

STANDARD
TECHNICAL SPECIFICATION FOR
BESS- CIVIL WORKS

BESS CIVIL WORKS – Rev 00

Document Code no.:

TECHNICAL SPECIFICATION: CIVIL WORKS
PEL/ENGG/SPEC/CIVIL/REV -0/MAY'26

SECTION: CIVIL WORKS

1.0 GENERAL

1.1 All civil works shall be carried out as per design/drawings provided by the Employer/ Contractor and as per this 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 BIS codes

1.1.3 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). 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 Unless leveling is in the scope of the bidder, fairly leveled site with single level/terraces with different levels/ gradual slope shall be handed over to the Contractor, in a phased manner. The finished ground level (FGL) with a tolerance of (+/-) 100mm shall be decided by the Employer.

The layout and levels of all structure etc shall be made by the Contractor at his own cost from the general grids of the plot and benchmarks set by the Contractor and approved by the Employer. The Contractor shall provide all assistance in instruments, materials and personnel to the Employer for checking the detailed layout and shall be solely responsible for the correctness of the layout and levels.

In case leveling is in the scope of bidder, FGL shall be decided by the employer.

1.8 Employer has standardized its technical specification for various items/ works. Specification for items which are covered in the scope and as defined in Section project & BPS shall only be referred.

1.9 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.

2.0 GEOTECHNICAL INVESTIGATION:

The Contractor shall perform a detailed soil investigation to arrive at sufficiently accurate conclusion regarding general as well as specific information about the soil profile and the necessary soil parameters of the site, in order to design and construct the foundation of the various structures safely and rationally.

A report to the effect shall be submitted by the Contractor for Employer's specific approval giving details regarding data proposed to be utilized for the design.

2.1 SCOPE:

This specification covers all the work required for detailed soil investigation and preparation of a detailed report. The work shall include mobilization of necessary equipment, providing necessary engineering supervision and technical personnel, skilled and unskilled labour etc. as required to carry out field investigation as well as, laboratory investigation, analysis and interpretation of data and results, preparation of detailed Geo-technical report including specific recommendations for the type of foundations and the allowable safe bearing capacity for different sizes of foundations at different founding strata starting from 0.5M from existing ground level for the various structures of the BESS Yard. The Contractor shall make his own arrangement for locating the co-ordinates and various test positions in field as per the information supplied to him and also for determining the reduced level of these locations with respect to the benchmark indicated by the Employer.

2.2 BORE HOLES:

- Bore holes of 150 mm diameter in accordance with the provisions of IS: 1892 at the rate of minimum one number bore hole per hectare up to 15meter depth into virgin soil or to refusal

whichever occurs earlier shall be drilled. Total area of site shall be considered for arriving at number of bore holes to be drilled. In any case number of boreholes shall not be less than two and shall not exceed twenty. By refusal it shall mean that a standard penetration blow count (N) of 100 is recorded for 30 cm penetration. In case rock is encountered within five meter from existing ground level, coring in all the boreholes shall be carried out up to 3 meter in rock.

- The Contractor shall carry out Standard Penetration Tests at approximately 1.5 m interval in the borehole starting from 0.5 m below ground level onwards and at every change of stratum. The disturbed samples from the standard penetrometer shall also be collected for necessary tests.
- The Contractor shall collect undisturbed samples of 100/75 mm diameter 450 mm long from the bore holes at intervals of 2.5 m and every change of stratum starting from 0.5 m below ground level onwards in clayey strata.
- The depth of Water Table, if encountered, shall be recorded in each borehole. In case the soil investigation is carried out in winter/summer, the water table for rainy season shall be collected from reliable sources and recorded in the report.
- All samples, both disturbed and undisturbed, shall be identified properly with the borehole number and depth from which they have been taken.
- The sample shall be sealed at both ends of the sampling tubes with wax immediately after the sampling and shall be packed properly and transported to the laboratory without any damage or loss.
- The logging of the boreholes shall be compiled immediately after the boring is completed and a copy of the bore log shall be handed over to the Engineer-in-charge.

2.3 TRIAL PITS:

Trial pits shall be carried out at minimum one location per hectare as directed by the Employer. In case hard rock is encountered in trial pit, test need not be carried out. Total area of site shall be considered for arriving at number of Trial Pit to be excavated. Minimum number of trial pits shall be two and maximum number shall be five. The trial pits shall be 2 m x 2 m in size extending to 4 m depths, or as specified by the Employer. Undisturbed samples shall be taken from the trial pits as per the direction of the Employer.

2.4 ELECTRICAL RESISTIVITY TEST :

The resistivity of earth varies over a wide range depending on its moisture content, temperature, salt content and compactness. Therefore, earth resistivity test shall be conducted preferably during the dry season in order to get conservative results.

2.4.1 TEST LOCATION

In the evaluation of earth resistivity for the BESS yard, at least eight test directions shall be chosen from the centre of the yard to cover the entire area. The number of test points shall be as per approved drawing.

2.4.2 PRINCIPLE OF TEST

Wenner's four electrode method shall be used. In this method, four small electrodes shall be buried in four small holes in the earth along a straight line at equal intervals. A test current (I) by earth resistivity tester shall be passed between two outer electrodes and the voltage difference (V) between the two inner electrodes shall be measured. The test current (I) thus flowing into the earth, produces an electric field proportional to its density and to the resistivity of the soil. The voltage (V) measured between the inner electrodes is proportional to the field. Consequently, the resistivity will be proportional to the ratio of the voltage to current. Thus the resistivity shall be calculated from the following equation.

$$\rho_a = \frac{4\pi a R}{1 + \frac{2a}{\sqrt{(a^2+4b^2)}} - \frac{a}{\sqrt{(a^2+b^2)}}$$

Where,

- ρ_a is the apparent resistivity of the soil in Ω -m
- R is the measured resistance in Ω
- a is the distance between adjacent electrodes in metres
- b is the depth of the electrodes in m

2.4.3 TEST PROCEDURE

In the selected test point and chosen direction, four electrodes with insulated connecting wires shall be driven into the earth along a straight line of equal intervals (a). The depth of the electrodes in the earth shall be of the order of 15 cm to 20 cm. The megger shall be placed on a steady and approximately level base, the link between terminals P1 and C1 shall be opened and the four electrodes connected to the instrument terminals. An appropriate range on the instrument shall be selected to obtain clear readings avoiding the two ends of the scale as far as possible.

Resistivity shall be calculated by substituting the value of R in the above equation. The test shall be repeated in a chosen direction with a number of different electrode spacing, increasing from 2m to 50m preferably in the steps of 2, 5, 10, 15, 25 and 50m. When the spacing is increased gradually from low values, at a stage, it may be found that the resistivity reading is more or less constant irrespective of the increase in the electrode spacing. The resistivity for this spacing is noted and taken as the resistivity for that direction. In a similar manner, resistivity for at least eight equally spaced directions from the centre of the test points shall be measured. These measurements shall be repeated for all test points.

NOTES:-

- i. Soil resistivity points shall preferably be one number in each 100mx100m grid and number of test points shall be such that the entire site area is covered.
- ii. Average resistivity value of all eight directions shall be considered for design of earthing system.

iii. Soil resistivity measurement may be done in dry season. Small amount of water may be applied at electrodes for making proper contact between the electrodes and soil.

2.5 PLATE LOAD TEST (if applicable)

Plate load test shall be conducted to determine the bearing capacity, modulus of sub grade reaction and load/settlement characteristics of soil at shallow depths by loading a plane and level steel plate kept at the desired depth and measuring the settlement under different loads, until a desired settlement takes place or failure occurs. The specification for the equipment and accessories required for conducting the test, the test procedure, field observations and reporting of results shall conform to IS: 1888. Modulus of sub grade reaction shall be conducted as per IS: 9214. Plate load test shall be conducted at one locations to be decided during detailed engineering at the proposed foundation depth below finished ground level for determining the bearing capacity.

Undisturbed tube samples shall be collected at 0.5 m and 2.5m depths from natural ground level for carrying out laboratory tests

The size of the pit in plate load test shall not be less than five times the plate size and shall be taken up to the specified depth. All provisions regarding excavation and visual examination of pit shall apply here.

Unless otherwise specified the reaction method of loading shall be adopted. Settlement shall be recorded from dial gauges placed at four diametrically opposite ends of the test plate.

The load shall be increased in stages. Under each loading stage, record of Time v/s Settlement shall be kept as specified in IS: 1888.

Backfilling of the pit shall be carried out as per the directions of the Employer. Unless otherwise specified the excavated soil shall be used for this purpose. In cases of gravel-boulder or rocky strata, respective relevant codes shall be followed for tests.

2.6 WATER SAMPLE

Representative samples of ground water shall be taken when ground water is first encountered before the addition of water to aid drilling of boreholes. The samples shall be of sufficient quantity for chemical analysis to be carried out and shall be stored in air- tight containers.

2.7 BACK FILLING OF BORE HOLES

On completion of each hole, the Contractor shall backfill all bore holes as directed by the Employer. The backfill material can be the excavated material.

2.8 LABORATORY TEST

- 2.8.1. The laboratory tests shall be carried out progressively during the field work after sufficient number of samples has reached the laboratory in order that the test results of the initial bore holes can be made use of in planning the later stages of the field investigation and quantum of laboratory tests.
- 2.8.2. All samples brought from field, whether disturbed or undisturbed shall be extracted/prepared and examined by competent technical personnel, and the test shall be carried out as per the procedures laid down in the relevant I.S. Codes.

The following laboratory tests shall be carried out

- i) Visual and Engineering Classification
- ii) Liquid limit, plastic limit and shrinkage limit for C- \emptyset soils.
- iii) Natural moisture content, bulk density and specific gravity.
- iv) Grain size distribution.
- v) Swell pressure and free swell index determination.
- vi) California bearing ratio.
- vii) Consolidated drained test with pore pressure measurement.
- viii) Chemical tests on soil and water to determine the carbonates, sulphates, nitrates, chlorides, Ph value, and organic matter and any other chemical harmful to the concrete foundation.
- ix) In case of rock samples following tests shall also be conducted:
 - Rock quality designation (RQD), RMR.
 - UCC test.
 - Point load index test.

2.9 TEST RESULTS AND REPORTS

- 2.9.1 The Contractor shall submit the detailed report in four (4) copies wherein information regarding the geological detail of the site, summarised observations and test data, bore logs, and conclusions and recommendations on the type of foundations with supporting calculations for the recommendations. Initially the Contractor shall submit draft report and after the draft report is approved, the final report in four (4) copies shall be submitted. The site test data shall bear the signatures of the Investigation Agency, Vendor and also site representative of Employer.
- 2.9.2 The report shall include, but not limited to the following: -
- 2.9.2.1 A plan showing the locations of the exploration work i.e. bore holes, trial pits, Plate load test etc.

