium silicate tiles into the grid so that there will be no displacement to grid and stains/ dirty marks put by the workers. (worker should preferably wear clean soft cotton gloves while placing tile).

26.19.4 Measurements

Length and breadth shall be measured correct to a cm. Areas shall be worked out to nearest 0.01sqm. The superficial area of the finished work ceiling shall be measured in square meters. No deduction in measurements shall be made for openings of areas upto0.36 Sqm. Nothing extra shall be payable either for any extra material or labour involved in forming such openings. For openings exceeding 0.36 sqm in area, deductions in measurements for the full opening in multiple of area of each tile (0.36 Sqm) will be made.

26.19.5 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above.

26.19.6 MTC: Manufacturers test certificate/ report of invoice to be submitted for every delivery challan by suppliers.

26.20 GLASS FIBRE REINFORCED GYPSUM (GRG) FALSE CEILING (SEMI PERFORATED MICRO TEGULAR EDGED)

26.20.1 Materials

26.20.1.1 Tiles

Glass fibre Reinforced Gypsum (GRG) false ceiling tiles shall be made of Gypsum plaster of 75 microns particle size mixed with short length glass fibre filament of 20 microns ± 5 microns diameter to give it high strength and shall be free from harmful or any toxic ingredients.

Tiles shall be appropriate class and of finished thickness as specified in the description of the item. Only selected tiles of uniform width shall be used. Unless otherwise specified in the description of the item or shown in the drawings, the width of tiles selected for use shall not be less than 595 x 595mm in size and of approved texture, design and patterns and patterns and shall be semi perforated 12mm thick micro tegular-edged type GRG tiles.

Where width of room/ corridor is in multiple of standard width of tiles, same pattern shall be maintained throughout the length. Where the width of rooms/ corridor is not in multiple of standard width of tiles, borders with appropriate width and material of boards shall be provided in design approved by the Engineer-in-charge and maintained uniformly throughout of the length/ width of room/ corridor. GRG tiles shall have the following properties:

(a) **Surface:** The GRG false ceiling tiles shall be painted with white dispersion type solvent free paint.

(b) **Dimensions:** 595mm x 595mm Semi perforated 12mm thick micro tegular-edged type GRG tiles. Size referred to are always module sizes. The nominal panel size may differ depending on the suspension system used.

(c) **Density of material:** 700 to 850 kg per Cum.

(d) **Relative humidity:**99% RH resistant.

(e) **Fire resistance:** Non-combustible as per BS:476, Part-4: 1970

(f) Moisture Content: < 2%

(g) Acoustic control: Noise reduction coefficient (NRC) = 0.50 to 0.75 as per IS: 8225-1981.

(h) Light reflectance:>85%

(i) Suspension system: Suspension system shall be made of interlocking metal T-grids of hot-dipped galvanized iron section.

26.20.1.2 Frame

Frame is made up of interlocking metal T-grids of hot dipped galvanized steel sections of 0.33mm thick(Galvanized @ 120 grams per sqm including both sides) comprising of main T runners of size 15 x 32mm of length 3000mm, cross T of size 15 x 32mm of length 1200mm and secondary intermediate cross T of size 15 x 32mm of length 600mm to form grid modules of size 600 x 600mm. This grid shall be suspended from ceiling using galvanized mild steel members (Galvanized @ 80 gms/m^2 including all sides) i.e. 50mm long, 8mm outer diameter M-6 dash fasteners, 6mmdia fully threaded hanger rod upto 1000 mm length and L-shaped level adjuster of size 85 x 25 x 2mm. Frame also consist of galvanized iron perimeter wall angle of size 24 x 24 x 0.40mm of length 3000mm to be fixed on periphery wall/ partition with the help of plastic rawl plugs at 450mm centre to centre and 40mm long dry wall SS screws.

The bottom surface of the frame shall be checked and corrected to true plans and slopes.

26.20.2 Fixing

Outer wall angle shall be fixed accurately and truly at required height and level, parallel and close to the wall. Thereafter all the T members shall be placed and fixed carefully to form the grid. The grid comprises of main T-runners at 1200mm centres securely fixed to the structural soffit by approved and adjustable hanger rods at 1200mm maximum centres and not more than 150mm from spliced joints of main T-runners. The last hanger at the end of each runner should not be greater than 600mm from the adjacent wall. Similarly, cross T-runners of 1200mm length shall be placed at 600mm centre to centre. 600x600mm modules to be formed by fitting 600mm long flush fitting cross Tees (secondary cross T) centrally between 1200mm cross T-runners. The tiles shall then be placed properly in the grids as per required pattern, texture and design/ drawing and as per directions of the Engineer-in-Charge. If required, level of the false ceiling grid shall be checked after placing of semi perforated GRG tiles and necessary adjustment shall be made wherever required through level adjuster.

26.20.3 Finishing

Care should be taken while placing semi perforated GRG tiles into the grid so that there will be no displacement to grid and stains/ dirty marks put by the workers.

26.20.4 Measurements

Length and breadth shall be measured correct to a cm. Areas shall be worked out to nearest 0.01sqm. The superficial area of the finished work ceiling shall be measured in square metres. No deduction in measurements shall be made for openings of areas upto0.36 Sqm. Nothing extra shall be payable either for any extra material or labour involved in forming such openings. For openings exceeding 0.36 sqm in area, deductions in measurements for the full opening in multiple of area of each tile (0.36 Sqm) will be made.

26.20.5 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above.

26.21 GLASS FIBRE REINFORCED GYPSUM (GRG) FALSE CEILING (FULLY PERFORATED MICRO TEGULAR EDGED)

26.21.1 Materials

26.21.1.1 Tiles

Glass fibre Reinforced Gypsum (GRG) false ceiling tiles shall be made of Gypsum plaster of 75 microns particle size mixed with short length glass fibre filament of 20 microns ± 5 microns diameter to give it high strength and shall be free from harmful or any toxic ingredients.

Tiles shall be appropriate class and of finished thickness as specified in the description of the item. Only selected tiles of uniform width shall be used. Unless otherwise specified in the description of the item or shown in the drawings, the width of tiles selected for use shall not be less than 595 x 595mm in size and of approved texture, design and patterns and patterns and shall be fully perforated 12mm thick micro tegular-edged type GRG tiles.

Where width of room/ corridor is in multiple of standard width of tiles, same pattern shall be maintained throughout the length. Where the width of rooms/ corridor is not in multiple of standard width of tiles, borders with appropriate width and material of boards shall be provided in design approved by the Engineer-in-charge and maintained uniformly throughout of the length/ width of room/ corridor. GRG tiles shall have the following properties:

(a) **Surface:** The GRG false ceiling tiles shall be painted with white dispersion type solvent free paint. fully perforated GRG false ceiling tiles shall have a non-woven fabric of density minimum 30 grams per square meter pasted at the back.

(b) **Dimensions:** 595mm x 595mm Fully perforated 12mm thick micro tegular-edged type GRG tiles. Size referred to are always module sizes. The nominal panel size may differ depending on the suspension system used.

(c) **Density of material:** 700 to 850 kg per Cum.

(d) **Relative humidity:**99% RH resistant.

(e) **Fire resistance:** Non-combustible as per BS: 476, Part-4: 1970

(f) **Moisture Content:** < 2%

(g) **Acoustic control:** Noise reduction coefficient (NRC) = 0.50 to 0.75 as per IS: 8225-1981.

(h) **Light reflectance:**>85%

(i) **Suspension system:** Suspension system shall be made of interlocking metal T-grids of hot-dipped galvanized iron section.

26.21.1.2 Frame

Frame is made up of interlocking metal T-grids of hot dipped galvanized steel sections of 0.33mm thick (Galvanized @ 120 grams per sqm including both sides) comprising of main T runners of size 15 x 32mm of length 3000mm, cross T of size 15 x 32mm of length 1200mm and secondary intermediate cross T of size 15 x 32mm of length 600mm to form grid modules of size 600 x 600mm. This grid shall be suspended from ceiling using galvanized mild steel members (Galvanized @ 80 gms/m^2 including all sides) i.e. 50mm long, 8mm outer diameter M-6 dash fasteners, 6mm dia fully threaded hanger rod upto 1000 mm length and L-shaped level adjuster of size 85 x 25 x 2mm. Frame also consist of galvanized iron perimeter wall angle of size 24 x 24 x 0.40mm of length 3000mm to be fixed on periphery wall/ partition with the help of plastic rawl plugs at 450mm centre to centre and 40mm long dry wall SS screws.

The bottom surface of the frame shall be checked and corrected to true plans and slopes.

26.21.2 Fixing

Outer wall angle shall be fixed accurately and truly at required height and level, parallel and close to the wall. Thereafter all the T members shall be placed and fixed carefully to form the grid. The grid comprises of main T-runners at 1200mm centres securely fixed to the structural soffit by approved and adjustable hanger rods at 1200mm maximum centres and not more than 150mm from spliced joints of main T-runners. The last hanger at the end of each runner should not be greater than 600mm from the adjacent wall. Similarly, cross T-runners of 1200mm length shall be placed at 600mm centre to centre. 600x600mm modules to be formed by fitting 600mm long flush fitting cross Tees (secondary cross T) centrally between 1200mm cross T-runners. The tiles shall then be placed properly in the grids as per required pattern, texture and design/ drawing and as per directions of the Engineer-in-Charge. If required, level of the false ceiling grid shall be checked after placing of semi perforated GRG tiles and necessary adjustment shall be made wherever required through level adjuster.

26.21.3 Finishing

Care should be taken while placing semi perforated GRG tiles into the grid so that there will be no displacement to grid and stains/ dirty marks put by the workers.

26.21.4 Measurements

Length and breadth shall be measured correct to a cm. Areas shall be worked out to nearest 0.01sqm. The superficial area of the finished work ceiling shall be measured in square metres. No deduction in measurements shall be made for openings of areas upto0.36 Sqm. Nothing extra shall be payable either for any extra material or labour involved in forming such openings. For openings exceeding 0.36 sqm in area, deductions in measurements for the full opening in multiple of area of each tile (0.36 Sqm) will be made.

26.21.5 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above.

26.22 MINERAL FIBRE FALSE CEILING (BEVELED TEGULAR MINERAL FIBRES)

26.22.1 Materials

26.22.1.1 Tiles

Mineral Fiber Ceiling Tiles shall be made of granulated high-density Mineral Wool as the main material and top production technique which gives it superior features of fire-proofing, sound absorption, heat insulation & sag resistance. They are cost effective and are mainly used for acoustics and decoration.

Tiles shall be appropriate class and of finished thickness as specified in the description of the item. Only selected tiles of uniform width shall be used. Unless otherwise specified in the description of the item or shown in the drawings, the width of tiles selected for use shall not be less than 595 x 595mm in size and of approved texture, design and patterns and patterns and shall be of 16mm/ 20mm thick Beveled Tegular edge type.

Where width of room/ corridor is in multiple of standard width of tiles, same pattern shall be maintained throughout the length. Where the width of rooms/ corridor is not in multiple of standard width of tiles, borders with appropriate width and material of boards shall be provided in design approved by the Engineer-in-charge and maintained uniformly throughout of the length/ width of room/ corridor. Mineral Fibre tiles shall have the following properties:

(a) Surface: Shall be of approved texture, design and pattern.

(b) Dimensions: 595mm x 595mm x 16mm (20mm) thick Beveled Tegular edge type. Size referred to are always module sizes. The nominal panel size may differ depending on the suspension system used.

(c) Relative humidity:99% RH resistant.

(d) Fire resistance: Fire performance as per BS:476 (Part-6 & 7)

(e) Thermal conductivity: 0.052 W/m–K – 0.057 W/m–K

(f) Acoustic control: Noise reduction coefficient (NRC) = 0.50 to 0.60

(g) Light reflectance:>85%.

(h) Weight: 3.10 Kg/m^2 (for 16mm thick) & 5.29 Kg/m^2 (for 20mm thick)

(i) Suspension system: Suspension system shall be made of interlocking metal T-grids of hot-dipped all round galvanized steel.

26.22.1.2 Frame

Frame is made up of interlocking metal T-grids of hot dipped all round galvanized steel sections of 0.33mm thick (Galvanized @ 120 grams per sqm including both sides) comprising of main T runners of size 15 x 32mm of length 3000mm, cross T of size 15 x 32mm of length 1200mm and secondary intermediate cross T of size 15 x 32mm of length 600mm to form grid modules of size 600 x 600mm. This grid shall be suspended from ceiling using galvanized mild steel members (Galvanized @ 80 gms/m^2 including all sides) i.e. 50mm long, 8mm outer diameter M-6 dash fasteners, 6mmdia fully threaded hanger rod upto 1000 mm length and L-shaped level adjuster of size 85 x 25 x 2mm. Frame also consist of galvanized iron perimeter wall angle of size 24 x 24 x 0.40mm of length 3000mm to be fixed on periphery wall/ partition with the help of plastic rawl plugs at 450mm centre to centre and 40mm long dry wall SS screws.

The bottom surface of the frame shall be checked and corrected to true plans and slopes.

26.22.2 Fixing

Outer wall angle shall be fixed accurately and truly at required height and level, parallel and close to the wall. Thereafter all the T members shall be placed and fixed carefully to form the grid. The grid comprises of main T-runners at 1200mm centres securely fixed to the structural soffit by approved and adjustable hanger rods at 1200mm maximum centres and not more than 150mm from spliced joints of main T-runners. The last hanger at the end of each runner should not be greater than 600mm from the adjacent wall. Similarly, cross T-runners of 1200mm length shall be placed at 600mm centre to centre. 600x600mm modules to be formed by fitting 600mm long flush fitting cross Tees (secondary cross T) centrally between 1200mm cross T-runners. The tiles shall then be placed properly in the grids as per required pattern, texture and design/ drawing and as per directions of the Engineer-in-Charge. If required, level of the false ceiling grid shall be checked after placing of calcium silicate tiles and necessary adjustment shall be made wherever required through level adjuster.

26.22.3 Finishing

Care should be taken while placing calcium silicate tiles into the grid so that there will be no displacement to grid and stains/ dirty marks put by the workers.

26.22.4 Measurements

Length and breadth shall be measured correct to a cm. Areas shall be worked out to nearest 0.01sqm. The superficial area of the finished work ceiling shall be measured in square metres. No deduction in measurements shall be made for openings of areas upto0.36 Sqm. Nothing extra shall

be payable either for any extra material or labour involved in forming such openings. For openings exceeding 0.36 sqm in area, deductions in measurements for the full opening in multiple of area of each tile (0.36 Sqm) will be made.

26.22.5 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above.

26.23 MINERAL FIBRE FALSE CEILING (BEVELED TEGULAR MINERAL FIBRE ANTI-MICROBIAL)

Specification for the mineral fibre false ceiling using 16 mm Beveled Tegular Mineral Fibre Anti-microbial is same as 16 mm Beveled Tegular Mineral Fibres specified in above clause 26.22.

26.24 CHIPPING OF UNSOUND / WEAK CONCRETE:

26.24.1 Precaution, Preparation and procedure

The Chipping of unsound work / concrete / delaminated layer of gunniting etc. shall be done by chipping(after properly supporting the member with false works) , in regular shape, with sides parallel or normal to the direction of the reinforcement. The chipping shall be done minimum 50 mm beyond the perimeter of the spell. For a single spell, the repair area should have a minimum width of 100 mm in any direction. If a number of spells are closely located to each other, these should be included in a single area marked for repair. The cut shall be made normal to the surface of member. The minimum depth of cut should be 12 mm.