2.9.2.2 Bore Logs: Bore logs of each bore holes clearly identifying the stratification and the type of soil stratum with depth. The values of Standard Penetration Test (SPT) at the depths where the tests were conducted on the samples collected at various depths shall be clearly shown against that particular stratum.

2.9.2.3 Test results of field and laboratory tests shall be summarized strata wise as well as in combined tabular form. All relevant graphs, charts tables, diagrams and photographs, if any, shall be submitted along with report. Sample illustrative reference calculations for settlement, bearing capacity, pile capacity shall be enclosed.

2.9.2.4 The report should contain specific recommendations for the type of foundation for the various structures envisaged at site. The Contractor shall acquaint himself about the type of structures and their functions from the Employer. The observations and recommendations shall include but not limited to the following:

- i) Geological formation of the area, past observations or historical data, if available, for the area and for the structures in the nearby area, fluctuations of water table etc.
- ii) Recommended type of foundations for various structures. If piles are recommended the type, size and capacity of pile and groups of piles shall be given after comparing different types and sizes of piles and pile groups.
- iii) Allowable bearing pressure on the soil at various depths for different sizes of the foundations based on shear strength and settlement characteristics of soil with supporting calculations. Minimum factor of safety for calculating net safe bearing capacity shall be taken as 2.5.
- iv) Recommendation regarding liquefaction potential/characteristics of soil during ground shaking and possible remedies shall be provided.
- v) Recommendations regarding slope of excavations and dewatering schemes, if required.
- vi) Comments on the Chemical nature of soil and ground water with due regard to deleterious effects of the same on concrete and steel and recommendations for protective measures.
- vii) If expansive soil is met with, recommendations on removal or detainment of the same under the structure, road, drains, etc. shall be given. In the latter case detailed specification of any special treatment required including specification or materials to be used, construction method, equipments to be deployed etc. shall be furnished. Illustrative diagram of a symbolic foundation showing details shall be furnished.
- viii) Recommendations for additional investigations beyond the scope of the present work, if considered such investigation as necessary.
- ix) In case of foundation in rocky strata, type of foundation and recommendation regarding rock anchoring etc. should also be given based on RMR value

2.9.2.5 All Geotechnical investigation reports must be signed and stamped by qualified Geotechnical engineer/ consultant even if they have been prepared by NABL accredited test labs.

3.0 STANDARD TENDER AND REFERENCE DRAWINGS:

- i) Standard tender drawings for Control Room Building Architecture, Security room architecture, RCC Boundary wall, Septic Tank & Soak Pit, Roads, Cable trench, Rail Cum Road, Chain Link Fencing, Main Gate, Rainwater Harvesting, street light pole foundation are enclosed with the tender documents.
- ii) Reference drawings for Inverter platform with canopy and PEB structures (enclosed) for auxiliary system are enclosed with the tender documents.
- iii) All tender drawings shall be read in conjunction with this specification. Discrepancy if any shall be brought to the notice of Employer prior to quote.
- iv) Items/ components of buildings not explicitly covered in the specification but required for completion of the project shall be deemed to be included in the scope.

3.1 ROADS, ROAD CULVERTS AND RAIL CUM ROAD:

- 3.1.1 The construction drawings showing section detail for road, road crossing as well as rail cum road are enclosed with the tender documents. The layout of roads shall be as per approved general arrangement drawing. Types of the roads in the scope of contract shall be either of RCC (if applicable) or bituminous road as indicated in the scope of work.
- 3.1.2 The width of the road shall be 3.75m. Type of pavement either rigid pavement (RCC Road) or flexible pavement (Bituminous Road) shall be as per tender documents.
- 3.1.3 The type & location of culverts i.e. the number and diameter of Hume pipes shall be as decided during detailed engineering. The invert level of Hume pipes of culverts shall match with the invert level of drain meeting the culvert.
- 3.1.4 100 mm diameter uPVC pipe encased with 75 mm thick concrete 1:2:4 all-around shall be provided below WMM/WBM. It shall be laid across the road at every 100M interval along the road.
- 3.1.5 All Road within the switchyard area, road leading to control room building, approach road and roads outside switchyard fence should have earthen shoulder 600mm wide on either side of road. The shoulder of the road in case of yard extension shall match with the shoulder of the existing road in all respect.
- 3.1.6 Road leading towards the area of Autotransformer/Reactor shall be as short as possible. Road layouts shall be prepared with adequate turning radius, so that easy movement of vehicles is possible. Roads which are to be used for carrying IDT/Battery Containers shall be provided with adequate turning radius. Turning radius of other roads may be decided at site depending on layout constraints

3.1.7 In case of rigid pavements, RCC shall be laid and finished with screed board, vibration, vacuum dewatering process etc.

3.2 DRAINS:

- 3.2.1 The Storm water drain in BESS area and connecting the same with existing Nearby drain. Design and construction of Drainage system as per General Layout & Topography
- 3.2.2 The construction drawing for the section of drain is enclosed with the tender documents
- 3.2.3 The drain section for BESS yard shall be as defined in scope of work. The drain section shall be either as per tender drawing or trapezoidal/ rectangle section made of in-situ 75mm thk cement concrete lining. Provision for suitable size drain along the road shall be provided. The drain shall be on both the sides or on one side of the road depending on the camber of the road and catchment area for drain
- 3.2.4 The Contractor shall propose an overall drainage layout during detailed engineering considering the site conditions which is to be approved by POWERGRID before execution. The type of drains used shall be of the sections standardized and indicated in the drawings enclosed with the tender documents.

3.3 BESS AREA FENCING AND MAIN GATE:

- 3.3.1 Chain link Fencing and Gate shall be constructed as per drawing attached with tender document.
- 3.3.2 A main gate and an emergency gate shall be provided at approved location in BESS yard. Separate gate shall be provided for men and equipment. Fence shall also be provided for the various equipments (if) mounted on ground or a height lower than 2.5m. Necessary gates shall be provided for each area so surrounded.
- 3.3.3 Chain link of galvanized fence fabric with 3.15mm dia wire and 75mm mesh size conforming to IS: 2721 shall be used. MS tube used shall be of grade YST210 and conform to IS: 1161. All other structural steel shall conform to IS: 2062.
- 3.3.4 The whole assembly of tubular post and frame of panels shall be hot dip galvanized. The zinc coating shall be minimum 610 gram per square meter. In case the site is located within 30km from sea coast, the zinc coating shall be 900gm per square meter. The purity of zinc shall be 99.95% as per IS: 209.
- 3.3.5 Barbed wire fencing detail: GI Barbed Wire conforming to IS: 278 shall be weighing 9.38 Kg per 100M roll minimum. The barbed wire shall be galvanized and formed by twisting together two line wires, one or both containing the barbs. • The barbed wire shall be stretched and

fixed in specified number of rows and two diagonals as per the drawing. The diagonal shall be stretched between adjacent posts from the top wire of one post to the bottom wire of 2nd post. The diagonal wire will be inter woven with horizontal wires by fixing the odd rows of wires first, then the diagonal cross wires and lastly even rows of wires. The barbed wire shall be held by tearing the holes of 10 mm dia in the MS flats and tied with G.I. wire, turn buckles and straining bolts shall be used at the end post. The zinc coating shall be minimum 610 gram per square meter. In case the substation is located in coastal area as indicated in the Section Project, the zinc coating shall be 900gm per square meter. The purity of zinc shall be 99.95% as per IS: 209.

3.3.6 Main Gate:- Mild Steel frame gate woven with chain linking having minimum span 4 m conform to IS: 2062 shall be provided. The gate shall be complete with the guide track, castor wheel, all fitting and fixture like hinges, aldrops, locking arrangement, posts, etc. The width of approach road shall cover the gate width at the main entrance with a suitable transition. Width of Main gate should be adequate to facilitate smooth movement of crane. All members used in gates shall be finished by cleaning of steel surfaces as per IS: 1477 (Part-II) and applying zinc chrome or zinc phosphate primer, followed by two coats of synthetic enamel paint. For finishing coat suitable colour pigment shall be added. All paints including primer shall be of reputed brand/manufacturer and as approved by the Engineer-In-charge. The method of application shall be as per the recommendations of the manufacturer. One man movement passage gate (minimum 1.2m width) shall also be provided at the main entry gate. 400 mm height concertina with all supporting members shall also be provided on a gate (gates other than main entry gate) for better security. The minimum size & requirements of the Gate's including all items shall be as per the fencing tender drawing title: "Details of Main Gate". The main gate shall be constructed inside the plant/plot boundary line to provide sufficient space for Heavy motor vehicle and light motor vehicle for inspection/check before entering the site and vehicles shall not disturb the traffic in the main approach road.

3.4 RAIN WATER HARVESTING: (if applicable)

3.4.1 In addition to drainage of rainwater, the Contractor shall make arrangement for rainwater harvesting also. A drawing showing details of recharge structure for rainwater harvesting is enclosed with tender document.

3.4.2 Rainwater harvesting shall be done by providing recharge structures with bore wells. The contractor shall propose location of recharge structures within the sub-station considering the site conditions which is to be approved by POWERGRID before execution. Branch drains from the main drain carrying rainwater from entire switchyard shall be connected to the recharge structures.

3.5 CABLE TRENCHES (Under ground/ overground)

3.5.1 The construction drawings of underground cable trenches, cable trench crossing road and sump are enclosed with tender documents. The underground construction of cable trenches

shall be cast in situ type or precast RCC as per drawings and meeting the technical specification. The Contractor shall propose an overall cable trench layout for the BESS yard during detailed engineering which is to be approved by POWERGRID before execution. Overground ladder type cable tray system (with/without cover) /underground cable trenches along with covers, road crossings, sump pits etc. shall be provided by contractor as per design requirement

- 3.5.2 Design for load carrying capacity of structural support members and FRP ladder type cable tray to be submitted during detailed engineering which is to be approved by POWERGRID before execution. FRP trays shall be tested as per NEMA-FGI-1993 and other relevant standards. Following test shall be carried out as acceptance test

FRP type cable trays (ladder/channel) & accessories shall be corrosion/ chemical resistant, weather resistant, easy to drill & cut, lightweight, high strength & flame retardant. All the composite materials shall have UV light inhibiting chemical additives to resist degradation from ultraviolet light. The connection between two sections of the FRP cable trays or a section of cable tray with associated accessories shall be done by bolting only, Nuts, bolts and washers shall be of stainless-steel SS 304. Standard straight length of cable Trays to be 3.0 meter. Bending radius of accessories to be 600 mm or as per design requirement

3.5.3 **CABLE TRAYS & ACCESSORIES specifications:** -

Certification of manufacturer that product is conforming following parameters shall be submitted by contractor:

- a) Glass Content: minimum 55%
- b) Manufacturing Process: Pultrusion using automated pultrusion machines
- c) Resin to be used: Corrosion & ultraviolet resistant resin, Flame retardant polyester resin
- d) Product complies to NEMA FG1-1993
- e) Loading on cable trays at 1500mm support span (For ladder type trays): 600mm Width tray: 90 Kg/m, 450mm Width tray: 75 Kg/m, 300mm Width tray: 60 Kg/m & 150mm Width tray: 30 Kg/m
- f) Loading on cable trays at 1500mm support span (For perforated type trays, 4mm min thk): 600mm Width tray: 90 Kg/m, 450mm Width tray: 75 Kg/m, 300mm Width tray: 60 Kg/m, 150mm Width tray: 30 Kg/m, 100mm Width tray: 15 Kg/m & 50mm Width tray: 7.5 Kg/m
- g) Tray cover: Min 3mm thk non-perforated, material same as cable tray
- h) Very Low flammability as per IS 6746
- i) Anti-Static, less surface resistivity as per ASTM D257
- j) UV resistance as per ASTM G154
- k) Resistance to heat and fire as per IEC 60695
- l) Ultimate tensile strength: 30000 PSI Longitudinal Direction
- m) Tensile modulus: 2.5×10^6 PSI Longitudinal Direction
- n) Compressive strength: 30000 PSI Longitudinal Direction
- o) Arc Resistance: > 120 seconds
- p) Dielectric strength: Axial: 30-45 Kv/25mm, Radial 10-15 KY/mm

- 3.5.4 The supplier shall perform all tests necessary to ensure that the material and workmanship conform to the relevant standards and comply with the requirements of the specification. Charges for all these tests for all the equipment & components shall be deemed to be included in the bid price.
- 3.5.5 The layout should show type of cable trench, longitudinal slope and invert level. The types of cable trench shall be of the section indicated in the drawings enclosed with the tender.

3.6 BOUNDARY WALL (if applicable)

Boundary wall shall be brick masonry wall with RCC frame or Stone masonry wall or Pre cast RCC wall. The construction drawing of the boundary wall applicable is enclosed with tender document. All walls shall have adequate weep holes/ gratings as per drawing/ as per site conditions for the drainage of water. The layout shall be as per approved layout drawing during detail engineering.

3.6.1 Brick masonry wall with RCC frame:

Boundary wall shall consist of frame of RCC column and foundation at regular intervals connected through plinth beam and supporting 230 thick brick masonry. Details such as height, column spacing, structural details, fencing/grating works, plastering/ painting, etc. shall be as per tender/construction drawing.

3.6.2 Stone masonry wall:

Boundary wall shall be Random Rubble masonry wall and coursed rubble masonry (for front portion). The wall thickness shall be 350 thk and foundation, height, fencing shall be as per tender/construction drawing.

3.6.3 Pre cast boundary wall: (if applicable)

3.6.3.1 Pre-cast reinforced concrete units such as columns, posts, wall panels etc. shall be of grade M-25 Design Mix. Mix design concrete should be well proportioned, mixed, placed and thoroughly compacted by mechanical/platform/form vibrators to give a dense concrete free from voids and honey combing. Fly ash conforming to grade-I of IS: 3812 (Part-1) may be used as part replacement of OPC as per IS: 456. Uniform blending with cement to be ensured in accordance with clauses 5.2 and 5.2.1 of IS: 456 -2000. Admixtures may be used with the approval of the engineer-in-charge. However use of any admixture containing chlorides in any form is prohibited. No admixtures shall be accepted for use in concrete unless these are tested in accordance with IS: 9103 and the test results are approved by the Engineer-in-Charge.

3.6.3.2 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 angle for concertina coils, hooks and forming of notches and holes.

- 3.6.3.3 The contractor may pre-cast 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.
- 3.6.3.4 Pre-cast articles shall have a dense surface finish showing no coarse aggregate and shall not have 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 angles of the pre-cast units with the exception of the angles resulting from the splayed or chamfered faces shall be true right angles. Arises shall be clean and sharp except those specified or shown to be rounded. Gaps if any noticed during installation shall be finished with 1:3cement Mortar. The wearing surface shall be true to the lines. On being fractured, the interior of the units should present a clean homogeneous appearance.
- 3.6.3.5 The pre-cast 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. Date of casting shall be marked on the surface which should not be visible after installation.
- 3.6.3.6 The exposed surfaces of walls & columns shall be painted with water proofing cement paint of approved shade to give an even shade as per BOQ item.
- 3.6.3.7 Reinforcement as per approved design drawing shall be placed inside the mould in such a way as to fulfill the minimum cover requirement or as per the drawing. Concrete shall then be poured in middle and the sides and compacted with a plate vibrator (platform/table/surface vibrator).
- 3.6.3.8 Each Pre-cast unit shall have marking like; date of manufacturing and identification number. Units without marking shall not be accepted.
- 3.6.3.9 The mould sizes shall satisfy the following dimensional tolerances:

S.No.	DIMENSION	TOLERANCE
1	Length	±4 mm
2	Width	±2 mm
3	Depth	±2 mm

- 3.6.3.10 Contractor shall make his own arrangement for curing by making suitable size pond for curing as directed by Engineer-in-charge. 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 placing of concrete in case of OPC and at least 10 days where mineral admixtures or blended cements are used. In hot & arid regions, the minimum curing period shall be 14 days.

OR

Pre-cast units shall be stacked against a vertical support in nearly vertical position and cured for at least two weeks by sprinkling water. If necessary, low pressure steam curing may be employed. It shall further be air cured for another two weeks before it can be used for construction. During initial stages of hardening, the Pre-cast units shall be adequately protected from shocks as well as harmful effects of frost, sunshine, drying winds and cold.

3.6.3.11 SAMPLING

- All Pre-cast units (viz. planks and columns) of the same size, manufactured from similar materials and under similar conditions of production shall be grouped together to constitute a lot.
- Five units shall be selected at random out of a lot consisting of 300 units or less. For lots bigger than 300 units, 5 units shall be selected for every additional 300 units or part thereof.
- The units shall be selected from the lot at random. In order to ensure randomness of selection, procedure given in IS: 4905-1968 may be followed. The sampling procedure may be modified, if the Engineer-In-Charge desires so.

3.6.3.13 DIMENSIONAL TOLERANCES

Pre-cast units manufactured in accordance with the drawings/specifications shall be required to satisfy following dimensional tolerances:

S.No.	DIMENSION	TOLERANCE
1	Length	±5 mm
2	Width	±3 mm
3	Thickness	±2 mm
4	Bow (Deviation from intended line or plane)	±2 mm
5	Twist (Distance of any corner from the plane containing other three corners)	1 mm

If four out of the five samples satisfy the shape (as per the drawing) and dimensional requirements as tabulated above, the lot represented by the sample shall be deemed to have passed the dimensional requirements.

3.6.3.14 HANDLING, STORAGE AND DELIVERY

- Pre-cast units shall be stored, transported and placed in position in such as manner that they will not be overstressed or damaged.
- Pre-cast units shall be transported to the site by suitable means as approved by the Engineer-In-Charge. Care shall be taken to ensure that no damage occurs during transportation.
- In case the units are to be transported in trolleys, the overhang of the units from the trolley shall not be more than one-fifth of length of the Pre-cast unit.

- For lifting/handling the units, rope slings shall be used at locations where lifting hooks have been provided. The units shall be lifted manually or with the help of chain pulley blocks or mechanically with a hoist or a crane. The Pre-cast units shall be handled and transported in nearly vertical position as far as possible and these should be supported only near the edges.
- Any defect/breakage arising during transportation, due to mishandling or due to faulty storage practice shall be the sole responsibility of the Manufacturer/Supplier/Agency.

3.6.3.15 ERECTION

- Precast concrete columns and wall panel shall be placed in truly vertical position with the aid of a compatible light crane/manually/by suitable means.
- For erection, panels are handled by means of lifting devices/manually to set into columns wedge. Panels may be carefully placed in successive horizontal position by means of temporary wooden wedges placed at the junction of the two adjacent panels during construction and which shall be removed after proper placement of panels.
- After placement of wall panels, gaps if any between the wall panels shall be filled with 1:3 cement mortar and shall be finished before taking up of painting. No extra payment shall be made for filling of joints with cement mortar.
- Pre-cast units shall be erected in such a manner that no part is overstressed or damaged due to faulty erection.
- Any defect/breakage occurred during erection shall be the sole responsibility of the Agency/Manufacturer/Supplier and such units shall not be accepted for use in construction.

3.6.3.16 MISCELLANEOUS

The work to be performed under this specification shall include providing all labour, supervision, materials, storages, inventories, all enabling works like scaffolding, watch and ward for the works, power, fuel, construction equipment, water, tools and plants, transportation, all taxes and duties, all labour welfare and safety measures, complete and all other incidental items not shown or specified, but reasonably implied or necessary for successful completion of the work including Contractor's supervision and in strict accordance with the drawings and specifications, inspection and testing standards and field quality control and testing as given in the tender documents and the complete execution of the works.

Any technical clarifications required regarding the drawings/specifications during the progress of works shall be obtained from the Engineer-in-Charge.

Employer reserves the right to inspect all the material before dispatch.

3.6.4 All structural steel angle for supporting barbed wire/concertina coil shall be painted with epoxy paint of approved brand and colour shade.

4.0 STONE SPREADING AND ANTI-WEED TREATMENT

4.1 The layout of the area, where anti-weed treatment and stone spreading is to be done, shall be developed by the Contractor during detailed engineering and the same shall be submitted to the employer for approval. The Contractor shall arrange all labour, equipment and materials required for complete performance of the work in accordance with the drawings, specification and direction of the Employer. Requirement of stone spreading over non-woven geosynthetic fabric (min 200gsm) layer in the areas of the BESS yard shall be as per scope of work.

4.2 Stone spreading over non-woven geosynthetic fabric (min 200gsm) layer shall be done as per scope of work.

4.3 The material required for site surfacing/stone filling shall be free from all types of organic materials and shall be of standard quality, and as approved by the Employer.

4.4 The material to be used for stone filling/site surfacing shall be stone aggregate of 40mm nominal size (ungraded single size) conforming to Table 2 of IS:383 – 1970. Hardness, flakiness shall be as required for wearing courses are given below:

i) Sieve Analysis limits (Gradation) (IS: 383 – Table – 2)

Sieve Size	% passing by weight
63mm	100
40mm	85-100
20mm	0-20
10mm	0-5

ii) Hardness: Abrasion value (IS:2386 Part-IV) – not more than 40% Impact value (IS: 2386 Part-IV) – not more than 30%.

iii) Flakiness Index: As per IS: 2386 Part – I maximum value is 25%.

iv) Frequency of test shall be conducted for sieve analysis, Hardness & Flakiness index as per approved SFQP.