Adequate care is to be taken not to cut the reinforcement steel and a cover metre could be used to estimate the depth of cover, for which nothing extra shall be paid.

Chipping should be done upto the required depth as decided by the Engineer-in- Charge to produce sound concrete surface to a near uniform depth for the repair areas.

Removal of concrete should begin at the interior of the repair areas and progress towards the boundaries. All edges and cavities shall be square shouldered.

26.24.2 Measurements

Dimensions of area chipped off for RCC slabs, beams, columns etc. shall be measured in centimeters after the chipping / dismantling operation is completed for different thicknesses as specified in the item separately. The area of the chipped / exposed RCC surface shall be measured in sq. m correct to second place of decimal for different thicknesses as specified in the item separately .

26.24.3 Rate:- The rate shall include the cost of all the T&P required, labour involved and cost of all the operations as described above.

26.25 CLEANING OF EXISTING REINFORCEMENT AND PASSIVATING ITS SURFACE

26.25.1 Material:-

The alkaline chemical rust remover as approved by the Engineer-in Charge and should be procured in sealed containers indicating the batch number and the date of manufacture etc.

26.25.2 Surface preparation-

The rust has to be removed from the surface of the reinforcement manually using chisels, wire brush, emery paper etc. as directed by Engineer-in-Charge at no extra cost, till the steel surface is cleared of all rust that could be removed manually or mechanically.

26.25.3 Application:-

Then alkaline chemical rust remover, as approved by the Engineer-in Charge shall be applied with brush over the reinforcement surface thoroughly along the full length of rusted reinforcement. After 24 hours of its application the surface shall be cleaned with wire brush and all loose particles removed. It should then be washed clean, with water, thoroughly and allowed to dry. alkaline chemical rust remover should be applied to the reinforcement approximately one litter for 6 to 7 sqm. Of the steel area (assuming the surface of the reinforcement of rough) the consumption of the alkaline chemical rust remover should be about 0.40 liters per 10 Sqm. Area of RCC unit.

26.25.4 Measurements: - The length of the reinforcement bar cleaned shall be measured correct to a centimeter in two categories i.e. i) Bars upto 12mm dia. ii) Bars above 12mm dia.

26.25.5 Rates :- shall include cost of all materials, labour, T&P etc. involved in all the operations as described above.

26.26 DRILLING SUITABLE HOLES IN RCC OR PLAIN CEMENT CONCRETE

26.26.1 Preparation and Procedure

For introducing additional reinforcement bars for new structural connections or supplementing additional steel area to the existing RCC member, the cross sectional area (diameter and no. of bars) and length required shall be approved by the Engineer-in-Charge. Also the depth of embedment of reinforcement bar shall be approved by the Engineer-in-Charge. The holes have to be power drilled in RCC. The drilled hole in dry state has to be cleaned with round brush and by blowing air through a tube inserted in the hole and connected to hand operated blower.

Then epoxy is to be injected from foil pack with help of epoxy dispenser and epoxy cartridge holder and disposable PVC mixing nozzle inserted inside the drilled hole to fill it from bottom of hole and upwards. Then the reinforcement bar is to be inserted and allowed to remain undisturbed for minimum 24 hours and allow epoxy adhesive to be air cured. Epoxy resin anchor grout shall be approved by the Engineer-in Charge.

26.26.2 Measurements:- Holes shall be enumerated.

26.26.3 Rates :- Shall include cost of all inputs of material, labour and T&P etc. involved in all the operations except the cost of reinforcement.

26.27 BONDING COAT

26.27.1 Material:- SBR polymer modified cementitious bond coat and epoxy bonding adhesive shall be approved by the Engineer-in Charge.

26.27.2 Surface Preparation:-

Bonding coat is required to be applied for adhesion of applied repair concrete or mortar to the parent concrete. For this, the surface should be thoroughly cleaned by brushes and by blowing air from hand operated pump. The surface shall then be saturated with water (but without excess water).

26.27.3 Application:-

The components of bonding coat shall be weigh batched and mixed in specific proportions, in a clean container, as directed by the Engineer-in-Charge. They should then be blended to a uniform and homogeneous mixture, lump free and of creamy consistency.

The specified bond coat should be applied by stiff nylon bristle brush. The bonding material should be worked well onto the concrete surface of the parent concrete including reinforcement surface ensuring that no pinholes are visible. The SBR polymer modified bonding cement slurry shall be applied to a thickness not more than 2 mm. A second coat shall be applied within 15 to 20 minutes of application of the first coat at right angles to the first coat to ensure complete coverage and absence of pin holes.

26.27.4 Measurements

Area of exposed RCC unit shall be measured in sqm correct to two decimal places for the purpose of payment.

26.27.5 Rates :-

Shall include cost of all inputs of material, labour and T&P etc. involved in all the operations as described above.

26.28 PROVIDING, MIXING AND APPLYING SBR POLYMER MODIFIED CEMENT MORTAR

26.28.1 Procedure and application

Fresh mortar shall be applied while the bond coat is still tacky and well within setting period. If adhesive cured to the extent of loosing its tack or has set before mortar is applied. The same shall be removed or slightly abraded and another coat of bond coat shall to be applied by the contractor at his own cost. Freshly placed mortar shall be thoroughly consolidated to ensure full bonding of the fresh mortar with the parent concrete. If there is a failure of bond of fresh mortar/ plaster with parent concrete surface and it sounds hollow on tapping, the repair work shall be dismantled and redone by the contractor at his own cost and to the entire satisfaction of the Engineer-in-Charge**.**

26.28.2 Testing : 75mm size cube of the mortar, crushing strength at the end of 28 days to be not less than 30 N/Sqmm2**.**

26.28.3 Measurement

Length and breadth of the application shall be measured correct to a cm and area worked out to in sqm upto 2 decimal places, separately for different thicknesses specified in the item.

26.28.4 Rates

Rates shall include all the materials, labour, T&P in all the operations as described above.

26.29 APPLYING SBR POLYMER MODIFIED CEMENT CONCRETE FOR STRUCTURAL MEMBERS

26.29.1 Material: SBR polymer or equivalent material shall be approved by Engineer-in-charge.

26.29.2 Preparation & application

After bonding coat pre fabricated shuttering shall then be erected immediately. Fresh concrete shall be placed /applied while the bond coat is still tacky and well within pot - life / setting period. If adhesive cures to the extent of loosing its tack or has set before concrete is placed / applied, the same shall be removed or slightly abraded and another coat of adhesive / bond coat shall have to be applied by the contractor at his own cost. Freshly placed concrete shall be thoroughly consolidated to ensure full bonding of the fresh concrete with the parent concrete. If there is a failure of bond of fresh concrete with parent concrete surface and it sounds hollow on tapping, the repair work shall be dismantled and redone by the contractor at his own cost and to the entire satisfaction of the Engineer-in-Charge.

Thickness and grade of concrete: As specified in the item with graded stone aggregate of 10 mm maximum size in proportion as per design criteria.

26.29.3 Testing: As per design mix criteria.

26.29.4 Measurement: Length and breadth of the application shall be measured correct to a cm and area worked out to in sqm upto 2 decimal places, separately for different thicknesses specified in the item.

26.29.5 Rates

Rates shall include all the materials, labour, T&P and full curing period in all the operations as described above.

26.30 PROVIDING AND INJECTING GROUT

26.30.1 MATERIAl : The materials for injection grouting shall be approved by the Engineer-in-charge.

26.30.2 Surface preparation

The final chipped off concrete surface and exposed reinforcement, if any, of the affected structural member should be cleaned off all loose and foreign materials by free air blast and then with water and allow it to dry. For the honey combed portion of the concrete or cracked concrete, drill holes at least 18 mm in diameter and depth upto 50 mm or half the member thickness whichever is less, at the required spacing, as directed by the Engineer-in-Charge. For cracked surface, open up cracks by making V notch or groove of size 12 mm X 12 mm as directed by the Engineer-in-Charge. Remove coarse debris and dust in opened up cracks and drilled holes by blowing air with hand operated blow out pump. Concrete surface required to be grouted shall be free from all loose and unsound material. The prepared surface should be clear of dust which could obstruct free flow of grout material and also impede its bonding with concrete surface. Saturate the concrete in vicinity of crack / honey combed concrete surface with water (but without excess water) only if the cement / polymer admixed grout is to be injected.

26.30.3 Application: The emulsified acrylic polymer/SBR polymer shall be as specified and shall conform to Manufacturer's specification. The physical and mechanical properties of polymers shall conform to manufacturer's specification. One test shall be carried out mandatory for every lot of acrylic polymer/SBR polymer supplied at site, before use in the work. The grouting equipment shall be capable of supplying mixing, stirring and pumping grout to the satisfaction of Engineer-in-charge. It shall have capacity to inject grout at a pressure upto 7 kg / sq. cm measured at grout connections. It shall be capable of mixing and pumping the cement sand grout 1:2(1 cement : 2 sand) with water cement ratio ranging from 0.5 to 1.0. Wherever epoxy is to be used, the surface of the concrete shall be dried with air blast, before grouting or applying epoxy. The cement grout in proportion as directed by the Engineer-in-Charge shall be prepared. It should be lump free of creamy consistency, thoroughly blended and shall be continuously stirred to keep the cement particles in suspension to retain uniform consistency till grout is injected. In case of vertical cracks the injection shall be started at the lowest nipple and continued until the injected grout begins to flow out at the next higher nipple. The first nipple shall then be closed and injection continued from second until grout flows out at the third and so on. The process shall be repeated until the whole surface is treated. As soon as the system is cured, the nipples shall be suitably cut. In case of honey combed concrete, each grout hole shall be grouted individually. The sequence of injection shall be as per the directions of the Engineer-in-Charge.

26.30.4 Measurement : The measurement of grout material shall be on the basis of actual weight of approved grout injected. Pre measurements of the quantities of such grouting materials brought at site and balance quantities remaining at the end of grouting application shall be recorded separately, which will determine the quantity of grout material actually injected. Adequate care is to be taken by the contractor as not to waste the grout. The quantity which can be consumed immediately within the prescribed time only shall be prepared in batches. The quantity of grout material wasted, discarded, hardened shall not qualify for payment and shall be recorded for deduction at the end of each operation.

26.30.5 Rates: The rate shall include all the operation, labour, materials described above except injection nipple which will be paid in the relevant item.

26.31 PROTECTIVE FABRIC SCREENS

26.31.1 Material : The PVC woven cloth shall be approved by Engineer-in-charge.

26.31.2 Procurement & Execution :

Before execution, profile of protective fabric screen shall be got approved by the Engineer-in-charge. Protective Fabric screening shall be provided by the contractor with PVC woven cloth covering full height of the structure. It shall be provided by properly stitching the screen, having adequate lapping on sides to prevent any rubbish from falling outside while demolishing, dismantling, gunniting, plastering etc. and to protect passers -by from the falling debris. Screen material shall be fixed by suitable means to the frames of scaffolding etc, and it is to be ensured that sagging of screen does not hinder the repair process. The contractor shall maintain the protective screen in acceptable working conditions for the entire duration of the repair work as required by the Engineer-in-Charge. All the windows, ventilators, RCC jalis and openings shall be suitably covered and protected, in advance so as not to cause any damage while doing the repair work. If any damage is caused or glass panes are broken, these shall be made good by the contractor at his own cost and to the entire satisfaction of Engineer-in-Charge.

26.31.3 Measurement: Length and height of the Protective fabric screen along the approved profile shall be measured correctly and area worked out to in sqm upto 2 decimal places,

26.31.4 Rates; Rates shall include all the materials, labour, T&P in all the operations as described above i/c cost of double scaffolding for fixing the protective screen.

26.32 CLEANING OF EXPOSED CONCRETE SURFACE BY SAND BLASTING.

26.32.1 Equipment: Sand blasting equipment and air compressor shall be got approved by Engineer-in-Charge and should be capable of doing at least 14 sqm of cleaning the surface a day. The coarse sand used in blasting shall be of zone III.

26.32.2 Operation: The cleaning should start after program for Shotcreting/Guniting, etc. is fixed, such that cleaned, surface shall not be left alone for long. Cleaned surface should also be got approved by Engineer –in-Charge. Proper care to the workers and environment should be taken and other parts of the bldg should be protected to avoid any mishap.

26.32.3 Procedure – As described in the item.

26.32.4 Measurement- Length & breadth shall be measured correct to a cm and area worked out to be sqm. upto 2 places of decimals.

26.32.5 Rates- Rate shall include all the operations as described above and in the item.

26.33 SHOTCRETING

26.33.1 Materials

Design mix of specified grade shall be got approved by Engineer-in-Charge before start of work. The maximum size of graded stone aggregate shall not exceed 10mm. The minimum cement content shall be as specified in the item.

26.33.2 Surface preparation- The surface shall be thoroughly cleaned and the cleaned surface should be got approved by Engineer-in-Charge

26.33.3 Equipment- The compressor, gun, rubber pipes & other accessories shall be approved by Engineer-in-Charge. The equipment should be capable of doing at least 40m2 of shotcreting a day for 25mm thickness

26.33.4 Application – Application should start from top to bottom vertically and then from left to right or right to left as per feasibility horizontally. The thickness shall be as spciefied in the item. Then the surface shall be kept wet for at least 14 days or as per direction of Engineer-in-Charge. Thereafter the surface shall be evaluated by sounding/tapping with a blunt metal instrument. If any hollow or defective portion is observed, the same shall be redone after dismantling the same.

26.33.5 Testing: C.C cube strength should confirm the specified grade of concrete.

26.33.6 Measurement- The length and breadth shall be measured correct to a cm for different thicknesses separately and area shall be worked out in m2 upto 2 decimal places.

26.33.7 Rates- Rate shall include all materials, labour, operations described above. The rate shall also include for providing necessary ground wires etc. The leveling gauges if used shall be paid separately. Payment under this item shall be made only after proper wet curing has been done and surface has been satisfactorily evaluated.

26.34 PROVIDING AND INSERTING GALVANIZED STEEL INJECTION NIPPLE

26.34.1 Materials

Galvanized Steel injection nipple 12mm dia 75mm long shall be got approved by Engineer-in-Charge. The chemical adhesive shall be got approved by the Engineer-in-Charge.

26.34.2 Surface preparation and operation: Holes shall be drilled in honey comb area and along crack line of required dia (20mm to 30 mm) upto depth from 30mm to 80mm at required spacing. Spacing and pattern of the holes shall be got approved by Engineer-in-Charge. The holes and cracks shall be made dust free by blowing compressed air. After inserting the injection nipple, the holes shall be sealed with chemical adhesive. The chemical adhesive shall be allowed to cure completely.

26.34.3 Measurement – Injection nipples shall be enumerated.

26.34.4 Rates- The rate shall include all the materials, labour, operations as described above.

26.35 PROVIDING & FIXING HARD DRAWN STEEL WIRE FABRIC

26.35.1 Materials- Hard drawn steel wire fabric of size 75 x 25 mm weighing not less than 7.75 kg/m^2 or any other suitable size wire mesh shall be got approved by Engineer-in-Charge before use on work. 10 mm dia mild steel bar for shear key shall be approved by Engineer-in-Charge before use on work.

26.35.2 Preparation and procedure- The surface should be cleaned thoroughly before fixing of the mesh. 100mm long pieces of mild steel 10mm dia bar shall be cut. Each piece shall be bent into L shape. One arm of the L shape piece shall be welded to existing reinforcement with the spacing 50cm center to center or less in both directions as approved by Engineer-in-Charge. Then hard drawn steel wire fabric shall be inserted into the shear keys and fastened with the help of binding wire or welded to shear keys as approved by Engineer-in-Charge

26.35.3 Measurement – Length & breadth/height shall be measured correct to a cm and area shall be worked out in sqm upto 2 decimal places.

26.35.4 Rates- Rates shall include all the materials labour and operations as described above.

26.36 LIGHT GAUGE STEEL FRAMED STRUCTURE (LGSFS)

26.36.1 General

Light Gauge Steel Framed Structure (LGSFS) is based on factory made galvanized light gauge steel components produced by the cold forming method assembled as panels at site forming structural steel framework of a building and varying wall and floor construction. The panels are assembled on site with screws and bolts to form the internal and separating walls and inner leaf of the external walls of a building and floors & ceiling.

The system can incorporate all types of architectural features like coving, boxes, cantilevers, projections, infill walls, mezzanine floors etc. This system can also incorporate all types of services viz. electrical, gas and plumbing etc. The design and engineering of the structures is executed by following the norms & guidelines stipulated in relevant Indian Standards.

The system shall be used as framed steel structure.

26.36.2 **Limitation of Use**

(i) LGSFS may be used only upto G+3 level without any composition.

(ii) LGSFS may be used in G+3 and above with composition of hot rolled structures.

(iii) LGSFS shall not be used for buildings with vibrations.

(iv) Advisable span for LGSFS buildings shall be up to 6.5m.

26.36.3 Profiles and Sizes of Framing Components

The wall and floor panels are assembled from C section having minimum web depth 89 mm x 39 mm flange x 11 mm lip in required length as per structural design. The minimum thickness of section shall be 0.75 mm and it shall be governed by the structural design requirement. The slots will be along centre line of webs and shall be spaced minimum 250mm away from both ends of the member.

The steel sheet shall be galvanized (AZ-150gms Aluminium Zinc Alloy coated steel having minimum yield strength 300-550 Mpa) conforming to AISI specifications and IBC 2009 for cold formed steel framing and construction and also as per IS: 875-1987, ISO 800-1984 and IS:801- 1975.

26.36.4 Design and Stability Report

LGSFS frame shall be designed as per IS: 801 using commercially available software such as Frame CAD Pro-11.7/ STAAD PRO-V8i/ArchitekV2.5.16/ Rivet architecture-2011 or equivalent. The wind load shall be as per provisions of IS 875 (part -III).

The item also includes the submission of stability reports duly examined and issued by any NIT/IIT.

26.36.5 Connections

The frame can be supplied in panellized or knock down condition in specific dimensions and fastened with screws extending through the steel beyond by minimum of three exposed threads. All self drilling tapping screws for joining the members shall have a Type II coating in accordance with ASTM B633(13) or equivalent corrosion protection of gauge 10 & 12, TPI 16 & 8 of length 20mm. The frames shall be fixed to RCC slab or Tie beam over Neoprene rubber using self expanding carbon steel anchor bolt of dia as per approved drawings. design subject to minimum 12mm diameter and 121mm length conforming to AISI 304 and 316 at 500mm c/c with minimum embedment of 100mm in RCC (RCC to be paid separately) and located not more than 300mm from corners or termination of bottom tracks complete in all respects.

26.36.6 Measurement:

Only weight of Cold form light gauge Steel C-section of thickness 0.75mm i/c zinc coating/sliting etc. shall be considered in Kg, excluding connection accessories such as screws, nuts, bolts etc.

26.36.7 Rate

The rate includes the concept design, detailed design, fabrication of sections, transportation, installation and all required fixing arrangement at site as described above.RCC to be paid separately.

26.37 EXTERNAL WALL SYSTEM ON LIGHT GAUGE STEEL FRAME WORK WITH OUTER FACE HAVING 6MM THICK FIBER CEMENT BOARD

26.37.1 For Cement Fibre Board

26.37.1.1 Nominal Length and Width

Flat fibre cement sheets shall be available in nominal lengths up to 3 000 mm and nominal widths up to 1240 mm.

26.37.1.2 Min. Modulus of Rupture: For 6mm & 9mm :13MPA

26.37.1.3 Thickness: Flat fibre cement sheets shall be 6, 8, 9mm.

26.37.1.4 Tolerances on Dimensions: Tolerances on nominal dimensions shall be as follows:

(a) On length and width (indicated by d)

$d \leq 1000$ mm :	± 5mm
1000 mm < $d \leq 1600$ mm:	± 0.5 percent
d>1600 mm :	± 8mm

These tolerances do not apply to oversize sheets.

(b) On thickness, e :

$e \leq 6$mm: ± O.6mm

e > 6mm: ± 10percent

For sheets without texture on the exposed face, the maximum difference between extreme values of the thickness measurements within one sheet shall not exceed 15 percent of the maximum measured value

26.37.1.5 Tolerances on Shape

Straightness of edges: The tolerance on the straightness of edges shall be 3 mm/m for the relevant dimension (length or width) when measured in accordance with the method given

Squareness of edges: The tolerance on the squareness of sheets shall be 4 mm/m when measured in accordance with the method given.

26.37.1.6 Acceptance Tests

The objective of an acceptance test is to establish whether a batch of products conforms to a specification. The tests shall be performed on samples drawn either from continuous production or from a consignment (see also 8). The acceptance test" shall be cariedout at the manufacturer's works on sheets and test specimens cut from sheets as delivered. The following acceptance tests shall be carried out:

(a) Dimensional and geometrical characteristics (compulsory) ,

(b) Bending strength (compulsory) , and

(c) Apparent density (compulsory).

26.37.1.7 Method for testing: As per IS 14862 2000

26.37.2 For Gypsum Plaster Board

26.37.2.1 Material

Gypsum Plaster Board shall conform to IS 2095.

Gypsum plaster shall conform to IS 2547 (Part 1). Byproduct gypsum conforming to the requirements of IS 12679 shall also be used for the preparation of plaster.

Requirements, tests, sampling, finishing etc of Gypsum Plaster Board shall be as per IS 2095.

26.37.2.2 Fixing

Fixing the outer face with moisture resistant/ fire resistant fibre cement board of 6mm and 9mm thickness (High Pressure Steam cured) with necessary accessories & GI self drilling/ tapping screws etc., of required size(Screws shall be of counter sunk rib head of 1.60mm to 4 mm thick of 8 to 10 gauge of length varying from 25 to 45 mm) @ 60cm c/c, and a grove of 2-3mm shall be maintained and filled with suitable arrangement as per approval of Engineer-in-charge.

Filling the groove (i.e. 2-3mm gap between boards),taping and jointing of the first layer 6mm and 9mm thick fiber cement boards with epoxy based sealing compound or with silicon sealant. Second layer is fixed over it in a staggered pattern.

Fixing the internal face with 12.5mm thick gypsum plaster board fixed on 8mm thick fiber cement board with self-drilling / taping screws / fasteners @ 60cm c/c of approved make, proper taping and jointing to be done using fiber mesh tape and epoxy and acrylic based jointing compound for seamless finish.

Fill the groove (i.e. 2-3mm gap between boards),taping and jointing 8mm thick fiber cement board and 12.5mm thick gypsum plaster boards with epoxy based sealing compound, Acrylic based sealing compound, Non woven reinforcement Tape as per direction of Engineer in charge.(Use a flexible knife so that no air bubble is entrapped. Allow 1-2 hours gap. Once hard tacky or set, apply a coat of Acrylic based sealing compound paste to flash fill the beveled area. After 2-4 hours go on to repeat a skin coat with Acrylic based sealing compound to securely embed the 40mm width (non

woven reinforcement Tape. Use only flexible steel knife, such as provided with packs, to avoid air entrapment within compound. After overnight drying shrinkage apply a coat of acrylic based sealing compound to compensate shrinkage. Finally cover the bevel portion with any suitable overall skin coat with a desired full surface-leveler material).

26.37.2.3 Measurement:

The length and breadth of fibre cement board shall be measured in any one face, correct to the nearest cm and area worked out in square metres correct to two places of decimal.

26.37.2.4 Rate:

The rate shall include the cost of materials and labour involved in all the operations described above. Nothing extra shall be paid for fixing arrangement i.e. drilling, nut & bolts, filling groove etc.(cost of frame work to be paid for separately).

26.38 INTERNAL WALL PANELS ON LIGHT GAUGE STEEL FRAME WORK WITH 12.5MM THICK GYPSUM PLASTER BOARD

26.38.1 For Cement Fibre Board

26.38.1.1 Nominal Length and Width

Flat fibre cement sheets shall be available in nominal lengths up to 3 000 mm and nominal widths up to 1240 mm.

26.38.1.2 Min. Modulus of Rupture: For 8 mm :10 MPA

26.38.1.3 Thickness: Flat fibre cement sheets shall be 8 mm.

26.38.1.4 Tolerances on Dimensions: Tolerances on nominal dimensions shall be as follows:

(a) On length and width (indicated by d)

$d \leq 1000$ mm :	±5mm
1000 mm < $d \leq$ 1600 mm:	± 0.5 percent
d > 1600 mm :	±8mm

These tolerances do not apply to oversize sheets.

(c) On thickness, e :

$e \leq$ 6mm:	± 0.6mm
e > 6mm:	± 10percent

For sheets without texture on the exposed face, the maximum difference between extreme values of the thickness measurements within one sheet shall not exceed 15 percent of the maximum measured value

26.38.1.5 Tolerances on Shape

Straightness of edges: The tolerance on the straightness of edges shall be 3 mm/m for the relevant dimension (length or width) when measured in accordance with the method given Squareness of edges: The tolerance on the squareness of sheets shall be 4 mm/m when measured in accordance with the method given.

26.38.1.6 Acceptance Tests

The objective of an acceptance test is to establish whether a batch of products conforms to a specification. The tests shall be performed on samples drawn either from continuous production or

from a consignment (see also 8). The acceptance test shall he carried out at the manufacturer's works on sheets and test specimens cut from sheets as delivered. The following acceptance tests shall be carried out:

(a) Dimensional and geometrical characteristics (compulsory) ,

(b) Bending strength (compulsory) , and

(c) Apparent density (compulsory).

26.38.1.7 Method For Testing

As per IS 14862 2000

26.38.2 For Gypsum Plaster Board

26.38.2.1 Gypsum Plaster Board

Gypsum Plaster Board shall conform to IS 2095.

Gypsum plaster shall conform to IS 2547 (Part 1). Byproduct gypsum conforming to the requirements of IS 12679 shall also be used for the preparation of plaster.
Requirements, tests, sampling, finishing etc of Gypsum Plaster Board shall be as per IS 2095.

26.38.2.2 Fixing

Fixing the 12.5mm thick gypsum plaster board on 8mm thick fiber cement board with self-drilling / taping screws / fasteners @ 60cm c/c of approved make, Screws shall be of counter sunk rib head of 1.60mm to 4 mm thick of 8 to 10 gauge of length varying from 25 to 45 mm. Proper taping and jointing to be done using fiber mesh tape and epoxy and acrylic based jointing compound for seamless finish.

Fill the groove (i.e. 2-3mm gap between boards),taping and jointing 8mm thick fiber cement board and 12.5mm thick gypsum plaster boards with epoxy based sealing compound, Acrylic based sealing compound, Non woven reinforcement Tape as per direction of Engineer in charge.(Use a flexible knife so that no air bubble is entrapped. Allow 1-2 hours gap. Once hard tacky or set, apply a coat of Acrylic based sealing compound paste to flash fill the beveled area. After 2-4 hours go on to repeat a skin coat with Acrylic based sealing compound to securely embed the 40mm width (non woven reinforcement Tape. Use only flexible steel knife, such as provided with packs, to avoid air entrapment within compound. After overnight drying shrinkage apply a coat of acrylic based sealing compound to compensate shrinkage. Finally cover the bevel portion with any suitable overall skin coat with a desired full surface-leveler material).

26.38.2.3 Measurement:

The length and breadth of fibre cement board shall be measured on one face,correct to the nearest cm and area worked out in square metres correct to two places of decimal.

26.38.2.4 Rate:

The rate shall include the cost of materials and labour involved in all the operations described above. Nothing extra shall be paid for fixing arrangement i.e. drilling, nut & bolts, filling groove etc.

26.39 EXTERIOR FACE PANELS BREATHABLE VAPOUR BARRIER UNDERNEATH THE CEMENT FIBER BOARD

26.39.1 General

Vapour diffusion will occur through exterior face panels where there is difference of vapour pressure between interior and exterior of the building. Vapour flows from high vapor pressure to low vapor pressure area.

In colder climates, cold outdoor contains little moisture and moisture it does contain will be at low Pressure, so net vapor flow is generally inside to outside. In warmer climates the reverse is true, so the net vapour flow is from outside to inside of building. Therefore, in warmer climates, exterior elements are typically more resistant to vapor flow. So the breathable vapor barrier shall be fixed on the exterior face of panels.

It shall be used to control water vapor diffusion through the wall. It Building exterior require this, so that water condensation is minimized within wall assemblies otherwise Condensation can lead to deterioration of the structure and mold growth.

26.39.2

Some common vapour barriers include polyethylene, aluminium foil, some rubber membranes, and polyurethane coatings.

The material shall be chos en on the basis of the property called “permeance”. It is the maximum rate of water vapour that can pass through a vapour barrier. As per NBCC (National Building code of Canada), the maximum permeance shall be 1 perm (60 Nano gram per second per square meter per pascal)

26.39.3 Measurement:

The length and breadth of vapour barrier shall be measured on one face, correct to the nearest cm and area worked out in square metres correct to two places of decimal.

26.39.4 Rate:

The rate shall include the cost of materials and labour involved in all the operations described above. Nothing extra shall be paid for fixing arrangement.

26.40 MOISTURE RESISTANT/FIRE RESISTANT 6 MM THICK FIBER CEMENT BOARD

26.40.1 The specification for fibre cement board shall be as per 26.37.1.

26.40.2 Fixing

Fixing the moisture resistant/ fir resistant 6mm thick fibre cement board (High Pressure Steam cured) with necessary accessories & GI self drilling/ tapping screws etc., of required size(Screws shall be of counter sunk rib head of 1.60mm to 4 mm thick of 8 to 10 gauge of length varying from 25 to 45 mm), and filling the groove (i.e. 2-3mm gap between boards),taping and jointing of the first layer 6mm and 9mm thick fiber cement boards with epoxy based sealing compound or with silicon sealant. Second layer is fixed over it in a staggered pattern, with suitable arrangement as per approval of Engineer-in-charge.

26.40.3 Measurement:

The length and breadth of fibre cement board shall be measured correct to the nearest cm and area worked out in square metres correct to two places of decimal.

26.40.4 Rate:

The rate shall include the cost of materials and labour involved in all the operations described above. Nothing extra shall be paid for fixing arrangement i.e. drilling, nut & bolts, filling groove etc.

26.41 GLASS FIBRE REINFORCED GYPSUM (GFRG) PANEL

26.41.1 Materials:

26.41.1.1 GFRG panel

Glass Fiber Reinforced Gypsum is a building panel made-up of calcined gypsum plaster, reinforced with glass fibers.

Grade and Type:

Class 1- Water Resistant grade – Panels that shall be used for external walls, in wet areas and/ or as floor and wall formwork for concrete filling.

Class 2 – General grade - panels that shall be used structurally or non-structurally in dry areas. These panels are generally unsuitable for use as wall or floor formwork.

Class 3 – Partition grade – panels that may only be used as non- structural internal partition walls in dry areas only.