4.5 After all the structures/equipments are erected, antiweed treatment shall be applied in the yard wherever cement concrete is to be done and the area shall be thoroughly de-weeded including removal of roots. The recommendation of local agriculture or horticulture department may be sought wherever feasible while choosing the type of chemical to be used.

4.6 The antiweed chemical shall be procured from reputed manufacturers. The doses and application of chemical shall be strictly done as per manufacturer's recommendation. Nevertheless, the effectiveness of the chemical shall be demonstrated by the Contractor in a test area of 10MX10M (appx) and shall be sprinkled with water at least once in the afternoon every day after forty eight hours of application of chemical. The treated area shall be monitored over a period of two to three weeks for any growth of weeds by the Engineer – in- charge. The final approval shall be given by Engineer – in –charge based on the results.

- 4.7 Engineer-in-charge shall decide final formation level so as to ensure that the site appears uniform devoid of undulations. The final formation level shall however be very close to the formation level indicated in the approved drawing.
- 4.8 After antiweed treatment is complete, the surface of the switchyard area shall be maintained, rolled/compacted to the lines and grades as decided by Engineer-in-charge. The sub grade shall be consolidated by using half ton roller/surface vibrator with suitable water sprinkling arrangement to form a smooth and compact surface. The roller shall run over the sub grade till the soil is evenly and densely consolidated and behaves as an elastic mass.
- 4.9 In areas that are considered by the Engineer-in-Charge to be too congested with foundations and structures for proper rolling of the site surfacing material by normal rolling equipments, the material shall be compacted by hand rammer, if necessary. Due care shall be exercised so as not to damage any foundation structures or equipment during rolling / compaction.
- 4.10 Non-woven Geosynthetic fabric (min 200 gsm) shall be used in place of switchyard PCC.

Materials:

- i. Geosynthetics / Geotextiles shall be of non-woven type and made from polypropylene (PP). Geosynthetics shall meet the requirements of Class-I characteristics with Elongation $\geq 50\%$ Geosynthetics for separation application as per IS 16391. Mass per unit area of Geosynthetics non-woven fabric shall be minimum 200GSM.
- ii. Materials shall be supplied directly from manufacturers or through the authorized dealers who can produce MTC from manufacturers in roll length minimum 50m, Roll width minimum 2.5m and thickness minimum 1.5mm.
- iii. MTC of each lot shall be checked by contractor and submitted to POWERGRID for counter check & acceptance. Mass per unit area shall be also measured at site for each roll.

Laying:

- iv. The Contractor shall arrange all materials, labour, equipment etc. required for complete performance of the work in accordance with the drawings, specification and direction of the Engineer-in-charge.
- v. Over the prepared sub grade and anti-weed treatment, Geosynthetics non-woven fabric shall be laid in specified area. Geosynthetics should be placed and rolled out as smoothly as possible. Wrinkles and folds in the fabric should be removed by stretching and stacking as required.
- vi. The geosynthetic can be stapled or pinned or stitched at the overlaps to maintain their positions during construction activities. The roll shall be laid in staggered manner and minimum offset between adjacent roll end shall be 1.5m. Adjacent rolls of geosynthetic should be overlapped with 300mm for ends and 150mm for sides.
- vii. Stone spreading shall be done over the Geosynthetics in such a manner that the Geosynthetics is not torn, punctured or shifted.

- 4.11 A final layer of 100mm thickness of stone aggregate of 40mm nominal size (conforming to relevant clause) shall be spread uniformly over Non-woven Geosynthetic fabric.

5.0 EXCAVATION AND BACKFILL OF FOUNDATIONS:

Excavation for foundations shall be in accordance with CPWD Specification/ the relevant BIS code. Excavation shall include removal of all materials of whatever nature at all depth and whether wet or dry necessary for the construction of foundations. The bottom of excavation shall be leveled both longitudinally and transversely unless otherwise mentioned in the drawings or as directed by Engineer-in-charge. Excavation shall be measured as classified under: -

- a) Excavation in all kinds of soil including soft/ disintegrated rock, PCC, WBM, Brickwork/ stone masonry etc (excluding hard rock).
- b) Excavation in hard rock (required blasting)

- 5.1 If required the sides of excavations should be supported in such a way as is necessary to secure these from falling in, and the shoring, if required, shall be provided and maintained in position as long as necessary. No extra payment shall be made for shoring.

- 5.2 Whenever water table is met during the excavation, it shall be dewatered and water table shall be maintained below the bottom of the excavation level during excavation, The excavation shall be kept free from water: -

- a) When concrete and/or masonry works are in progress and till they come above the natural water level
- b) Till the Employer considers that the concrete/ mortar is sufficiently set.

No extra payment shall be made for dewatering.

- 5.3 Material unsuitable for foundations shall be removed and replaced by suitable fill material as per specification and to be approved by the Employer.

- 5.4 Backfill material around foundations or other works shall be suitable for the purpose for which it is used and compacted. Requirements regarding density / tests of backfilled earth shall be as specified in Field Quality Plan. The sub-grade for the roads and embankment filling shall be compacted to minimum 95% of the Standard Proctor's density at OMC (optimum moisture content). Cohesion less material sub-grade shall be compacted to 70% relative density (minimum).

- 5.5 If, excavated material is not suitable or not required for backfill, it shall be disposed off in areas as directed by Employer up to a maximum lead of 2 km from the site boundary.

5.6 DISMANTLING & DEMOLISHING WORKS

- a. The scope of work includes dismantling of existing R.C.C. works at all levels (in foundations or super structures) either manually or by mechanical means including disposal of steel bars and unserviceable material as per direction of Engineer – in-charge. The work of dismantling of RCC works shall be measured in cu. m. Dismantling work must be carried out very carefully under strict close supervision to ensure structural stability of the remaining and/or adjoining/ abutting structure.
- b. The scope of work includes Demolishing/dismantling of existing chain link fencing either manually or by mechanical means including disposal of unserviceable material as per direction of Engineer – in-charge. The work of dismantling/demolishing of existing chain link fencing shall be measured in running meter.

5.7 REQUIREMENT FOR FILL MATERIAL UNDER FOUNDATION:

- 5.7.1 The thickness of fill material under the foundations shall be such that the maximum pressure from the footing, transferred through the fill material and distributed onto the original undisturbed soil will not exceed the allowable soil bearing pressure of the original undisturbed soil.
- 5.7.2 The filling shall be done in accordance with clause 4.10 of IS: 1080. For expansive soils the fill materials and other protections etc. to be used under the foundation is to be got approved by the Employer.
- 5.7.3 Cohesive Non Swelling (CNS) soil, if required, for filling under / around the foundations, cable trenches, drains, roads etc shall conform to IS: 9451: 1994 reaffirmed 2004

6.0 CEMENT:

- 6.1 The type of cements which can be used are Ordinary Portland Cement (OPC) (conforming to IS: 269), Portland Pozzolana Cement (PPC) (conforming to IS: 1489), and Portland Slag Cement (PSC) (Conforming to IS: 455). Cement shall be supplied by contractor.
- 6.2 Generally, PPC type shall be used for concrete work. However, depending on availability, OPC may also be used without any additional financial implication to POWERGRID.
- 6.3 Extra care for curing shall be taken for concrete made with OPC 53 grade & PPC.
- 6.4 Extra care for removing form work shall be taken, when PPC is used.
- 6.5 Portland Slag Cement has low heat of hydration and is relatively better resistant to soils and water containing excessive amount of sulphates of alkali metals, alumina and iron, as well as to acidic waters. Hence it can be specifically allowed for above conditions with prior approval of EIC.

7.0 CHEMICAL ADMIXTURES & ADDITIVES

- 7.1 Use of chemical admixtures shall be permitted in accordance, with the provisions of IS 456 and IS 9103.
- 7.2 It shall be the responsibility of the producer to establish compatibility and suitability of any admixture with the other ingredients of the mix and to determine the dosage required to give the desired effect. The amount of admixture added to mix shall be recorded in the production record by the producer.
- 7.3 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.
- 7.4 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.

8.0 REINFORCED CONCRETE CEMENT (RCC):

All RCC work including material properties, proportioning, batching, mixing, transporting, pouring, compacting, finishing, curing, sampling, testing, acceptance criterion etc. shall be as per SFQP/ IS : 456

8.1 DESIGN MIX CONCRETE

- 8.1.1 Reinforced cement concrete shall be M-25 or higher design mix conforming to IS: 456. IS: 10262 shall be followed for mix proportioning.
- 8.1.2 Design mix concrete may be procured from approved RMC plant as per latest IS: 4926 or may be prepared by using a portable/mini/compact weigh batch plant conforming to latest IS: 4925.

Self-loader viz Ajax Fiori/ small portable weigh batcher may be permitted for batching and mixing of concrete subjected to compliance of following:-

- a) Calibration certificate of self-loader/concrete producing equipment shall be checked before start of concreting work. The accuracy of the measuring equipment shall be within +/- 2% of the quantity of cement and within +/- 3% of the quantity of aggregate.
- b) Preferably, print out of each load indicating weight of all the constituent's material i.e. Cement, fine aggregate, coarse aggregate, water, admixture (if any) is to be ensured or proper records shall be maintained to ensure weight of constituents materials.

8.1.3 As per provisions of IS: 456, fly ash conforming to grade I of IS: 3812 (part-1) may be used as part replacement of cement, when OPC cement is used for concrete works. Uniform blending with cement is to be ensured.

8.2 NOMINAL MIX CONCRETE

8.2.1 Nominal mix concrete shall be used with approval of engineer in charge. In such cases reinforced cement concrete shall be of nominal mix 1:1.5:3 (1 cement: 1.5 coarse sand: 3 well graded stone aggregate 20mm nominal size) by volume conforming to CPWD specifications. Nominal mix 1:1.5:3 shall be considered equivalent to M-20 for design purpose.

8.2.2 For Plain Cement Concrete 1:2:4 (1 cement: 2 fine aggregate: 4 well graded stone aggregate 20mm nominal size), Plain Cement Concrete 1:3:6 (1 cement: 3 fine aggregate: 6 well graded stone aggregate 40mm nominal size), Plain Cement Concrete 1:4:8 (1 cement: 4 fine aggregate: 8 well graded stone aggregate 40mm nominal size) or any other type of PCC, the concrete by volumetric mix shall be prepared and cement consumption shall be as per DSR (CPWD).

8.2.3 In case of Nominal mixes, Standard measuring boxes of 35cmX40cmX25cm (35 liters capacity as per CPWD) shall be used for measuring fine and coarse aggregates.

8.2.4 However, full 50 kg of OPC/PPC/Slag cement shall be directly unloaded into the mixer hopper to ensure that cement consumption is 400kg per cum of 1:1.5:3 concrete irrespective of different types of cements with different densities.

8.2.5 The cement consumption shall be as per DSR (CPWD) for other grades of concretes provided as nominal concrete mixes in the BPS.

8.2.6 For volumetric mix concretes, the cement used may be generally PPC type, however concrete may be prepared with OPC also, without any financial implication to POWERGRID.

8.2.7 In case of weigh batching of nominal mixes, the proportions of materials for nominal mix concrete shall be in accordance of IS 456.

8.3 SPACERS & COVER BLOCKS

In line with IS 456, spacers and cover blocks (concrete of same strength or PVC) may be used for RCC and PCC.

8.4 MEMBRANE CURING

In line with IS 456, membrane curing may be used in place of moist curing with the approval of Engineer-in-Charge.

9.0 REINFORCEMENT STEEL:

Reinforcement steel shall be thermos mechanically treated (TMT) or HYSD reinforcement bars of grade Fe 500/500D conforming to IS: 1786. In line with IS 456, reinforcement couplers for mechanical splices complying to IS 16172 may be used.

Corrosion resistant steel (CRS) of grade Fe 500/500D Fe 550/550D conforming to IS 1786 shall be used in coastal region or site with aggressive soil and water

Is design of RCC structure shall be done using properties of Fe 550 or Fe 550D, use of Fe500/Fe500D/Fe500S shall not be permitted.

Reinforcement shall be arranged by contractor.

10.0 DRAWINGS AND DESIGN TO BE DEVELOPED BY CONTRACTOR / EMPLOYER DURING DETAILED ENGINEERING:

The following clauses are applicable for the design and drawings which are to be developed during detailed engineering either by contractor/ vendor or by employer as per section project.

10.1 CONTROL ROOM BUILDING:

10.1.1 Control room building shall be of RCC framed structure & brickwork (Conventional). Minimum plinth area requirement shall be 10mX12m, layout of control room shall be finalized as per detailed engineering to suit project requirement. Tentative dimensions of different rooms required for control room shall be as per tender drawing. Minimum headroom of 3m below soffit of beams/false ceiling shall be considered for rooms.

10.1.2 In case of extension of Control room building, the same shall be matched with existing building, whether it is PEB or Conventional.

10.1.3 All walls shall be of non-load bearing Minimum wall thickness of full brick with 1:6 cement sand mortar. Partition walls in toilets and pantry can be half brick walls with 1:4 cement sand mortar and two nos. 6mm dia MS bars at every third course. CPWD specifications shall be followed for brick masonry work.

10.1.4 Partitions, if any required shall be made of uPVC /powder coated aluminium frame (minimum thickness of powder coating is 50 micron) provided with minimum 5.5mm thick clear glass or pre-laminated board depending upon the location of partition.

10.1.5 The details of doors and windows of the control room building shall be as per finish schedule Table-1.

- 10.1.6 IS approved or ISI Marked PVC electrical conduits of shall be provided as per the requirement of electrical installations including its accessories, junction boxes/surfaces boxes, fan boxes etc. Areas where false ceiling is provided electrical conduit may be laid on exposed surfaces of walls or ceiling, above false ceiling area. In rest areas conduits & junction boxes, fan boxes etc. shall be concealed.
- 10.1.7 Contractor shall develop conduit layout drawing based on electrical illumination & Electrical installation drawings approved by POWERGRID. For control Room conference Hall/Admin Hall conduits are also to be provided below floor tiles for extending power supply/internet cables to Conference table users/ Admin Cubicles.
- 10.1.8 The calculation of plinth area shall be as per IS:3861-2002. It shall comprise of following, to meet the functional requirement:
- Control room, ACDB & DCDB room, Battery room, , In Charge Room, Pantry, Lobby, Passage, toilet, shafts etc.
- 10.1.9 The area for above provisions shall be suitably decided by bidder during detailed engineering stage in consultation with employer.
- 10.1.10 Control room building shall be so designed that most of the area of switchyard is visible from control room.
- 10.1.11 Open cable trenches in the building shall be covered with minimum 6mm thick steel chequered plate with suitable stiffeners. Chequered plate shall be painted with two or more coats of epoxy paint as per item 13.52 of DSR' 2014 over a coat of steel primer.
- 10.1.12 The isometric view of the CRB with local aesthetic and best industry practices shall be submitted by vendors for approval of POWERGRID.
- 10.1.13 All flooring area other than foundations shall be designed as industrial floor with minimum 100 mm thick RCC floor slab, laid over well compacted stone soiling of minimum 200 mm thick using stone of size 150 mm & below with interstices filled with sand over well compacted earth.

10.2 PRE-ENGINEERED STEEL STRUCTURE.

- 10.2.1 In case of extension of PEB building, the same shall be matched with existing type either PEB or conventional.
- 10.2.2 Size of the building shall be as per requirement of panel, O&M needs and housekeeping considerations. Any clearance required as per Electricity Act or any other Standard shall also be kept. Separate fire escape doors shall also be provided in the GIS Building.

- 10.2.3 The base plate of steel columns shall be mounted on the RCC foundation by means of hot dip galvanized foundation bolts (The zinc coating shall be minimum 610 gram per square meter. In case the site is located within 30km from sea coast, the zinc coating shall be 900gm per square meter. The purity of zinc shall be 99.95% as per IS: 209). The RCC pedestal shall not protrude above floor level to avoid obstruction in the movement.
- 10.2.4 PVC electrical conduits of ISI marked or IS approved shall be provided as per the requirement of electrical installations its accessories, junction boxes/surfaces boxes, fan boxes etc. Areas where false ceiling is provided and on puff panels, electrical conduit may be laid on exposed surfaces of walls or ceiling, above false ceiling area. In rest area conduit & junction boxes, fan boxes etc. shall be concealed wherever brick wall/RCC is provided.
- 10.2.5 Open cable trenches shall be covered with minimum 6mm thick steel chequered plate with suitable stiffeners. Chequered plate shall be painted with two or more coats of synthetic enamel paint of approved brand and color shade, over priming coat of steel primer. However, for coastal regions, over priming coat of steel primer, structural steel shall be painted with epoxy paint.
- 10.2.6 Colour Scheme matching with local aesthetic and best industry practices shall be submitted by vendors for approval of POWERGRID. The colour of roof sheet shall be light coloured to minimize heat absorption. External and internal masonry walls (if any) shall be painted with suitable approved colour in consultation with Employer.
- 10.2.7 All external openings for duct entries shall be provided with all round sunshade/chajjas to ensure that no rain water shall directly splashes on the sealant. Adequate ventilation to be provided in Pre-Engineered Buildings (PEBs) for reducing heat accumulation and ensuring better air flow.
- 10.2.8 All flooring area other than foundations/raised RCC platform structure shall be designed as industrial floor with minimum 100 mm thick RCC floor slab, laid over well compacted stone soiling of minimum 200 mm thick using stone of size 150 mm & below with interstices filled with sand over well compacted earth and with floor finish as per table - 1.

10.3 BUILDING DESIGN CONSIDERARIONS:

- 10.3.1 To the requirements of the National Building Code of India, and the standards quoted therein.
- 10.3.2 For the specified climatic & loading conditions.
- 10.3.3 To adequately suit the requirements of the equipment and apparatus contained in the buildings and in all respects to be compatible with the intended use and occupancy.
- 10.3.4 With a functional and economical space arrangement.

- 10.3.5 To be aesthetically pleasing. Different buildings shall show a uniformity and consistency in architectural design.
- 10.3.6 To allow for easy access to equipment and maintenance of the equipment.
- 10.3.7 With wherever required, fire retarding materials for walls, ceilings and doors, which would prevent supporting or spreading of fire.
- 10.3.8 With materials preventing dust accumulation.
- 10.3.9 With the FFL of building shall be minimum 500 mm above finished ground level or as indicated in the tender drawings (same shall be finalised during detailed engineering). In case of extension of existing buildings, FFL should match with the existing buildings.
- 10.3.10 With anti-termite treatment, plinth protection, DPC, peripheral drain, sanitary, water supply, electrification etc.
- 10.3.11 With the building lighting, in accordance with the requirements of relevant section.
- 10.3.12 With the building auxiliary services like air conditioning and ventilation systems, fire protection and detection systems and all other miscellaneous services, in accordance with the requirements specified in relevant section or elsewhere in this Specification.
- 10.3.13 Most critical combinations of dead loads, super- imposed loads, equipment loads, crane load, wind loads, Snow load, seismic loads, any other load etc whichever is applicable shall be considered.
- 10.3.14 The individual members of the buildings frame shall be designed for the worst combination of forces such as bending moment, axial force, shear force, torsion deflection etc.
- 10.3.15 The permissible stresses for different load combinations shall be taken as per relevant BIS Codes.
- 10.3.16 All structures and its components must be designed and detailed as per latest BIS standards incorporating ductile detailing. List of reference codes e.g IS 456-2000 (latest), IS 875 all parts, IS 1893 all parts, IS 4326, IS 13920, SP34 etc.
- 10.3.17 RCC columns shall be provided with rigid connection at the base.
- 10.3.18 The design of steel structures for the Pre-engineered buildings shall be done in accordance with IS: 800-2007 with limit state method or elsewhere mentioned in section project.

10.3.19 Limit state method of Concrete design shall be adopted unless specified otherwise in the specification.

10.3.20 Clear cover to reinforcement shall be as per IS: 456 (latest).

10.3.21 Expansion joints wherever necessary with provision of twin columns shall be as per the provisions of relevant IS or National building codes.

10.3.22 Any sub-soil water encountered at founding level, same shall be considered in the design.

10.4 DESIGN LOADS:

The following loads shall be considered in design, in addition to the equipment manufacturer's requirements if any. However, all the loads, which are required for design, are subjected to employer's approval.

10.4.1 DEAD LOADS

- i) Dead loads shall include the self-weight of all structures complete with finishes, fixtures and partitions.
- ii) In addition, RCC beams shall be designed for any incidental point loads to be applied at any point along the beams if applicable.

10.4.2 IMPOSED LOADS

- i) Super-imposed loads in different areas shall include live loads, minor equipment loads, cable trays, small pipe racks/hangers and erection, operation and maintenance loads wherever these loads are expected. Equipment loads shall constitute, if applicable, all load of equipments to be supported on the building frame.
- ii) Floors/slabs shall be designed to carry loads imposed by equipment, cables and other loads associated with building. Cable load shall also be considered additionally for floors where these loads are expected.
- iii) The floor loads shall be subject to Employer's approval. Floors shall be designed for live loads as per relevant IS 875 part 2 (latest), however, for Buildings, the following loads may be considered.