Dimension

Typical Dimension of GFRG building panel is 12.0m x 3.0m x 0.124m. Each 1.0m segment of the panel contains four cells. Each cell is 250mm wide and 124mm thick containing a cavity of 230 mm x 94 mm. The various cells shall be inter- connected by solid 'ribs' (20 mm thick) and 'flanges' (15 mm thick), comprising gypsum plaster, reinforced with 300 - 350 mm glass fiber roving, located randomly but centrally. The weight of panel shall be 40kg / sqm and density is 1140 kg/m2.

26.41.1.2 Infill:

M25 concrete at initial 50mm thickness and thereafter with quarry dust mixed with 5% cement (by volume) in three stages each after 90 minute interval.

26.41.1.3 Weld mesh:

10 gauge weld mesh of size 100mm x 100 mm for floor/roof slab concrete screed over the micro beams as reinforcement.

26.41.1.4 Joint sealant:

Joint filling sealant compound with grout RW/or equivalent.

26.41.1.5 Water Proofing:

Water proofing of vertical joints between door/windows/ventilators frames by Zycosil/equivalent & Zycoprime/equivalent solution.

26.41.2 Construction Procedure

26.41.2.1 GFRG Panel

As per the building plan and design, each wall panel shall be cut at the factory using an automated cutting saw. Door/window/ventilator and openings for AC unit etc. shall also be cut and panels for every floor marked as per the building drawing. Panels are vertically loaded at the factory on stillages for transportation to the construction site on trucks. Panels shall be erected over the RCC plinth beam and concrete is infilled from top. All the panels shall be erected as per the building plan by following the notation.

26.41.2.2 Erection:

Each panel shall be erected level and plumb and shall be supported by lateral props to keep the panel in level, plumb and secure in position. Embedded RCC lintels shall be provided wherever required by cutting open external flange. Reinforcement for lintels and RCC sunshades shall be provided with required shuttering and support. All GFRG wall panels at the ground floor are to be erected over a network of RC plinth beams supported on suitable foundation. For providing embedded micro beams, top flange of the respective cavity is cut and removed in such a way that minimum 25

mm flange on both end is protruded . RC concrete screed of minimum 50 mm thickness is provided above the GFRG floor panel, which is reinforced with weld mesh of minimum size of 10 gauge 100 mm × 100 mm. This RC screed and micro beam act together as series of embedded T beams. The thickness of the RC screed, reinforcement and interval of embedded RC micro beams depends on the span and intensity of imposed load. The connectivity between the horizontal tie beam, embedded RC micro beams, concrete screed and vertical rods in GFRG wall, and ensures perfect connection between floor/roof slab and walling system.

The procedure of Erection of panel shall be as follow:

1) Align the wall by marking with chalk line, where wall is to be erected.
2) Then fix the hold fast (regular door frame hold fast of 150mm) by plumbing wall. Two nos. of hold fasts are required for each panel.
3) Simultaneously cut the pocket of electrical points & electrical conduits to be inserted inside cavity of Rapid wall.
4) Then erect the panel by supporting with props.
5) Fix electrical switch boxes.
6) Fix other panels same as per the above method up to required length
7) Check the plumb & line of the wall.
8) Fill the holdfast gap with concrete.
9) Finish the joints of two panels by fixing fiber tape with stucco as follow:
    (i) Make a slot of 8mm wide & 2mm deep at the joint of panel.
    (ii) Fix the jointing fiber tape and finish the surface with stucco.
10) Joints of panel with RCC column/ beam shall be finished by stucco with reinforcing fiber of used cement bags.
11) Finish the gap around electrical points and between panel & slab/beam by stucco.

26.41.2.3 Reinforcement:

Reinforcement for micro-beams shall be placed and weld mesh as reinforcement is placed. Concrete is poured for micro-beams and RCC slab. These should results in the embedded RCC micro beams and 50 mm thickness screed concrete become a series of “T” beams. Erection of wall panel and floor slab for upper floor can be arranged the following day. Vertical reinforcement of floor below is provided with extra length so as to protrude to 0.45 m to serve as start up rods and lap length for upper floor. Once the wall panels are erected on the upper floor, vertical reinforcement rods are provided, door/window frames fixed and RCC lintel cast.

26.41.2.4 Concrete infill:

After inserting vertical steel reinforcement as per the structural design and clamps for wall corners are in place to keep the wall panels in perfect position, concrete having 12mm aggregate shall be poured from the top into the cavities using a small hose to go down at least 1.5 to 2 m into the cavities for directly pumping the concrete from ready mixed concrete truck. For small building construction, concrete can be poured manually using a funnel. Filling the panels with concrete shall be done in three layers of 1m height with an interval of 90 minute between each layer. There is no need to use vibrator because gravitational pressure acts to self compact the concrete inside the water tight cavities.

26.41.2.5 Embedded RCC tie beam all around at each floor/roof slab level:

An embedded RCC tie beam to floor slab is to be provided at each floor slab level, as an essential requirement of national building code against earth quakes. For this, web portion to required beam depth at top shall be cut and removed for placing horizontal reinforcement with stirrups and concreted. GFRC panel for floor/ roof slab in combination with RCC for floor/roof slab shall also be cut to required size and marked with notation. First the wall joints and other cavities and horizontal RCC tie beams are in- filled with concrete; then wooden plank of 0.3 to 0.45 m wide is provided to room span between the walls with support wherever embedded micro beams are there; finally roof panels shall be lifted by crane using strong sling tied at mid-diagonal point, so that panel will float perfectly horizontal. Each roof panel is placed over the wall in such a way that there shall be at least a gap of 40 mm. This is to enable vertical rods to be placed continuously from floor to floor and provide monolithic RCC frame within GFRC panel. Wherever embedded micro-beams are there, top flanges of roof panel are cut leaving at least 25mm projection.

26.41.2.6 GFRG panel for floor/roof slab in combination with RCC

GFRG panel for floor/roof slab shall be cut to required size and marked with notation. First, wall joints, other cavities and horizontal RCC tie beams are in-filled with concrete; then wooden plank 0.3 to 0.45m wide shall be provided to room span between the walls with support wherever embedded micro beams are there and then roof panels shall be lifted by crane. Each roof panel shall be placed over the wall in such a way that there will be a gap of at least 40mm. This is to enable vertical rods to be placed continuously from floor to floor and provide monolithic RCC frame within GFRG panel. Wherever embedded micro-beams are there, top flanges of roof panel shall be cut leaving at least 25mm projection. Reinforcement and weld mesh is placed for micro beams and then concrete shall be poured for micro beams and RCC slab.

26.41.2.7 Erection of wall panel and floor slab for upper floor

Vertical reinforcement of floor below shall be provided with extra length so as to protrude to 0.45m to serve as start up rods and lap length for upper floor. Once the wall panels are erected on the upper floor, vertical reinforcement rods, door/window frames fixed and RCC lintels shall be casted. Then concrete where required and joints shall be filled. Thereafter, RCC tie beams all around shall be concreted.

26.41.2.8 Waterproofing:

Water proofing treatment of Vertical joints (of external side and internal side) between door frame, window & ventilator frames (on all four sides) of outer wall over the Zycosil/equivalent & Zycoprime/equivalent solution already applied(before the installation of door / window / ventilator frames in position) and fine finish with Grout RW/equivalent. Water proofing treatment of RCC sunshade with Zycosil/equivalent water proofing Solution (1 litre of Zycosil/equivalent& 20 litres of water stirred first & 2 litres of Zycoprime/equivalent added and stirred (total 23 litres)) till it meets the saturation level and testing as per RILEM or by water drops test in which water drops do not absorb but drops remain or rolls.

26.41.2.9 Sealing of joints :

In-filling / sealing of joint between RCC lintel cum sunshade and wall (on external side) in all floors by pushing in Grout RW/equivalent in paste form and coving 20 mm x 20 mm after applying a coat of Zycosil/equivalent & zycoprime/equivalent solution before cement plastering of top, bottom and sides of RCC sunshade.

The Quality Assurance Plan for GFRG Panel mentioned in Table 26.9

Table 26.9
Material Testing
Quality Assurance Plan for GFRG Panel

S. No.	Parameters to be inspected	Requirement Specified	Test Method As per BMBA PC-3:2011	Frequency of Testing
A. Rapidwall/GFRG Panel				
1.	Visual Appearance	Shall be free from defects like cracks, corrugations, ripples, stains, pockmarks, loose corners etc.	Clause10.4.1	Once in every ten panels
2.	Overall Dimensional Tolerances	Length & height shall be within tolerance limit of ±3mm & thickness +3mm to 0mm	Clause10.4.2	Once in every fifty panels
3.	External Skin thickness tolerance	Shall be ± 3mm (General /Water resistance grade) Min 8mm Partition grade	Clause10.4.2	Once in every fifty panels
4.	Internal Rib thickness tolerance	Shall be ± 2mm (General /Water resistance grade) Shall be ± 5mm (Partition grade)	Clause10.4.2	Once in every fifty panels
5.	Cavity Width & Depth Tolerance	Shall be ± 3mm (General / Water resistance grade) Shall be ± 7mm (Partition grade)	Clause10.4.2	Once in every fifty panels
6.	Unevenness	Shall be less than 1mm (Side A) Shall be less than 3mm (Side B)	Clause10.4.2	Once in every fifty panels
7.	Panel weight	Shall be 40 Kg/m^2 ± 6% (Class 1 & 2) shall be 40 Kg/mm^2±15% (Class 3)	Clause10.4.4	Once in every fifty panels
8.	Water Content	Shall be less than 1% (measured immediately after drying process)	Clause 10.4.3	Once in every fifty panels
9.	Water Absorption Rate	Shall be less than 5% by weight (after 24 hrs of immersion in water)	Clause 10.4.5	Once in every fifty panels
10.	Vertical Load bearing capacity (Compressive strength)	Shall be more than160 kN/m (General / Water resistance grade) Shall be more than 90 kN/m (Partition grade)	Clause 10.4.6	Once in every fifty panels
11.	Out of plane Flexural capacity (Flexural strength)	Shall be more than 2.1kN/m (General /Water resistance grade) Shall be more than1.3 kN/m (Partition grade)	Clause 10.4.7/ Clause 10.4.8	Once in every fifty panels

12.	" U" Value	Shall be 2.85W/M² C	IS3346:1980	Once in a year or when the composition changes and initially at the time of approval
13.	Thermal Conductivity (K)	Shall be 0.617 W/m C	IS3346:1980	
14.	Sound transmission	Shall be 40 (STC)	ISO 140-3:1996	
15.	Durability i. wetting & drying ii. Salt spray	Average compressive strength shall not be less than 7.52 N/mm^2 Shall not suffer any apparent damage after 20 cycles	Clause10.4.9	Once in a year or when the composition changes and initially at the time of approval
16.	Fire Resistance	Shall withstand 700-1000^{0}C after 4hr	Clause10.4.10	
B. Raw Materials				
1.	Calcined Gypsum	i.Shall be more than 90% as Calcium Sulphate ii. Combined moisture shall not be more than 6.2%	As per Company Standard	i. Once in a day ii. Once in a shift
2.	Ammonium Carbonate	Shall not be less than 99.14% as purity	As per Company Standard	Once on delivery at site
3.	Glass Roving	These raw materials are performance based. Test Certificates provided by the manufacturers are verified at the time of delivery.		
4.	BS-94 M			
5.	Retarder D-50			

26.41.3 Measurement:

All measurement of the area is to be measured correct to a centimeter. The area shall be calculated in square meter correct to two decimal places. No deductions shall be made for making openings for doors, windows, ventilators etc.

26.41.4 Rates :

The rates shall include the cost of all materials and labour involved in all the operations described above.

26.41.5 Glossory:

Cavity : The internal hollow cores inside the panel are called the cavity .

Panel Length: The panel length is the maximum horizontal dimension of a single wall without vertical joint.

Panel Thickness: The panel thickness is the distance between the external faces of the two external skins.

Height :The panel height is the maximum vertical dimension of a single wall without a horizontal joint.

A and B Side: The smoother side of the GFRG panel cast against the machine bed in the manufacturing process is called the A side. The B side is screeded and is relatively rougher than A side.

26.42 GALVANIZED STEEL DECK SHEET ROOFING COVERED WITH CONCRETE

26.42.1 Materials

26.42.1.1 Galvanized Steel Deck Sheet (Fig 26.14)

The base metal of plain galvanized sheets and coils shall conform to IS 1079 or IS 513 as the case may be. However, deck sheet shall conform to IS 277:2003. When it is not possible to test the base metal before galvanizing, the base metal may be tested after stripping off the zinc coating. The grade of coating shall be minimum 275 g/sqm.

Galvalume and pre-painted galvalume sheets are not recommended for use in contact with concrete.

26.42.1.2 Shear Connectors (See Fig 26.15 A, 26.15B & 26.15C)

Shear connectors (Shear studs) at the interface of the concrete and sheet are provided. These shear connectors are embossment in deck sheets as typical pattern unique to each profile.

To ensure friction at the embossments, there should not be any paint or grease on the sheet surface in contact with concrete nor should any vibrating load be permitted to act on the slab until the concrete has set completely.

The length after weld should extend at least 35mm above the top of the main rib of the deck profile. The distance from the deck rib shall be minimum 25mm.

Single connector to be located at the center of beams except at butt joints where connectors to be staggered.

To avoid damaging to decking, connectors to be located along the predetermined lines marked on it.

Minimum Spacing of the connectors shall be 5 times the diameter of shank and maximum shall not be more than 600 or 4 times the depth of slab.

Connectors in pair to have a minimum gap of 4 times the diameter of shank.

26.42.1.3 Wire Mesh

3 mm wire mesh laid at 100x100 mm grid is to be provided to control the cracking.

26.42.1.4 Edge Trim

Galvanized edge trim is provided where requested around perimeter and void edges. This edge trim acts as permanent formwork only to support the wet weight of concrete during construction.

26.42.2 Finish

The roof when completed shall be true to lines, and slopes and shall be leak proof.

26.42.3 Measurements

The length and breadth shall be measured correct to a cm. Area shall be worked out in sqm correct to two places of decimal.

The area of roof shall be measured on the flat without allowance for laps and corrugations. Roof with curved sheets shall be measured and paid for separately. Measurements shall be taken on the flat and not girthed.

No deduction in measurement shall be made for opening upto 0.4 sqm and nothing extra shall be allowed for forming such openings. For any opening exceeding 0.4 sqm in area, deduction in measurements for the full opening shall be made and in such cases the labour involved in making these openings shall be paid for separately. Cutting across corrugation shall be measured on the flat and not girthed. No additions shall be made for laps cut through.

26.42.4 Rate

The rate shall include the cost of all the materials and labour involved in all the operations described above including all shear connectors, wire mesh, edge trim, seal, scaffolding, machinery for operations required etc. but excluding the cost of structural steel like beams, columns, joists etc. and concrete of different grade as per design.

26.43 PRECAST CONCRETE SOLID BLOCK

26.43.1 Precast Concrete Solid Block Made of C & D Waste

The block shall be machine moulded and should be free from visible cracks, flaws warpage & organic matter.

26.43.1.1 Dimensions

The nominal dimensions of block shall be as follows:

Length: 400 or 600mm

Height: 100mm

Width: 200mm.

Most commonly used size is 400 x 200 x 100mm.

26.43.1.2 Classification

Blocks shall have minimum compressive strength of 10N/mm² or 100kgf/cm.

The blocks shall have smooth rectangular faces with sharp corner and shall be uniform in colour.

26.43.1.3 Sampling and Tests

Samples of Blocks shall be subjected to the following tests:

(a) Block density

(b) Dimensional tolerance.

(c) Water absorption.

(d) Drying shrinkage

(e) Compressive strength.