Roof	1.5 kN/m ² for accessible roofs and 0.75 kN/m ² for in-accessible roofs
RCC-Floor	i) 5 kN/m ² for offices

	ii) 10 kN/m ² (min.) for equipment floors or actual requirement, if higher than 10kN/m ² on equipment component and layout plans
Stairs & balconies	5 kN/m ²
Toilets	2 kN/m ²
Chequered plate floor	4 kN/m ²
Walkways	3 kN/m ²

10.4.3 WIND LOAD

- i) The wind loads shall be computed as per IS 875 part 3 (latest), the class of structure for design, k₁ factor, shall be considered under the category as 'important buildings and structures like hospitals, communication buildings/towers, power plant structures' for Control Room building, PEB structure. Wind loads on Towers, Gantries, equipment structure shall be as per Technical Specification, Section: Structures).
- ii) Wind and Seismic forces shall not be considered to act simultaneously.

10.4.4 SEISMIC LOAD

- i) Seismic Coefficient method/Response Spectrum method shall be used for the seismic analysis as per IS: 1893: Part 1 to Part 4 with importance factor 1.5.
- ii) Wind and Seismic forces shall not be considered to act simultaneously.

10.4.5 SNOW LOAD

- i) Snow load shall be computed as per IS:875 part 4 (latest).
- ii) When snow load is present in roofs, replace imposed load by snow load in respective load combinations.

10.4.6 LOAD COMBINATIONS

- i) The critical load combinations for design of RCC structures shall be computed or generated by using IS: 875 Part-5 (latest), IS: 456 (latest), IS: 1893- part 1 (latest). ii) The critical load combinations for design of Steel structures shall be computed or generated by using IS: 875 Part-5 (latest), IS: 800, IS: 1893- part 1 (latest).

10.5 DESIGN OF FOUNDATIONS FOR BUILDINGS & OTHER SWITCH YARD STRUCTURES:

- 10.5.1 All foundation shall be of reinforced cement concrete. The design and construction of RCC structures shall be carried out as per IS: 456. Minimum 75mm thick lean concrete (1:4:8) shall be provided below all underground structures, foundations, trenches etc. to provide a base for construction
- 10.5.2 The BESS yard foundation's plinths shall be minimum 450mm and buildings plinth shall be minimum 500mm above finished ground level in BESS area respectively (same shall be finalized during detail engineering). If the site is sloping, the foundation height will be adjusted to maintain the exact level of the top of structures to compensate such slopes. BESS yard shall be as per recommendation of Battery energy storage Manufacturer. Layout of yard shall be such that crane movement for placing, lifting of battery units PCS unit, Transformer etc. shall not disturb the adjacent facilities. All system, room and building shall be connected by rigid path as per layout submitted by contractor during detailed engineering.
- 10.5.3 Factor of Safety for foundation shall be 1.5 in both Normal and Short circuit condition. Factor of Safety for stability of tower and equipment foundation will as per IS 1904. The factor of safety for the design of members for switchyard structures shall be considered as 1.5 for normal condition and 1.2 for short circuit condition.
- 10.5.4 The design and detailing of foundations shall be done based on the approved soil data and sub-soil conditions as well as for all possible critical loads and the combinations thereof. The Isolated/ Combined/ Strip footings / Raft or pile foundation as may be required based on soil/sub-soil conditions and superimposed loads shall be provided
- 10.5.5 The procedure used for the design of the foundations shall be the most critical loading combination of the steel structure and or equipment and/or superstructure and other conditions which produces the maximum stresses in the foundation or the foundation component and as per the relevant BIS Codes of foundation design. Detailed design calculations shall be submitted by the bidder showing complete details.
- 10.5.6 Necessary protection to the foundation work, if required shall be provided to take care of any special requirements for aggressive alkaline soil, black cotton soil or any other type of soil which is detrimental/harmful to the concrete foundations.
- 10.5.7 If pile foundations are adopted, the same shall be cast-in-situ bored or pre-cast or under reamed type as per relevant parts of IS: 2911. Only RCC piles shall be provided. Necessary initial load test shall be carried out by the Contractor to establish the pile design capacity. Only after the design capacity of pile has been established, the Contractor shall take up the job of piling. Routine tests for the pile shall also be conducted as per IS: 2911/IS :10262. All the testing work shall be planned in such a way that these shall not cause any delay in project completion. RCC for pile works shall be Design Mix of minimum grade M-25 and also

minimum cement content shall be 400Kg/ cu.m as per IS:2911 (Latest revision). In case extra cement is required to meet the provisions of IS: 2911, it will be paid extra.

10.5.8 The foundations shall be proportioned so that the estimated total and differential movements of the foundations are not greater than the movements that the structure or equipment is designed to accommodate.

10.5.9 Design consideration for Equipment support: The supporting structure for B.P.I., LA, CVT and Isolator CT, CSE & Wave Trap equipment shall comprise of lattice structural steel conforming to IS 2062 and shall be designed as per IS: 802. Common raft foundation shall be provided for each pole of isolator.

10.5.10 Special design consideration for Lightning Mast: Diagonal wind condition shall be considered for Lightning Mast. Diagonal wind shall be taken as 1.2 times the wind calculated on longitudinal/transverse side. Lightning mast shall be provided with minimum two nos. of platforms as per requirement and an external cage ladder for climbing purpose shall be provided up to the platforms. Top of platform shall have grating, railing and two guard plates. The minimum width of platform shall be 900mm. Live load of 300kg/m² above platforms shall be considered for design of Lightning Mast. The fabrication and erection of the switchyard works shall be carried out generally in accordance with IS: 802 and IS: 800. All materials shall be completely shop fabricated and galvanized.

10.6 DESIGN OF TRANSFORMER AND REACTOR FOUNDATION:

10.6.1 The foundations of Transformer shall be of block type foundation. Minimum reinforcement shall be governed by IS: 2974 and IS: 456.

10.6.2 The Contractor shall provide a RCC Rail cum road system integrated with the Autotransformer foundation to enable installation and the replacement of any failed unit. The transfer track system shall be suitable to permit the movement of any failed unit fully assembled (including OLTC, bushings) with oil.

10.6.3 This system shall enable the removal of any failed unit from its foundation to the nearest road. If trench/drain crossings are required then suitable R.C.C. culverts shall be provided in accordance with I.R.C. standard / relevant IS.

10.6.4 The Contractor shall provide a pylon support system for supporting the firefighting system.

10.6.5 Each Autotransformer including oil conservator tank and cooler banks etc. shall be placed in a self-sufficient pit surrounded by retaining walls (Pit walls). The clear distance of the retaining wall of the pit from the Autotransformer shall be 20% of the Autotransformer/ cooler bank height or 0.8m whichever is higher. The oil collection pit thus formed shall have a void volume equal to 200% volume of total oil in the Autotransformer. In case of transformers of 132kV

and below, where hydrant system for firefighting is not provided, volume of pit may be reduced to 130% of total oil volume. However, in case common oil pit is envisaged during detailed engineering, the individual oil collection pit thus formed shall have a void volume equal to 33% volume of total oil in the Autotransformer/Reactor. The common oil collection pit shall have a void volume equal to 200% volume of maximum total oil of either Autotransformer.

10.6.6 The minimum height of the retaining walls of pit shall be 20 cm above the finished level of the ground to avoid outside water pouring inside the pit. The bottom of the pit shall have a uniform slope towards the sump pit. While designing the oil collection pit, the movement of the autotransformer / reactor must be taken into account.

10.6.7 The grating shall be made of MS flat of size 30mm x 5mm placed at 30mm centre to centre and 6mm dia MS bar at spacing of 150mm at right angle to each other. Maximum length of grating shall be 2000mm and width shall not be more than 500mm. The gratings, supported on ISMB 150 mm, shall be placed at the formation level and will be covered with 100mm thick layer of stone aggregate having size 40mm to 60mm. All steel work used for grating and supports shall be painted with epoxy-based zinc phosphate primer (two packs) conforming to IS: 13238- 1991, thereafter with two or more coat of bituminous paint of approved quality shall be applied. Contractor shall have option to provide factory made electro forged MS grating made of specified size MS flat and round bars without any extra cost to employer.

10.6.8 Each oil collection pit shall be drained towards a sump pit of size 750X750mm and 400mm deep below the floor level within the collection pit whose role is to drain water and oil due to leakage within the collection pit so that collection pit remains dry.

10.6.9 In case common oil pit is envisaged during detailed engineering, the individual oil collection pit thus formed shall have a void volume equal to 33% volume of total oil in the Autotransformer/Reactor. The common oil collection pit shall have a void volume equal to 200% volume of maximum total oil of either Autotransformer or Reactor. Each Transformer/reactor foundation shall have sump pit without grating and it shall be connected to the common oil collection pit by means of hume pipes. 2 Nos. of 150mm diameter, NP2 RCC hume pipes shall be used for connection of foundation sump pit to Main line. Main line connecting to oil collection pit shall be laid by using 250mm diameter NP2 RCC hume pipes. All required manholes including their covers are deemed to be included in the quoted rates.

10.7 DESIGN OF FIRE PROTECTION WALLS: (if applicable)

10.7.1 The construction of fire walls shall be cast in situ type or precast RCC as per drawings and meeting the technical specification.

10.7.2 The firewall shall have a minimum fire resistance of 4 hours. The walls of the building, which are to be used as firewalls, shall have also a minimum fire resistance of 4 hours. The firewall

shall be designed to protect against the effect of radiant heat and flying debris from an adjacent fire.

10.7.3 The firewall shall extend 600 mm on each side of the Autotransformer or Reactors and 600 mm above the conservator tank or safety vent. A minimum of 2.0-meter clearance shall be provided between the equipment's e.g. Autotransformer or Reactors and firewalls. In case of space constraints, these dimensions can be reduced as per the approval of Employer.

10.7.4 The building walls, which act as firewalls, shall extend at least 1 m above the roof or 600 mm above the conservator tank or safety vent, whichever is maximum, in order to protect it.

10.7.5 The firewall will be made of reinforced cement concrete with smooth surfaces devoid of honeycomb, undulations etc. and shall be finished with cement wash paint of approved colour.

10.8 DESIGN OF WATER TANKS, CHANNELS, SUMPS, TRENCHES AND OTHER UNDER-GROUND STRUCTURES:

10.8.1 RCC water retaining structures like storage tanks, etc. shall be designed as un-cracked section in accordance with IS: 3370 (Part I to IV) by working stress method. In case of water channels, shall be designed as cracked section with limited steel stresses as per IS: 3370 (Part I to IV) by working stress method.