26.43.1.3.1 ***Sampling:*** For carrying out compressive strength, water absorption, and dimensional tests, the samples of blocks shall be taken at random according to the size of lot as given in Table A below. The sample thus taken shall be stored in a dry place until tests are made. For the purpose of sampling, the following definition shall apply.

(***a)*** ***Lot****:* A collection of blocks of same class and size, manufactured under relatively similar conditions of production. For the purpose of sampling a lot shall contain a maximum, of 10000 blocks.

In case a consignment has blocks more than 10000 of the same classification and size and manufactured under relatively similar conditions of production, it shall be divided into lots of 10000 Blocks or part thereof.

(b) ***Sample:*** A collection of blocks selected for inspection and/or testing from a lot to reach the decision regarding the acceptance or rejection of the lot.

(c) ***Defective:*** A block failing to meet one or more of the specified requirements.

26.43.1.3.2 The samples shall be taken as below:

(i) ***Sampling from a Stack:*** When it is necessary to take a sample from a stack, the stack shall be divided into a number of real or imaginary sections and the required number of blocks drawn from each section. For this purpose blocks in the upper layers of the stack shall be removed to enable units to be sampled from places within the stack.

Visual characteristics: The blocks shall be selected and inspected for ascertaining their conformity to the requirements of the relevant specification. The number of blocks to be selected from a lot shall depend on the size of lot and shall be in accordance of Table A for visual characteristics in all cases and dimensional characteristics if specified for individual blocks.

(ii) ***Visual Characteristics:*** All the blocks selected above in accordance with Table A shall be examined for visual characteristics. If the number of defective blocks found in the sample is less than or equal to the corresponding number as specified in of Table A the lot shall be considered as satisfying the requirements of visual characteristics, otherwise the lot shall be deemed as not having met the visual requirements.

(iii) ***Dimensional Characteristics:*** The number of blocks to be selected for inspecting the dimensions and tolerance shall be in accordance with Table A. These blocks will be divided into groups of 20 blocks at random and each of the group of 20 blocks thus formed will be tested for all the dimensions and tolerances. A lot shall be considered having found meeting the requirements of dimensions and tolerance if none of the groups of blocks inspected fails to meet the specified requirements in table 26.10.

TABLE 26.10

No. of blocks in lot	Sample size	No. of samples required to be tested from sample size					
		Dimensional characteristics	Visual defects	Blocks density	Compressive strength	Water absorption	Drying shrinkage
0-10000	20	20	20	3	8	3	3

(i) ***Scale of Sampling and Criteria for Physical Characteristics:*** The lot which has been found satisfactory in respect of visual and dimensional requirements shall be next tested for physical characteristics like block density compressive strength, water absorption, drying shrinkage as specified in relevant material specification. The blocks for this purpose shall be taken at random from those already selected above. The number of blocks to be selected for each of these characteristics shall be in accordance with relevant columns of Table A.

26.43.1.3.3 ***Dimensional Tolerances:*** The variation in the length of the units shall not be more than ± 5mm and variation in height and width of units, not more than ± 3mm.

The dimensions of blocks when tested as described above as per procedure described in Appendix A of chapter 6 shall be within the following limits per 20 blocks or locally available size as approved by Engineer-in-charge.

Length 8100 to 7900 mm (8000 ± 100 mm)

Width 4060 to 3940 mm (4000 ± 60 mm)

Height 2060 to 1940 mm (2000 ± 60 mm) for 100 mm high block.

26.43.1.3.4 ***Block Density*****:** The average block density when tested in accordance with the procedure laid down in IS 2585 Part 1-2005 shall not be less than 1800kg/m^3.

26.43.1.3.5 ***Compressive Strength:*** The blocks, when tested in accordance with the procedure laid down in IS 2185 (part-1) shall have a minimum average compressive strength of 10N/mm^2.

26.43.1.3.6 ***Water Absorption:*** The average water absorption of blocks when tested in accordance with the procedure laid down in IS 2185 part 1- 2005 shall be not more than 10% by weight.

26.43.1.3.7 ***Drying Shrinkage:*** The average drying shrinkage of block when tested in accordance with the procedure laid down in IS 2185 part 1- 2005 shall not be more than 0.1%

26.43.2 Block Work

26.43.2.1 Mortar

The mortar for the C&D waste block work shall be as specified, and conform to accepted standards. Lime shall not be used where reinforcement is provided in block work.

26.43.2.2 Soaking of Blocks

Blocks shall be soaked in water before use for a period for the water to just penetrate the whole depth of the blocks. Alternatively blocks may be adequately soaked in stacks by profusely spraying with clean water at regular intervals for a period not less than six hours. When the blocks are soaked they shall be removed from the tank sufficiently early so that at the time of laying they are skin-dry. Such soaked blocks shall be stacked on a clean place where they are not again spoiled by dirt earth etc.

Note I: The period of soaking may be easily found at site by a field test in which the blocks are soaked in water for different periods and then broken to find the extent of water penetration. The least period that corresponds to complete soaking will be the one to be allowed for in construction work.

Note II: If the blocks are soaked for the required time in water that is frequently changed the soluble salt in the blocks will be leached out, and subsequently efflorescence will be reduced.

26.43.2.3 Laying

26.43.2.3.1 Blocks shall be laid in single Block masonry, blocks shall be laid in stretcher bond. Half or cut blocks shall not be used except as closer where necessary to complete the bond. Closers in such cases, shall be cut to the required size and used near the ends of the wall.

Block work for wall thickness 200mm shall be done with block laid flat with its height (100mm) vertical. It shall be done with cement mortar 1:6 (1 cement: 6 coarse sand) Block work for wall thickness 100mm shall be done with the same block laid such that its height of 100mm being horizontal. It shall be done with cement mortar 1:4 (1cement: 4 coarse sand).

26.43.2.3.2 All loose materials, dirt and set lumps of mortar which may be lying over the surface on which block work is to be freshly started, shall be removed with a wire brush and surface wetted. Blocks shall be laid on a full bed of mortar, when laying, each block shall, be properly bedded and set in position by gently pressing with the handle of a trowel. Its inside face shall be buttered with mortar before the next block is laid and pressed against it. Joints shall be fully filled and packed with mortar such that no hollow space are left inside the joints.

26.43.2.3.3 The walls shall be taken up truly in plumb or true to the required batter where specified. All courses shall be laid truly horizontal and all vertical joints shall be truly vertical. Vertical joints in

the alternate course shall come directly one over the other. Quoin, Jambs and other angles shall be properly plumbed as the work proceeds. Care shall be taken to keep the perpends properly aligned within following maximum permissible tolerances :

(a) Deviation from vertical within a storey shall not exceed 6 mm per 3 m height.

(b) Deviation in verticality in total height of any wall of building more than one storey in height shall not exceed 12.5 mm.

(c) Deviation from position shown on plan of any block work shall not exceed 12.5 mm.

(d) Relative displacement between load bearing wall in adjacent storeys intended to be vertical alignments shall not exceed 6 mm.

(e) A set of tools comprising of wooden straight edge, masonic spirit levels, square, 1 metre rule line and plumb shall be kept on the site of work for every 3 masons for proper check during the progress of work.

26.43.2.3.4 All quoins shall be accurately constructed and the height of block courses shall be kept uniform. This will be checked using graduated wooden straight edge or storey rod indicating height of each course including thickness of joints. The position of damp proof course, window sills, bottom of lintels, top of the wall etc. along the height of the wall shall be marked on the graduated straight edge or storey rod. Acute and obtuse quoins shall be bonded, where practicable in the same way as square quoins. Obtuse quoins shall be formed with squint showing three quarters block on one face and quarter block on the other.

26.43.2.3.5 The block work shall be built in uniform layers.

No part of the wall during its construction shall rise more than one metre above the general construction level. Parts of wall left at different levels shall be raked back at an angle of 45 degrees or less with the horizontal. Toothing shall not be permitted as an alternative to raking back. For 100mm block partition to be keyed into main walls, indents shall be left in the main walls.

26.43.2.3.6 All pipe fittings and specials, spouts, hold fasts and other fixtures which are required to be built into the walls shall be embedded, as specified, in their correct position as the work proceeds unless otherwise directed by the Engineer-in-Charge.

26.43.2.3.7 To facilitate taking service lines later without excessive cutting of completed work, sleeves (to be paid separately) shall be provided, where specified, while raising the block work. Such sleeves in external walls shall be sloped down outward so as to avoid passage of water inside.

26.43.2.3.8 Top of the block work in coping and sills in external walls shall be slightly tilted. Where block coping and sills are projecting beyond the face of the wall, drip course/throating (to be paid separately) shall be provided where indicated.

26.43.2.3.9 Care shall be taken during construction that edges of jambs, sills and projections are not damaged in case of rain. New built work shall be covered with gunny bags or tarpoulin so as to prevent the mortar from being washed away. Damage, if any, shall be made good to the satisfaction of the Engineer-in-Charge.

26.43.2.3.10 Horizontal reinforcement in the form of MS bars, 2 Nos, 6 mm dia each shall be provided at every alternate third coarse for block masonary of wall thickness 100mm.

26.43.2.3.11 In retaining walls and the like, where water is likely to accumulate, weep holes, 50 to 75 mm square shall be provided at 2 m vertically and horizontally unless otherwise specified. The lowest weep hole shall be at about 30 cm above the ground level. All weep holes shall be surrounded by loose stones and shall have sufficient fall to drain out the water quickly.

Note : Work of providing loose stone will be payable extra.

26.43.2.4 Joints

Specified thickness of joints shall be of 1 cm.

26.43.2.4.1 ***Finishing of Joints:*** The face of block work may be finished flush or by pointing. In flush finishing either the face joints of the mortar shall be worked out while still green to give a finished surface flush with the face of the block work or the joints shall be squarely raked out to a depth of 1 cm while the mortar is still green for subsequently plastering. The faces of block work shall be cleaned with wire brush so as to remove any splashes of mortar during the course of raising the block work. In pointing, the joints shall be squarely raked out to a depth of 1.5 cm while the mortar is still green and raked joints shall be brushed to remove dust and loose particles and well wetted, and shall be later refilled with mortar to give ruled finish. Some such finishes are 'flush', 'weathered', ruled, etc.

26.43.2.5 Curing

The block work shall be constantly kept moist on all faces for a minimum period of seven days. Block work done during the day shall be suitably marked indicating the date on which the work is done so as to keep a watch on the curing period.

26.43.2.6 Scaffolding

Shall be as specified in clause 6.2.7.

26.43.2.7 Measurements

26.43.2.7.1 Block work with 200mm wall thickness shall be measured in cubic metres unless otherwise specified. Any extra work over the specified dimensions shall be ignored. Dimensions shall be measured correct to the nearest 0.01 m i.e. 1 cm. Areas shall be calculated to the nearest 0.01 sqm. and the cubic contents shall be worked out to the nearest 0.01 cubic metres.

26.43.2.7.2 Block work shall be measured separately in the following stages:

(a) From foundation to floor one level (Plinth level)

(b) Plinth (floor one) level to floor two level

(c) Between two specified floor levels above floor two level

Note : (i) Block work in parapet walls, mumty, lift machine room and water tanks constructed on the roof upto 1.2 m height above roof shall be measured together with the corresponding work of the floor next below.

26.43.2.7.3 No deductions or additions shall be done and no extra payment made for the following :

Note : Where minimum area is defined for deduction of an opening, void or both, such areas shall refer only to opening or void within the space measured.

(a) Ends of dissimilar materials (that is, joists, beams, lintels, posts, girders, rafters, purlins, trusses, corbels, steps, etc.); up to 0.1 m2 in section;

(b) Opening up to 0.1 m2 in area (see Note);

(c) Wall plates, bed plates, and bearing of slabs, chajjas and the like, where thickness does not exceed 10 cm and bearing does not extend over the full thickness of wall;

(d) Cement concrete blocks as for hold fasts and holding down bolts;

(e) Iron fixtures, such as wall ties, pipes upto 300 mm diameter and hold fasts for doors and windows; and

(f) Chases of section not exceeding 50 cm in girth.

(g) Bearing portion of drip course, bearing of moulding and cornice.

Note : In calculating area of an opening, any separate lintel or sills shall be included with the size of the opening but end portions of lintel shall be excluded. Extra width of rebated reveals, if any, shall also be excluded.

26.43.2.7.4 Walls 100 mm thick and less shall each be measured separately in square metres stating thickness.

26.43.2.7.5 String courses, projecting pilasters, aprons, sills and other projections shall be fully described and measured separately in running metres stating dimensions of each projection.

26.43.2.7.6 Square or rectangular pillars shall be measured separately in cubic metres in multiple of 100mm thick block wall.

26.43.2.7.7 Circular pillars shall be measured separately in cubic metres as per actual dimensions.

26.43.2.7.8 Block work curved on plan shall be measured like the block work in straight walls and shall include all cutting and wastage of Blocks, tapered vertical joints and use of extra mortar, if any. Block work curved on plan to a mean radius not exceeding six metres shall be measured separately and extra shall be payable over the rates for Block work in straight walls. Nothing extra shall be payable if the mean radius of the block work curved in plan exceeds six metres.

26.43.2.7.9 Tapered walls shall be measured net as walls and extra payment shall be allowed for making tapered surface for block work in walls.

26.43.2.8 Rate

The rate shall include the cost of materials and labour required for all the operations described above except the reinforcement and its encasement in cement mortar or cement concrete. The rate shall also include the following:

(a) Raking out joints or finishing joints flush as the work proceeds;

(b) Preparing tops of existing walls and the like for raising further new Block work.

(c) Rough cutting and waste for forming gables, splays at eaves and the like.

(d) Leaving holes for pipes upto 150 mm dia. and encasing hold fasts etc.

(e) Rough cutting and waste for Block work curved in plan and for backing to stone or other types of facing.

(f) Embedding in ends of beams, joists, slabs, lintels, sills, trusses etc.

(g) Bedding wall plates, lintels, sills, roof tiles, corrugated sheets, etc. in or on walls if not covered in respective items and

(h) Leaving chases of section not exceeding 50 cm in girth or 350 sq cm in cross-section.

(i) Block on edge courses, cut Block corners, splays reveals, cavity walls, Block works curved on plan to a mean radius exceeding six metres.

26.43.3 Block Work In Arches

Block work in arches shall be same as specified in clause 6.3.

26.43.4 100mm thick block work

Block work in 100 mm thick walls shall be done in the same manner as described above in 26.43.2.3 2 Nos. M.S. bars of 6 mm dia., shall be embedded in every third course as given in the item (the dia of bars shall not exceed 8 mm). These shall be securely anchored at their end where the partitions end. The free ends of the reinforcement shall be keyed into the mortar of the main block work to which the 100 mm work is joined. The mortar used for reinforced block work shall be rich dense cement mortar of mix 1:4 (1 cement: 4 coarse sand). Lime mortar shall not be used. Over laps in reinforcement, if any shall not be less than 30 cm.

The mortar interposed between the reinforcement bars and the block shall not be less than 5 mm. The mortar covering in the direction of joints shall not be less than 15 mm.

26.43.4.1 Measurements

The length and height of the wall shall be measured correct to a cm. The area shall be calculated in sq.m. where 100 mm thick wall is joined to the main walls of 200mm or greater thickness and measurements for 100 mm thick wall shall be taken for its clear length from the face of the thicker wall.

26.43.4.2 Rate

The rate includes the cost of the materials and labour involved in all the operations described above except reinforcement which is to be paid for separately.

26.43.5 HONEY COMB BLOCK WORK

The honeycomb block work shall be done with specified class of block, laid in specified mortar. All joints and edges shall be struck flush to give an even surface.

The thickness of the block honeycomb work shall be 100 mm thick only, unless otherwise specified. Openings shall be equal and alternate with 100 mm thick block work laid with a bearing of 2 cm on either side.

26.43.5.1 Measurements

The length and height shall be measured correct to a cm. Area shall be calculated in square metres correct to two places of decimal. Honeycomb openings shall not be deducted.

26.43.5.2 Rate

The rate includes the cost of materials and labour involved in all the operations described above.

26.43.6 Joining old block work with new block work

26.43.6.1 In case the height of the blocks of old as well as new work is same, the old work shall be toothed to the full width of the new wall and to the depth of a quarter of block in alternate courses. In case the height of the blocks is unequal, then the height of each course of new work shall be made equal to the height of the old work by adjusting thickness of horizontal mortar joints in the new wall. Where necessary, adjustment shall be made equal to thickness of old wall by adjusting the thickness of vertical joints.

26.43.6.2 For joining new cross wall to old main walls, a number of rectangular recesses of width equal to the thickness of cross wall, three courses in height and half a block in depth shall be cut in the main walls. A space of the three courses shall be left between two consecutive recesses. The new cross wall shall be bonded into the recesses to avoid any settlement.

26.43.6.3 Joining of old block work with the new brick work shall be done in such a way that there shall not be any hump or projection at the joint.

26.43.6.4 Measurement

The height and thickness of vertical face in contact with new work shall be measured to the nearest 0.01 m and the area shall be calculated to the nearest 0.01 sqm.

26.43.6.5 Rate

The rate includes the cost of labour and material involved in all the operations described above.

26.43.7 Moulding and cornices

Shall be same as specified in 6.8

26.43.8 Exposed block work

Shall be same as specified in 6.10

26.43.9 Factory Made Cement Concrete interlocking Paver Block Made of C & D Waste

26.43.9.1 Base

Interlocking paver block to be fixed on the bed 50 mm or specified otherwise thick of coarse sand of approved specification and filling the joints with the sand of approved type and quality or as specified and as directed by Engineer-in-charge.

26.43.9.2 Interlocking Paver Block

Factory made cement concrete precast paver block of M-30 or otherwise specified grade to be used. Paver blocks to be of approved brand and manufacturer and of approved quality. Paver blocks shall be 60mm thick and made of C&D waste by block making machine with vibratory compaction. Minimum strength as prescribed by manufacturer and as per direction of Engineer-in-Charge for the grade specified to be tested as per method mentioned in specification of subhead cement concrete of CPWD Specification 2019 Vol. I.

26.43.9.3 Measurement & Rates

Area provided with paver block to be measured in sqm. correct upto two places of decimal. The rates include the cost of the material, labour, tools etc. required in all the operations described above.

26.44 PRECAST TECHNOLOGY

26.44.1 General

26.44.1.0 Design criteria

26.44.1.1 Design criteria of precast RCC structural units shall conform to the Design requirements of latest version of **IS: 456**.

26.44.1.2 Resistance to horizontal loading shall be provided by having appropriate moment and shear resisting joints or placing the shear walls. Where shear walls are provided, rotational stiffness of the floor wall joint is not to be considered.

26.44.1.3 Buttressing in the external walls shall be provided as external wall elements are not fully restrained on both sides by floor panels and that external wall panel connections are the weakest points in a precast panel structure.

26.44.1.4 In all load bearing elements, adequate restraint shall be provided at corners of the structure. These elements and the external ends of cross wall units should be stiffened either by introducing columns as connecting units or by joining them to non-structural wall units.

26.44.1.5 Bearing for Precast Units shall be as per clause 8.3 of **IS 15916**.

26.44.1.6 Slab panels shall be interconnected through joints at regular intervals to provide monolithic/ diaphragm action.

26.44.1.7 RCC decking/ topping reinforced screed shall be overlaid on precast panels for providing rigid diaphragm action, under seismic conditions.

26.44.2. Joints:-

Requirements of a structural joint:

26.44.2.1. It shall be capable of being designed to transfer the imposed load and moments with a known margin of safety.

26.44.2.2 It shall accept the loads without marked displacement or rotation and avoid high local stresses.

26.44.2.3. It shall accommodate tolerances in elements.

26.44.2.4 It shall enable the structure to absorb sufficient energy during earthquakes so as to avoid sudden failure of the structure.

26.44.2.5 Precast Components of the structure shall be designed for fire rating of two hours. Fire rating for joints of the components shall be higher or at least equal to the fire rating of connecting members.

26.44.2.6 The appearance of precast components joint shall merge with architectural aesthetic appearance and shall not be physically prominent compared to other parts of structural components.

26.44.2.7 Precast structures may have continuous or hinged connections subject to providing sufficient rigidity to withstand horizontal loading.

When only compressive forces are to be taken, hinged joints may be adopted. In case of prefabricated concrete elements, load is transmitted via the concrete.

When both compressive force and bending moment are to be taken, rigid or welded joints may be adopted. The shearing force is usually small in the column and can be taken up by the friction resistance of the joint. Here load transmissions is accomplished by steel inserted parts together with concrete.

26.44.2.8. When considering thermal shrinkage and heat effects, provision of Expansion joints as per **IS 3414** shall be provided.

26.44.3 Load Testing:

26.44.3.1 Tests for Components/Structure:

Sampling Procedure: Lot for sampling shall be as per criteria laid down under clause **10.1.1** of **IS 15916.** The lot found satisfactory with respect to the dimensional requirements shall be tested for load test. The lot shall be considered as conforming to the strength requirement, if all the units meet the requirement; otherwise not.

Testing on Individual Components: Test load on the component, duration of applying the test load, maximum deflection & recovery after removal of the test load & test observations shall satisfy the requirements under clause **10.2** of **IS 15916**.

26.44.3.2 Test on completed structure:

Load testing on a completed structure or part of completed structure should be made, if there is a reasonable doubt of adequacy in strength of the structure. The testing procedure on the structure or part of completed structure as to the quantum of test load, duration of applying of the test load, maximum deflection, and recovery after removal of the test load & other required test observations shall be as per clause 10.3.1 of **IS 15916.**

26.44.4 Compliance with Design codes:

26.44.4 .1 Precast construction is to be undertaken broadly as per relevant BIS/ BS/ ACI codes and standards for Precast constructions **IS: 456, IS:15916, IS 15917, IS: 11447, IS: 10297** etc.

26.44.5 Manufacturing: The precast concrete elements shall be manufactured at an established manufacturing facility in a factory with a quality controlled environment where a fully equipped quality laboratory is made available.

26.44.6 Pre-tensioning Specifications:

The pre-tensioning of the precast elements, if resorted to, shall be accordance with the applicable standards and the pre tensioning details of each typical element shall be submitted in advance for approval from Engineer-in- Charge.

26.44.7.Specifications of the precast elements: The specifications for all the Precast concrete elements should not be lower than the following:

(a) Grade of concrete: M40 min for precast & M50 min for pre-stressed.

(b) Reinforcing steel : Fe500D

(c) Prestressing steel :LRPS – FeP1860 – uncoated

(d) Cement – OPC 43/53 grade

(e) 2 hours fire rating for precast walls beams and slabs.

(f) Smooth finished surfaces for the precast elements

26.44.8.Product tolerances: All the pre-stressed precast concrete elements should be manufactured in conformation to the tolerance limits as per the PCI manual.

26.44.9.Curing: The curing for precast/ and pre-stressed concrete elements should be as per the applicable IS codes and supporting proof of curing records should be submitted.

26.44.10. Quality Assurance: The precast concrete elements should be tested in accordance with the IS or ASTM standards including the following tests:

1. Slump tests.
2. Compressive Strength test
3. Typical element load bearing test

26.44.11 Transportation of precast elements: Since the construction is planned with precast technology the precast concrete elements from the manufacturing location should not be removed and transported until they attain at least 75% of the required compressive strength of 28 day duration.

26.44.12 Cranes for Erection: Cranes with at least 1.5 times safety margin along with calibration certification only should be used for carrying out the erection of precast concrete elements at the site.

26.44.13 Erection of Precast elements: The erection of the pre-stressed precast elements should be done using experienced erection persons and as per the standard methodology and in safe manner in accordance with design sequence ensuring erection tolerances as per the accepted Standards (like PCI Manual).

26.44.13.1 for all precast/pre stressed elements irrespective of size, shape and thickness, should be provided with proper lifting accessories for loading ,unloading and erection at site, nothing shall be paid on account of this.

26.44.13.2 pre stressed elements should not be allowed to localized cutting after transporting to site as pre stressed steel may get disturbed.

26.44.13.3 suitable openings should be provided for all precast/pre stressed elements for inserting dowel bars ,passing the cables etc (Note: the size and shape of opening should as per relevant code provisions.)

26.44.14 Connections: The precast elements should be given wet connections or alternatively as per the design requirements. All the connection details and details of structural ties should be furnished in advance for review and approval.

26.44.15 Grouting / Fillings: The grouting/fillings should be done with Premixed, packaged shrink-resistant grout using materials of approved standards and technical specifications in accordance with accepted grouting practices.

26.44.16 Screeding: The floor constructed with solid / hollow core precast slabs should be covered with concrete screed of required thickness using the same grade as that of precast member and by providing reinforcement for integrating with adjacent precast components and to obtain the monolithic behavior to slab .However the change in grade of concrete from that of base precast members may be accepted depending upon the designer recommendations duly approved and based on the site conditions wherever it so warranted

26.44.17 Joint Fillings: The joints of the constructed precast elements should be filled with backer rods and weather proof mastic sealants using standard materials and as per the approved methodology.

26.44.18 Mock-up of precast elements: If required, the contractor should demonstrate mock-up of precast elements and their erection in advance for observation and approval.

26.44.19 Methodology Statements: Methodology statements for manufacturing of precast elements, transportation, erection, connection, and screeding should be submitted in advance for approval. The methodology statements for safety practices should also be submitted.

26.44.20 Testing of the Structure: After construction of the structure, the part of it should be loaded with 1.5 times the design load for deflections and other parameters.

26.44.21 Components of RCC structure shall be designed for loads in accordance with **IS 875 (Parts I to 5)** and **IS 1893-Part 1**. In addition, loads that might be expected during the construction shall also be considered in the design.

26.44.22 The pre-cast RCC manufacturing unit of pre cast elements shall be got approved from Engineer-in-charge before start of work.

26.44.22.1 The pre-cast manufacturing unit shall have minimum capacity of 45 cum/hour fully automatic batching plant and having manufacturing capacity of 300sqm/day of prestressed precast hollow core slab & 50 cum/day of solid pre-cast element.

26.44.22.2 The manufacturing unit of pre cast elements shall be within feasible distance from site so that quality of pre cast elements can be inspected by Engineer-in-charge or his representatives during casting.

26.44.22.3 The contractor shall at his own expenses furnish all stakes, templates, platforms, equipment, arrange labour that may be required in setting or laying out any part or which of the work. The contractor shall be held responsible for proper execution of the work to such lines and grades as may be established or indicated in the drawings and specifications.

26.44.22.4 Pre-cast concrete construction (RCC Columns and Hollow core slabs)

(a) The concrete mix used shall be of min of M-40 grade Ready mix concrete for solid precast elements viz. columns and footings and M-50 grade Ready mix concrete for prestressed hollow core slabs of required size and thickness in accordance **with IS:1343**

(b) The prestressing of steel strands for manufacture of hollow core slabs shall be done in accordance to the **IS: 1343**.

(c) Hollow core slabs shall be provided with suitable weep holes wherever necessary

(d) Contractor shall provide suitable steel shuttering moulds as per drawing to cast the RCC columns with the specified dimensions and tolerances in factory approved by Engineer-in-charge.

(e) Reinforcement shall be fabricated to the required shape & size and put in the mould as per drawings. Embedded parts, hooks if any shall be placed, anchored properly and aligned as per requirements for which no extra payment shall be made.

(f) Hollow core slab manufacturing details as per the manufacturer's recommendations satisfying the design intents showing the details of HTS wires, stressing etc shall be submitted prior to actual manufacturing.

(g) Concrete of specified grade as per the design shown in drawing shall be poured into the form work, compacted and finished to final shape. All the pre-cast elements shall then be sufficiently cured by steam curing method under strict supervision of Engineer-in-charge or his authorized representatives.

(h) Contractor shall transport the elements columns & footings to the site of the work / location and shall place in position by mechanically operated mobile cranes.

(i) Contractor shall be responsible for proper handling of the units and will ensure regular supply of precast RCC elements.

(j) Temporary Openings shall be provided at the base of columns and wall of its form work and other places necessary to facilitate cleaning and inspection.

(k) Immediately before concrete is placed, all forms shall be carefully inspected to ensure that they are properly placed, sufficiently rigid and tight, thoroughly cleaned, properly treated and free from foreign materials before they are again used. If forms appear to be unsatisfactory in any way either before or during the placing of concrete, the Engineer-in-charge shall have power to stop the work until the defects are corrected.

26.44.22.5 Transportation and Erection of Pre-cast elements:

(a) Necessary lifting hooks/holes shall be provided at structurally advantageous points to facilitate demoulding and erection of precast units in accordance with **IS: 10297**

(b) All the pre cast elements from the manufacturing unit shall be transported by suitable trailer in such a way that pre cast elements are not damaged in during transit.

(c) Contractor shall ensure that all the corners/edges are properly protected during transportation.

(d) Damaged elements shall not be allowed to use in the works.

(e) It shall be ensured that clearance of Engineer-in-charge is obtained prior to erection.

(f) Erection of all pre cast elements shall be done by telescopic crane of suitable capacity with skilled man power.

(g) Initially pre cast columns are to be erected in the designated locations to the required level, dimensions and tolerances as per lay out of the approved execution drawing after placement of leveling course of concrete.

(h) After successful erection of series of columns in a particular stretch, the intermediate panels are to be erected in between the columns by cranes.

(i) Panels are to be erected vertically without any offsets and suitable rubber packers approved by Engineer-in-charge, shall be provided where ever required for erection purpose for which no extra payment shall be made.

26.44.23 Documentations: All stages of manufacturers of precast element, i/c prestressing, testing & checking transportation, checking again at site, laying/erection at site, testing etc. shall be documented by the agency and shall be submitted to Engineer-in-charge before passing of final bill.

26.44.24 Fabrication & Manufacturing of Prestressed Hollow Core slab (Hollow area 25 to 30%) of different thickness & modular width 1200 mm in Controlled Factory Environment with approved methodology, conforming **to IS:10297** by using long line casting method having arrangement of proper steel bed.

Concreting should be done by batch mixing plant capable of producing **zero slump** concrete, transported through automatic shuttels of standard make & laid on bed with the help of extruder/Slip former, finishing, curing and also provision of steam curing. Cutting, making necessary cutout/holes of required sizes for services in slab element after achieving required strength, yard handling & stacking all complete as per approved shop drawings & design mix as per the direction of the Engineer-in-charge.

Note: Less cement used than the specified cement content as per design mix is recoverable. However, nothing extra shall be paid for excess use of cement than the specified. 3.9.1 Concrete Grade M-40 (Cement content 400kg)

26.44.25. Fabrication and manufacturing of solid precast concrete element with provisions of shear keys, connecting loops, dowel tubes and proper lifting accessories for walls, beams, slabs, stairs, column etc, of various thickness, shape and size of different concrete grades manufactured in controlled factory environment with approved methodology including moulds (Pallet system, Tilts form, table moulds, battery moulds, vertical moulds, beam moulds, column moulds, staircase moulds, Facade mould, etc,), mixing, transporting and placing of concrete, vibrating, curing, finishing, making necessary cutout/holes of required sizes for services, yard handling & stacking all complete as per **IS 11447** and as per approved shop drawings and design mix as per the direction of Engineer-in-Charge. (Cost of reinforcement, Mechanical, Electrical and Plumbing inserts will be paid separately).