10.8.2 All sub-structures shall be checked for sliding and overturning stability during both construction and operating conditions for various combinations of loads. Factors of safety for these cases shall be taken as mentioned in relevant BIS Codes or as stipulated elsewhere in the Specifications. For checking against overturning, weight of soil vertically above footing shall be taken and inverted frustum of pyramid of earth on the foundation should not be considered.

10.8.3 Earth pressure for all underground RCC structures like cable trenches, underground water tanks, Oil collection pits, Septic tanks, basements etc. shall be calculated using co-efficient of earth pressure at rest, co-efficient of active or passive earth pressure (whichever is applicable). However, for the design of substructures of any underground enclosures, earth pressure at rest shall be considered.

10.8.4 In addition to earth pressure and ground water pressure etc., a surcharge load of 2T/Sq.m shall also be considered for the design of all underground structures for the vehicular traffic in the vicinity of the structure.

10.8.5 Underground tanks shall be checked for full water pressure from inside and no earth pressure & ground water pressure & surcharge pressure from outside (application only to structures which are liable to be filled up with water or any other liquid). They shall also be checked for

full earth pressure, surcharge pressure and ground water pressure from outside and no water pressure from inside.

10.8.6 Design shall also be checked against buoyancy due to the ground water during construction and maintenance stages. Minimum factor of safety of 1.5 against buoyancy shall be ensured ignoring the superimposed loadings. Base slab of any underground enclosure shall also be designed for empty condition during construction and maintenance stages with maximum ground water table (GWT). Minimum factor of safety of 1.5 against buoyancy shall be ensured ignoring the super-imposed loadings.

10.8.7 Base slab of any underground enclosure like water storage tank shall also be designed for the condition of different combination of pump sumps being empty during maintenance stages with maximum GWT. Intermediate dividing piers of such enclosures shall be designed considering water in one pump sump only and the other pumps sump being empty for maintenance.

10.9 INTERNAL FINISH SCHEDULE FOR BUILDING/STRUCTURE EITHER RCC/ PEB TYPE:

10.9.1 Internal finishing Schedule for Building/structure either RCC/ PEB is given below: The Locations, which are not specified in finish schedule, shall be provided with vitrified tile flooring and premium acrylic emulsion paint over two mm thick POP putty. The below mentioned finishing schedule is also applicable for extension of Control room or PEB structure unless otherwise mentioned else-where in the Tender. Areas where false ceiling is provided, electrical conduit may be laid on exposed surfaces of walls or ceiling, above false ceiling area.

a) Floor Finishes

1. Control room/lobby/corridor/office/ etc: Heavy Duty Vitrified Ceramic Tiles with skirting
2. Battery Room: Acid/Alkali Resistance tile Flooring and Dado (2100mm)
3. Toilet: Heavy Duty Anti-skid ceramic tiles and dado up to 2100 mm
4. Steps/stairs/pantry: Kota stone/Granite-18 mm minimum thick.
5. Material loading/unloading bay/ Inverter platform with canopy: cement concrete flooring as per IS: 2571 with ironite hardener.

b) Windows, Doors, Ventilators, entrance lobby of all buildings shall have powder coated (minimum thickness of powder coating 50 micron) aluminium framework with glazing. Window shall be provided with Suitable aluminium grill. Toilet door will be Fibre reinforced plastic (FRP) type. For Single glazed aluminium partitions and doors, toughened float glass of 10mm thickness shall be used. All Windows and Ventilators shall be provided with minimum 6 mm thick toughened glass to used. All glazing work shall conform to IS: 1083 and IS: 3548. The Glass used should be from reputed brand / manufacturer and as approved by Engineer In charge. The glass should be free from distortion and thermal stress. Minimum size of door provided shall be 2.4 m high and 1.2 m wide. However, for toilets minimum width shall be 0.75 m and 2.1 m high and office areas minimum width shall be 1.20m. Fire-Proof doors with panic devices shall be provided at all fire exit points as per requirements. These doors shall be as per IS 3614 Part-II. Fire rating of the doors shall be of minimum 2 hours of

integrity and 30 minutes of insulation. These doors shall be double cover plated type with mineral wool insulation

Wherever functionally required Rolling shutter (fully closed/partly grilled) with manual operating arrangement shall be provided to facilitate smooth operations. Rolling shutters shall conform to IS: 6248. M.S sliding doors with suitable mechanical operations fixtures as per requirement for shall be used. Door Windows and Rolling shutter on external wall of the buildings shall be provided with RCC Sunshed over the opening. Projection of Sun shed of 450mm of window,600mm over door except main entrance door where projection shall be 1000mm. Projection of 900 mm over rolling shutter shall be provided.

- c) Painting of wall and ceilings Internal Wall surface: Acrylic Distemper.
- d) External faces of wall: Exterior Emulsion paint.
- e) Ceiling (Except in Control room/Entrance/Lobby) : Acrylic Distemper
- f) Ceiling in Control room/Entrance/Lobby/In charge room: Aluminium False Ceiling
- g) The Paint shall be antifungal quality of reputed brand suitable for masonry. All painting on masonry / concrete surface shall preferably be applied by roller. If applied by brush, then same shall be finished off with roller. For painting on concrete, masonry and plastered surface IS :2395 shall be followed. Minimum two finishing coats of paint shall be applied over a coat of Primer. A standard colour scheme for the different building/structures shall be prepared by the contractor and the approval of the owner shall be obtained before commencement of work.

10.10 FALSE CEILING DETAILS:

10.10.1 False ceiling painted with Non VOC acrylic emulsion paint to give an even shade is to be provided in control room, site in-charge room, battery room, Panel room/relay room in CRB, lobby, corridor. For Toilet and ACDB & DCDB room non VOC acrylic emulsion paint over approved primer coat to be provided for RCC building / False ceiling shall be provided in-case of PEB building

10.10.2 15mm thick densified tegular edged ecofriendly light weight calcium silicate false ceiling tiles of approved texture spintone/cosmos/ Hexa or equivalent of size 595x595 mm in true horizontal level, suspended on interlocking metal grid of hot dipped galvanised steel sections (galvanising @ 120 grams per sqm. Including both side).

Consisting of main 'T' runner suitably spaced at joints to get required length and of size 24x38 mm made from 0.33 mm thick (minimum) sheet, spaced 1200 mm centre to centre, and cross 'T' of size 24x28 mm made out of 0,33 mm (minimum) sheet, 1200 mm long spaced between main 'T' at 600 mm centre to centre to form a grid of 1200x600 mm and secondary cross 'T' of length 600 mm and size of 24x28 mm made of 0.33 mm thick (minimum) sheet to be interlocked at middle of the 1200x600 mm panel to form grid of size 600x600 mm, resting on periphery walls/partitions on a perimeter wall angle

precoated steel of size (24x24x300 mm made of 0.40 mm thick (minimum) sheet with the help of rawl plugs at 450 mm centre to centre with 25 mm long drywall screws @230 mm interval and laying 15 mm thick densified edges calcium silicate ceiling tiles of approved texture (Spintone/ Cosmos/ hexa) in the grid, including, cutting/making openings for services like diffusers, grills, light fittings, fixtures, smoke detectors etc., Wherever required.

Main 'T' runners to be suspended from, ceiling using G.I. slotted cleats of size 25x35x1.6 mm fixed to ceiling with 12.5 mm dia and 50 mm long dash fasteners, 4 mm G.I. adjustable rods with galvanised steel level clips of size 85x30x0.8 mm, spaced at 1200 mm centre to centre along main 'T', bottom exposed with 24 mm of all T-section shall be pre-painted with polyester baked paint, for all heights, as per specifications, drawings and as directed by engineer- in-charge.

10.11 WATER PROOFING TREATMENT

10.11.1 Integral cement-based water proofing treatment including preparation of surface as required for treatment of roofs, balconies, terraces etc consisting of following operations:

- a) Applying a slurry coat of neat cement using 2.75 kg/sqm. of cement admixed with water proofing compound conforming to IS. 2645 and approved by Engineer-in-charge over the RCC slab including adjoining walls upto 300mm height including cleaning the surface before treatment.
- b) Laying brick bats with mortar using broken bricks/brick bats 25 mm to 115 mm size with 50% of cement mortar 1:5 (1 cement : 5 coarse sand) admixed with water proofing compound conforming to IS : 2645 and approved by Engineer-in-charge over 20 mm thick layer of cement mortar of mix 1:5 (1 cement :5 coarse sand) admixed with water proofing compound conforming to IS : 2645 and approved by Engineer-in-charge to required slope and treating similarly the adjoining walls upto 300 mm height including rounding of junctions of walls and slabs
- c) After two days of proper curing applying a second coat of cement slurry using 2.75 kg/ sqm of cement admixed with water proofing compound conforming to IS : 2645 and approved by Engineer-in-charge.
- d) Finishing the surface with 20 mm thick joint less cement mortar of mix 1:4 (1 cement :4 coarse sand) admixed with water proofing compound conforming to IS : 2645 and approved by Engineer-in-charge including laying glass fibre cloth of approved quality in top layer of plaster and finally finishing the surface with trowel with neat cement slurry and making pattern of 300x300 mm square 3 mm deep.
- e) The whole terrace so finished shall be flooded with water for a minimum period of two weeks for curing and for final test. All above operations to be done in order and as directed and specified by the Engineer-in-Charge

f) With average thickness of 120mm and minimum thickness at khurra as 65 mm.

10.11.2 Alternatively in case of non- availability of good quality of brick bats, the water proofing treatment can also be done in the following manner:

The water proofing membrane shall be laid on the RCC slab without any break. The grading concrete (1:2:4) of average thickness of 50 mm with water proofing compound as per manufacturer's specification shall be laid over the membrane. Cement concrete flooring of 40mm thick with (1cement: 2 fine aggregate: 4 stone aggregate 20mm graded stone aggregate) finished with a floating coat of neat cement including cement slurry complete shall be laid over grading concrete and checkered pattern in the grid of 300mm x 300mm shall be made .

10.11.3 SUNKEN WATER PROOFING (RCC):

☒ Water proofing treatment shall be done in sunken portion of WCs, bathroom etc. by applying cement slurry mixed with water proofing cement compound consisting of:

- a) First layer of slurry of cement @ 0.488 kg/sqm mixed with water proofing cement compound @ 0.253 kg/ sqm. This layer will be allowed to air cure for 4 hours.
- b) Second layer of slurry of cement @ 0.242 kg/sqm mixed with water proofing cement compound @ 0.126 kg/sqm. This layer will be allowed to air cure for 4 hours followed with water curing for 48 hours.

☒ Treatment and sealing of joints, corners, junction of pipes and masonry with polymer mixed slurry shall be carried out as per CPWD specifications.