Note: Less cement used than the specified cement content as per design mix is recoverable. However, nothing extra shall be paid for excess use of cement than the specified.

26.44.26. Transportation of Precast Elements by flat bed Trailor (Double / Triple axle 40ft Length with proper accessories like A frame etc) from factory, including the cost of loading, unloading & stacking at site with the help of required capacity cranes.

26.44.27 Erection & Installation of Precast/Prestressed Concrete elements in correct & final position with proper line level and plumb at site making all arrangements (i.e. cranes, push-pull jacks & all another T & P for lifting Placing & Alignment of elements, within erection tolerance as per **IS 15916** as per approved shop drawings and all complete as per the direction of Engineer-in-Charge but excluding the cost of simpads, non shrink grout and steel works i.e hangers.

Pre-stressing wires shall confirm to IS: 14268.

RCC in column, Beams, stairs& slabs – all precast members

(i) Precast external insulated wall panels, 185mm thick with M40 & Fe 500D.

(ii) Precast internal wall panels, 125mm thick with M40 & Fe 500D.

(iii) Precast parapet wall panels, 185mm thick with M40 & Fe 500D.

(iv) Precast beams with M40 & Fe 500D/or prestressed with M50 & prestress steel Fe P1860

(v) Precast solid slabs, 150mm thick with M40 & Fe 500D/ or prestressed with M50 & prestress steel Fe P1860

(vi) Precast staircase (150mm riser and 300mm tread width) M40 & Fe 500D or prestressed with M50 & prestress steel Fe P1860

(vii) Precast solid slabs for ramps, 150mm thick with M40 & Fe 500D or prestressed with M50 & prestress steel Fe P1860

(viii) Precast columns with M50 & Fe 500D

Pre-cast reinforced concrete units shall be of grade or mix as specified. Provision shall be made in the mould to accommodate fixing devices such as hooks etc. and forming of notches and holes. Each unit shall be cast in one operation. A sample of the unit shall be got approved from Engineer-in-charge before taking up the work.

Pre-cast units shall be clearly marked to indicate the top of member and its location.

Pre-cast units shall be stored, transported and placed in position in such a manner that these are not damaged.

The compaction of the concrete shall be done by vibrating, table or external vibrator, as approved by Engineer-in-charge. The rates include the element for framework and mechanical vibration.

26.44.28 Measurement: Dimensions shall be measured nearest to a 0.50 cm The areas shall be worked out nearest to 0.01 Sq. mt. The cubical contents shall be worked out to nearest 0.01 cubic metre.

26.44.29 Rate

The rate for item includes cost of all materials. labour, and all operations involved. Cost of M.S. frames, lugs including their welding, lifting hooks is also included.

In the item of providing and fixing precast reinforced cement concrete in shelves the cost of cutting chases and making good the same shall be inclusive in the item and nothing extra shall be paid on this account.

26.45 SCAFFOLDING NET

26.45.1 Scaffolding net of required width made of high density Polyethylene UV stabilized knitted on warp knitting machines having density 100gm/sqm and shading coefficient minimum 75% around the construction site/ for vertical extension as per requirement including fastening/tying with building/ scaffolding pipes or with any other fixtures etc. should be used.

26.45.2 Net shall be made with a square or diamond mesh. Maximum size of opening shall not exceed 10X10 mm. A continuous length of net having no joints, shall be used to cover the span between the supports. When in use, the net shall have a sag at the centre of not less than one-fifth and preferably not more than one-fourth of the length of the shorter side. The ends of all cords used in the nets shall be secured to prevent unraveling. The maximum vertical distance between the working level and the level at which the safety net is to be used shall be such that it should not hamper the progress of the work or should not make inconvenience to the work force. The work shall be carried out as per **IS-11057**

26.45.3 Measurement: One time measurement will be given in square meters for throughout completion of the project including extended time, if any, as per various clauses and per direction of Engineer- in- Charge.

26.45.4 Rate:

Onetime payment shall be made for providing Scaffolding net from start of work till completion of work including shifting if any. The Scaffolding net shall be the property of the contractor on completion of the work

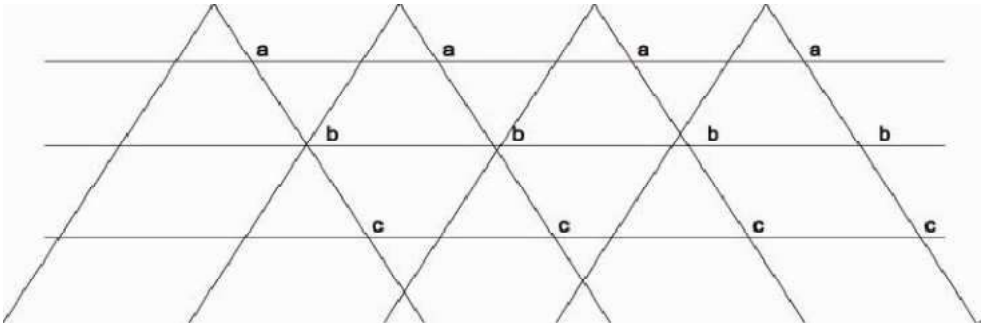


Fig. 26.1

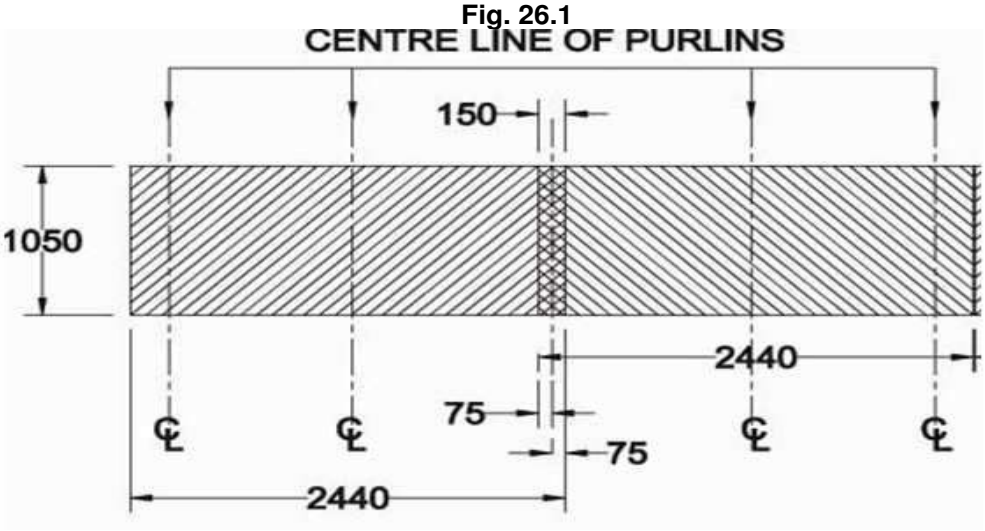
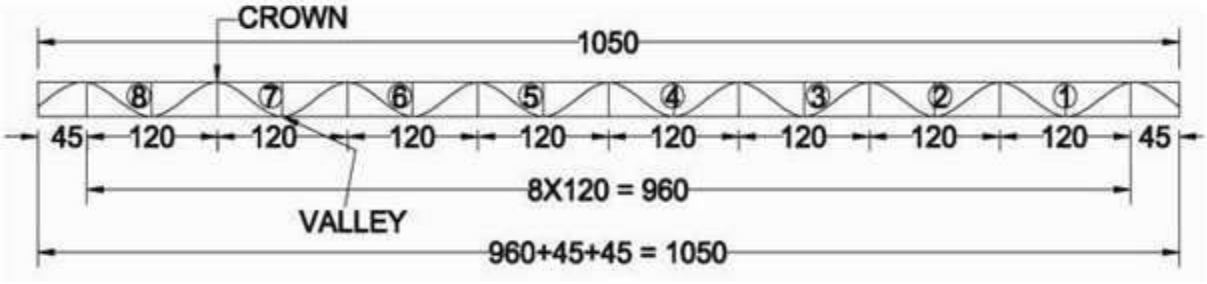


Fig 26.2 End lap of BMCS



CROWN- 09 Nos
VALLEY -08 Nos
Fig. 26.3 Details of Corrugation

BAMBOO MAT CORRUGATED SHEET (BMCS)

Sub Head : 26. New Technologies and Materials
Clause : 26.7.2

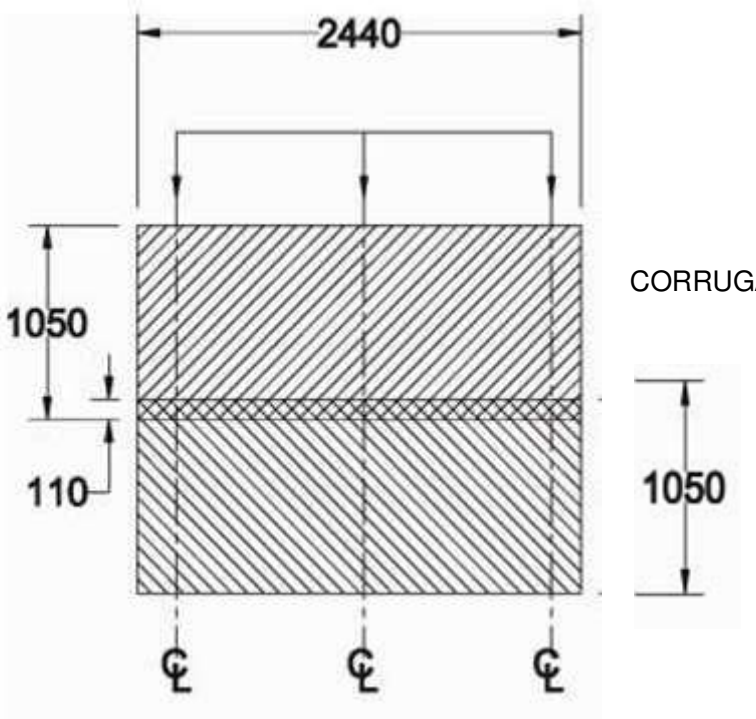


Fig .26.4 Side lap of BMCS

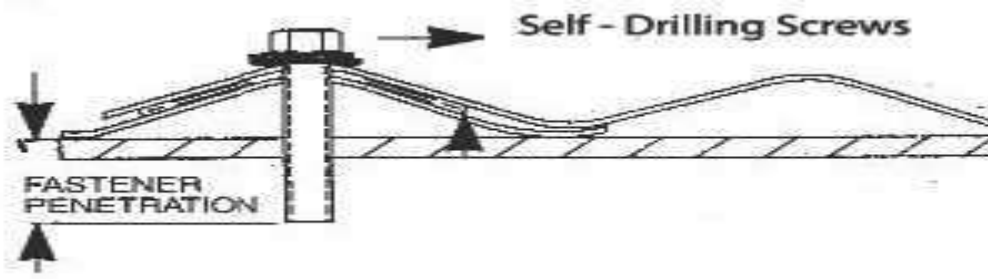


Fig No.26.5

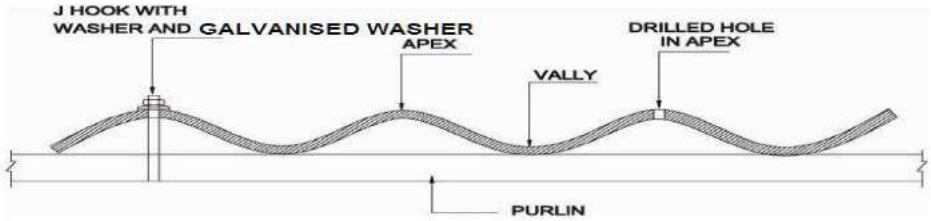


Fig. 26.6

BAMBOO MAT CORRUGATED SHEET (BMCS)

Sub Head : 26. New Technologies and Materials
Clause : 26.7.2

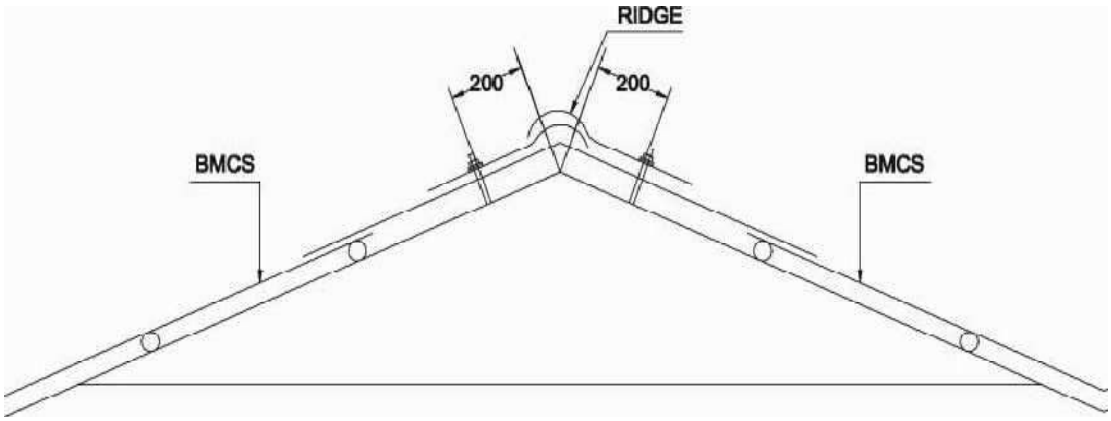


Fig. 26.7 BMRC Ridge purlin

Cavity wall thermal insulation system with rigid foam insulation

Sub Head : 26. New Technologies and Materials
Clause : 26.11.3

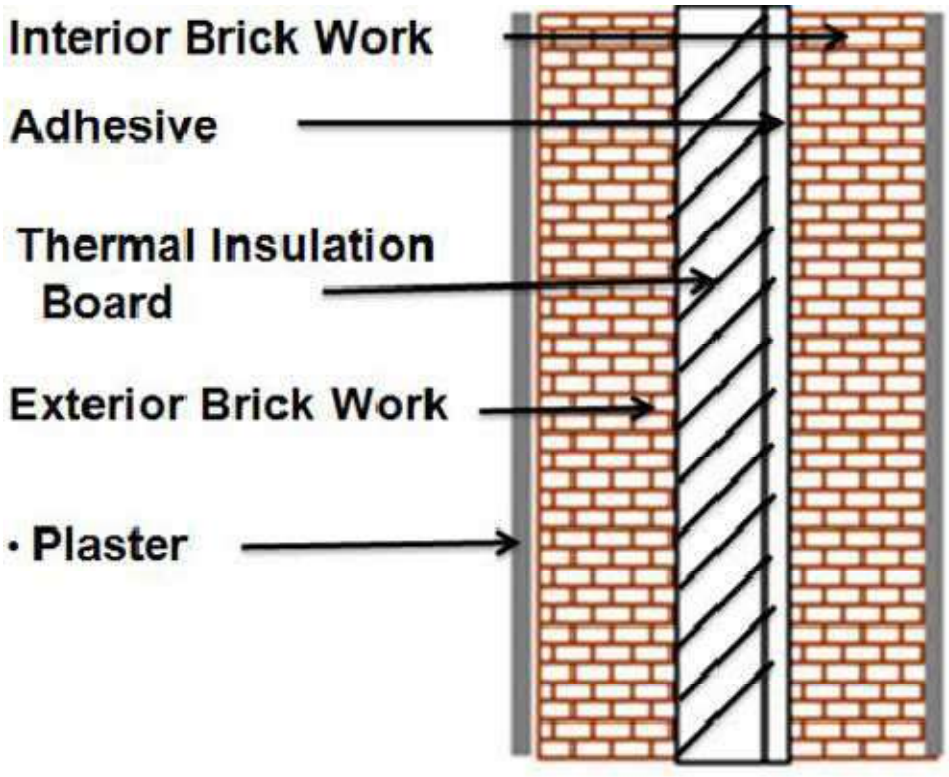


Fig. 26.8 Cavity wall thermal insulation system with rigid foam insulation

Under Deck insulation system

Sub Head : 26. New Technologies and Materials
Clause : 26.12.3

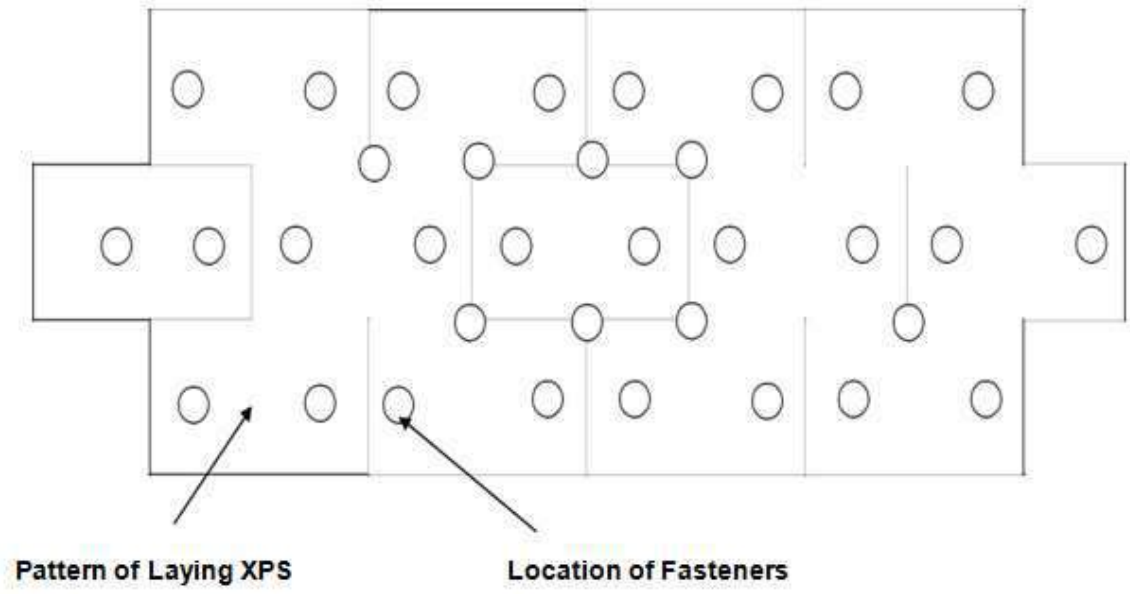


Fig. 26.9 Location of Fasteners of extruded Polystyrene Rigid Underdeck insulation.

GEOGRIDS

Sub Head : 26. New Technologies and Materials
Clause : 26.14.1



Fig.26.10 Extruded Geogrids

Fig.26.11 Coated Woven or knit Yarn Geogrids

Fig.26.12 Bonded Strap Geogrids

ALUMINUM PROFILE INDUSTRIAL TROUGHED SHEET - SELF-DRILLING FASTENERS

Sub Head : 26. New Technologies and Materials
Clause : 26.15.3



Fig 26.13A Self-tapping screw

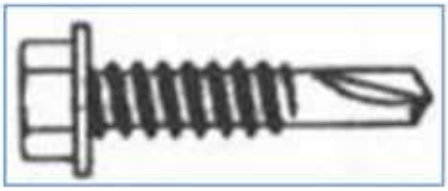


Fig 26.13B Self-Drilling Screw

GALVANIZED STEEL DECK SHEET

Sub Head : 26. New Technologies and Materials
Clause : 26.42.1.1

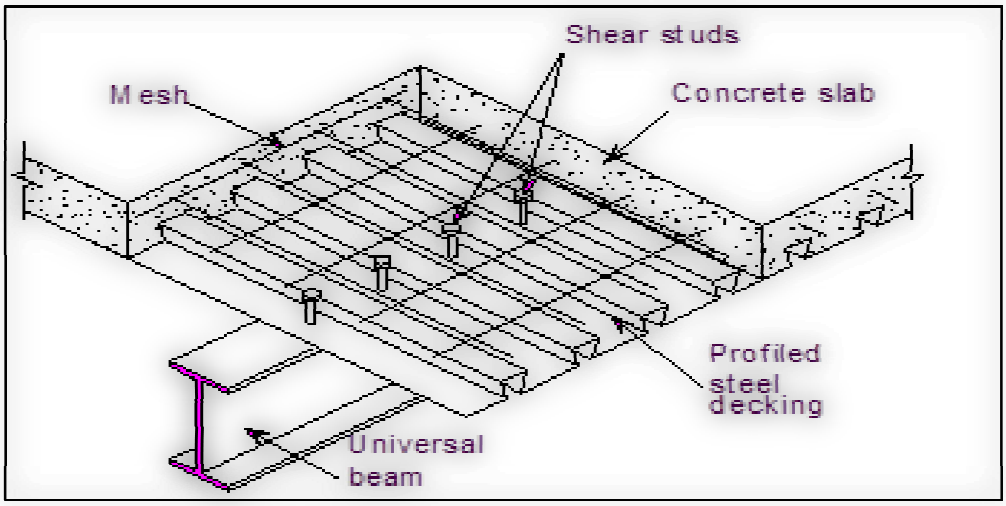


Fig 26.14 **Galvanized Steel Deck Sheet**

SHEAR CONNECTORS

Sub Head : 26. New Technologies and Materials
Clause : 26.42.1.2

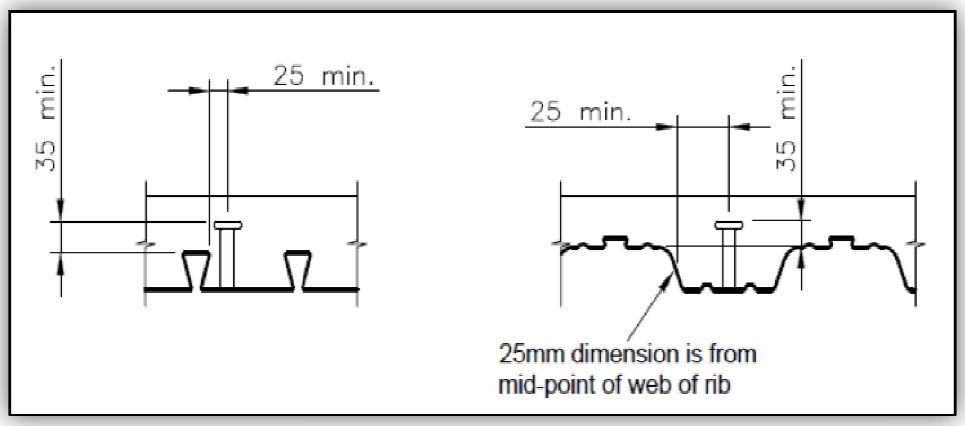


Fig 26.15 A

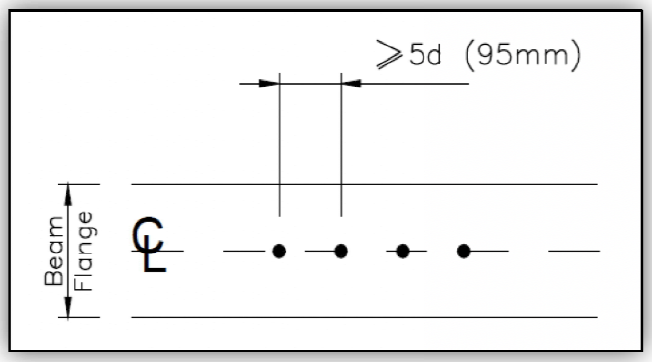


Fig 26.15 B

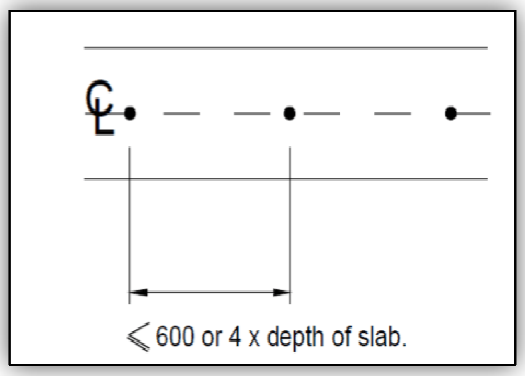


Fig 26.15 C

Fig 26.15 Shear Connectors

ECO FRIENDLY LIGHT WEIGHT CALCIUM SILICATE FALSE CEILING (MICRO LOOK EDGE)

Sub Head : 26. New Technologies and Materials
Clause : 26.17

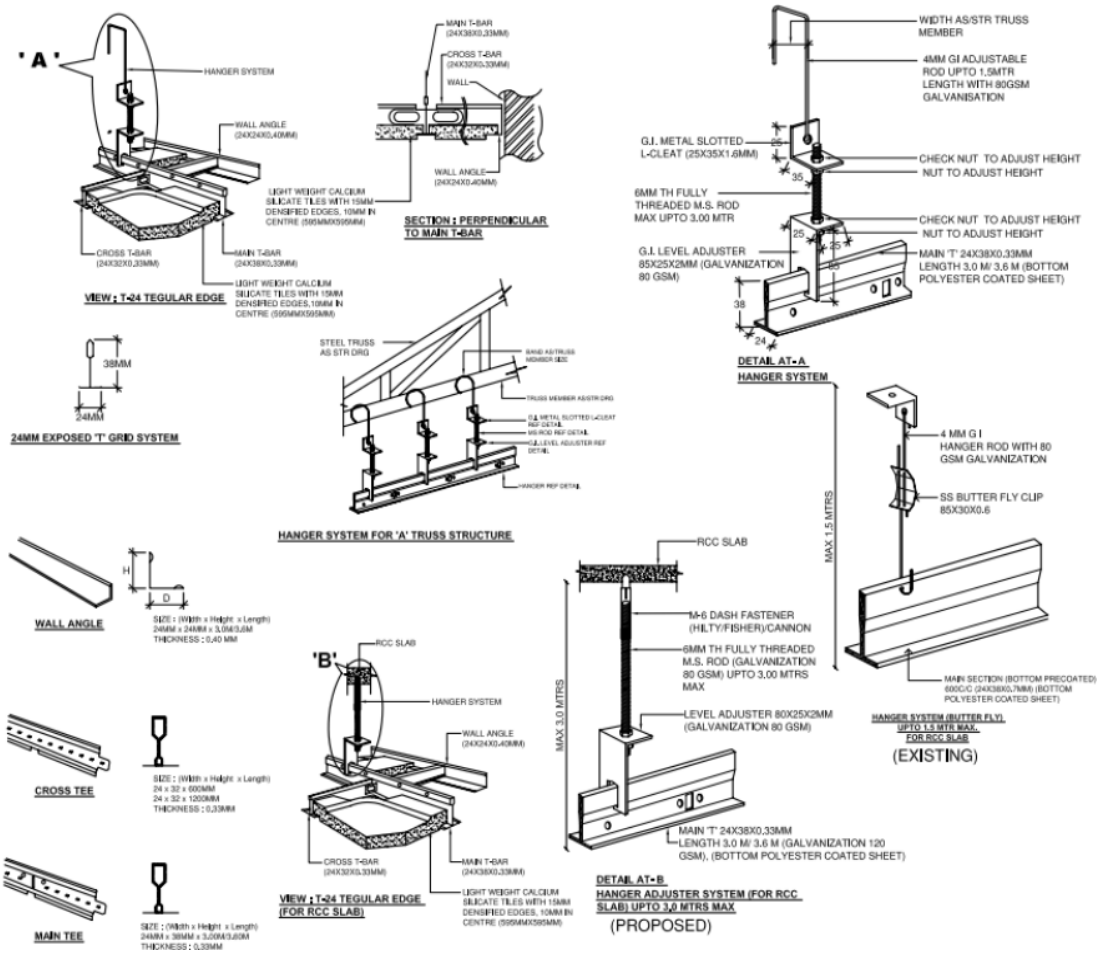


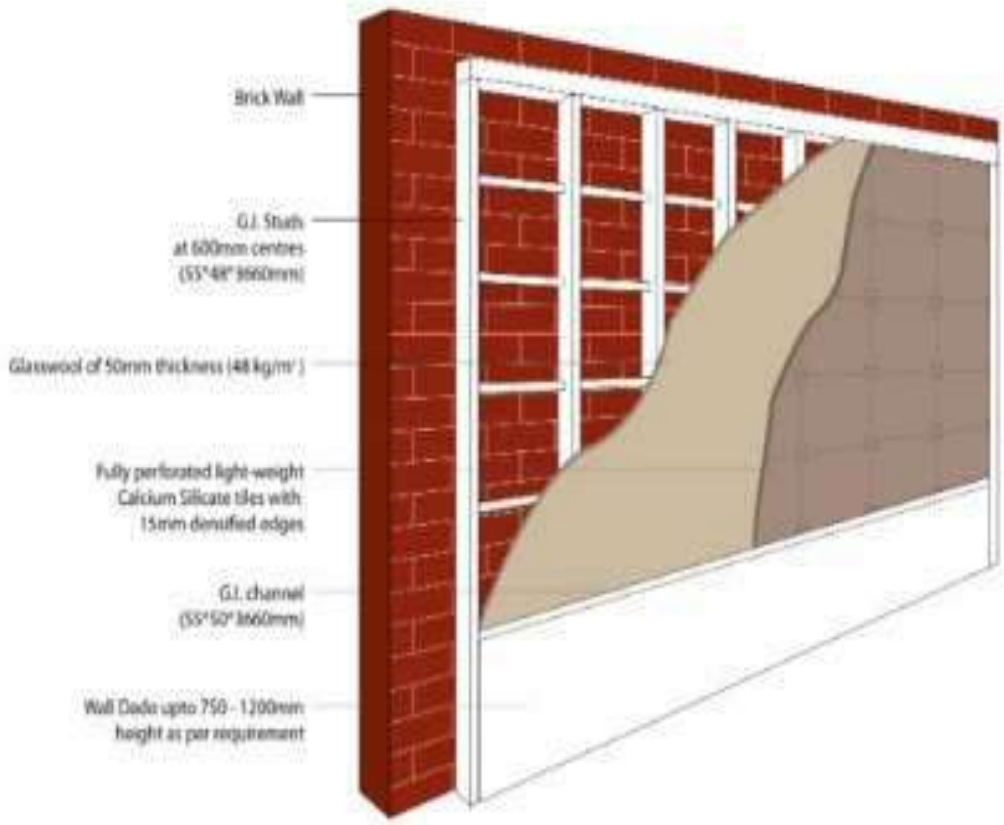




Fig . 16 Eco Friendly Light Weight Calcium Silicate False Ceiling (Micro Look Edge)

ECO FRIENDLY LIGHT WEIGHT CALCIUM SILICATE WALL PANELLING (FULLY PERFORATED SQUARE/ BUTT EDGED)

Sub Head : 26. New Technologies and Materials
Clause : 26.18



Drawing of wall panel/frame

Fig 17. Eco friendly light weight calcium silicate wall paneling (fully perforated square/ butt edged)

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