10.12 SPECIFICATION FOR PLUMBING, SANITATION & WATER SUPPLY ETC:

10.12.1 All plumbing and sanitation shall be executed to comply with the requirements of the appropriate bye-laws, rules and regulations of the Local Authority having jurisdiction over such matters. The Contractor shall arrange for all necessary formalities to be met in regard to inspection, testing, obtaining approval and giving notices etc.

10.12.2 Provision for water cooler shall be provided at suitable location.

10.12.3 Each toilet shall be provided with Water Closet, Wash hand basin, health faucet, Mirror, Towel Rail, Paper Holder, Liquid soap dispenser, twin coat holder.

10.12.4 In addition to general requirements of each toilet, 2 nos. Sensor based urinals shall be provided for common Gents toilet.

10.12.5 Pantry shall be provided with stainless steel kitchen sink.

10.12.6 The platform of kitchen sink and wash hand basin shall be provided with 18 mm thk. Mirror polished approved granite stone.

10.12.7 The specification of different items, which are to be used for plumbing, sanitation & water supply etc. in are given below, the same shall be used during detailed engineering, unless otherwise mentioned else-where in the tender.

S.No.	Items	Description
1	Wall hung Water Closet	Coloured vitreous china extended wall mounting water closet of approved size and shape including providing & fixing white vitreous china cistern with dual flush fitting, of flushing capacity 3 litre/6 litre (adjustable to 4 litre/8 litres), including seat cover, and cistern fittings, nuts, bolts and gasket etc complete.
2	Squatting Pan	(Indian type W.C. pan) (white vitreous china Orissa pattern W.C. pan of size 580x440mm with integral type foot rests) shall be with 100mm sand cast iron P or S trap. 10 litre low level white P.V.C flushing cistern with manually controlled device (handle lever) conforming to IS:7231, with all fittings and fixtures complete including cutting and making good the walls and floors wherever required.
3	Wash Basin	Providing and fixing coloured wash basin counter type of (approximate size 630x450mm size under counter or over counter type), in case flat wash hand is required the approximate size shall be 550x400mm and shall be provided with C.P. close basin mixer (ISI approved) with CI. Brackets taps with battery based infrared sensor, 32mm C.P. brass waste and bottle trap of standard pattern, including painting of fittings and brackets, cutting and making good the walls wherever required. Other details shall be as per the drawings.
4	Urinal	White vitreous china battery based infrared sensor operated urinal of approx. size 610 x 390 x 370 mm having pre & post flushing with water (250 ml & 500 ml consumption), having water inlet from back side, including fixing to wall with suitable brackets all as per manufacturers specification and direction of Engineer-in-charge.
5	Urinal partition	10mm thk toughened glass partition with frosted film to be fixed in position for urinals on appropriate stainless steel patch fittings of desired shape and size

6	Kitchen sink	Stainless steel AISI 304 (18/8) Kitchen sink of 510x1040 mm bowl with depth of 178mm with drain board shall be provided and fixed as per IS 13983 with C.I brackets, and stainless steel plug 40mm with provision of 2 nos. CP brass long body bib cock conforming to IS Standard and weighing not less than 650 gm for CP bottle trap etc. including painting of fittings and brackets, cutting and making good the wall.
7	Bib cock	C.P. brass short body and long body bib cock 15mm nominal bore shall be of approved quality conforming to IS: 8931.
8	Angle valve	C.P. brass angle valve of 15mm nominal bore provided and fixed in position for basin and cistern points of approved quality conforming IS :8931.
9	Towel rail	C.P. brass towel rail of approved make of 600mm length, 25mm dia with a pair of brackets or flanges provided and fixed to wall beside each wash basin/set of wash basin with necessary screws, plugs, etc.
10	Mirror	6mm thick beveled edge mirror approximate size 1000x600mm made of superior glass of approved make complete with a backing of 6 mm thick water proof hard board fixed to wooden cleats with 25mm dia SS studs, washers etc complete for each wash basin.
11	Hooks	Double type coat & hat hooks with flanges, fixed to wall / shutter, etc. with necessary screws, washers & plugs.
12	Liquid soap holder	C.P. brass liquid soap holder of approved make fixed with each wash basin to the wall with necessary CP brackets, CP screws, washers, plugs etc.
13	C.P. Brass or S.S. cockroach trap	Approved C.P. Brass cockroach trap shall be provided in the Kitchen, Toilets and pantry
14	Floor traps	PVC floor traps of self cleansing design shall be provided & fixed in position with 100 mm dia. inlet and 75mm dia. outlet of approved make, including making connection with PVC soil/waste pipes using rubber gaskets, embedding the trap in 150 mm thick PCC 1:2:4.

15	Internal Soil, waste and vent pipe	Unplasticised rigid PVC pipes of 75mm for waste & 110mm dia for soil shall be provided conforming to IS:13592 type B and all its fittings like bends, sockets, door bend, Y-tee etc. as per requirement with seal ring conforming to IS: 5382 including jointing with cement solvent conforms to IS:14182. All underground or under floor pipes shall be encased with 1:3:6 concrete. Minimum concrete cover shall be 75 mm thk.
16	Rain Water Pipe and fittings	<p>a) Unplasticised rigid PVC rain water pipes of required dia shall be provided and fixed on the wall face conforming to IS: 13592 type A as per requirement including jointing with seal ring conforming to IS: 5382 leaving 10mm gap for thermal expansion single socketed pipes including all fittings like bends, bat clamps gratings etc.</p> <p>b) Unplasticised PVC Moulded fittings/accessories including suitable dia. bend & shoes shall be provided and fixed for unplasticised rigid PVC rain water pipes conforming to IS:13592 type A including jointing with seal ring conforming to IS: 5382 leaving 10mm gap for thermal expansion.</p> <p>c) Clips of approved design shall be provided and fixed to unplasticised PVC rain water pipes by means of 50x50x50mm hard wood plugs, screwed with MS screws of required length including cutting brick work and fixing in cement mortar 1:4 (1 cement : 4 coarse sand) and making good the wall etc</p>
17	Internal & External water supply	<p>a) All CPVC pipes and fittings shall conform to IS:15778</p> <p>b) All internal CPVC pipe shall be concealed including cutting of chases and making good the wall.</p> <p>c) Wherever CPVC pipes are buried the same shall be provided and laid in position including trenching, sand cushion and refilling, etc. For trenching, sand cushion and refilling refer CPWD specification applicable for external piping work.</p> <p>d) All internal CPVC pipe shall be concealed including cutting of chases and making good the wall.</p> <p>e) ISI approved CPVC ball valve, non-return valves shall be provided and fixed in position as per requirement and direction of Engineer-in-charge.</p>
18	Water storage tanks	Triple layered Polyethylene water storage tanks shall be provided of approved brand and manufacture with cover and suitable locking arrangement, float valve and making necessary holes for inlet, outlet and overflow pipes. Capacity of water tank shall be 2x1000 litres for control room.

19	Road Gully Chamber	Brick Masonry Road gully chamber of 50x45x60cm shall be provided with FPS brick with cement mortar 1:4 including 500x450mm pre cast RCC Horizontal/vertical grating with frame complete.
19	Sluice valve chamber	Masonry chamber for sluice valve shall be 600x600mm size in plan and depth 750mm, or matching with the site condition inside with 50 class designation brick work in cement mortar 1:5 (1 cement : 5 fine sand) with CI surface box 100 mm. Top diameter, 160 mm bottom dia and 180 mm deep (inside) with chained lid and RCC top slab 1:2:4 mix (1cement : 2 coarse sand: 4 graded stone aggregate 20 mm nominal size) necessary excavation foundation concrete 1:5:10 (1 cement : 5 fine aggregate : 10 graded stone aggregate 40 mm nominal size) and inside plastering with cement mortar 1:3 (1 cement : 3 coarse sand) 12 mm thick finished with a floating coat of neat cement complete as per standard design with FPS bricks of class 75.
20	External Sewerage	Glazed stoneware pipes of 100 & 150mm diameter grade 'A' shall be provided, laid and jointed with stiff mixture of cement mortar in the proportion of 1:1 (1cement :1 fine sand) including testing of joints etc. complete. SW pipes shall be encased with Cement concrete 1:5:10 (1 cement: 5 coarse sand: 10 graded stone aggregate 40 mm nominal size) including bed concrete as per CPWD standard design and CPWD specifications. In case of non-availability of SW Pipe, contractor may use UPVC Pipe of similar dia with the prior approval of EIC without any financial implication to POWERGRID.
21	Gully trap	100x100 mm or 150x100 mm size P type Square-mouth S.W. gully trap class SP-1 complete with C.I. grating brick masonry chamber and water tight C.I. cover frame o f 300 x300 mm size (inside), the weight of cover to be not less than 4.50 kg and frame to be not less than 2.70 kg as per standard design. FPS Bricks class designation 75 shall be provided for brick masonry chamber.
22	Foot Rest	Orange colour safety foot rest of minimum 6 mm thick plastic encapsulated as per IS : 10910, on 12 mm dia steel bar conforming to IS: 1786, having minimum cross section as 23 mmx25 mm and over all minimum length 263 mm and width as 165 mm with minimum 112 mm space between protruded legs having 2 mm tread on top surface by ribbing or chequering besides necessary and adequate anchoring projections on tail length on 138 mm as per standard drawing and suitable to with stand the bend test and chemical resistance test as per specifications and having manufacture's permanent identification mark to be visible even after fixing, fixing in manholes with 30x20x15

		cm cement concrete block 1:3:6 (1 cement : 3 fine aggregate : 6 graded stone aggregate 20 mm nominal size) complete.
23	Manholes	<p>FPS brick masonry manhole shall be constructed in cement mortar 1:4 (1 cement :4 coarse sand) RCC top slab with 1:2:4 mix (1 cement : 2 fine aggregate : 4 graded stone aggregate 20 mm nominal size) foundation concrete 1:4:8 mix (1cement : 4 coarse sand :8 graded stone aggregate 40 mm nominal size) inside plastering 12 mm thick with cement mortar 1:3 (1 cement : 3 coarse sand) finished with floating coat of neat cement and making channels in cement concrete 1:2:4 (1 cement: 2 coarse sand :4 graded stone aggregate 20 mm nominal size) finished with a floating coat of neat cement complete as per standard design. The size and depth of manhole shall be suitably decided based on requirement of layout in line with CPWD specification.</p> <p>a) Inside size shall be 90 x 80 cm and 60 cm deep including CI cover with frame (light duty) 455 x 610 mm internal dimensions total weight of cover and frame shall not be less than 38 kg (weight of cover 23 kg and weight of frame 15 kg) and shall be constructed with F.P.S. bricks with class designation 75.</p> <p>b) Inside size shall be 120 x 90 cm and 90 cm or more deep including CI cover with frame (medium duty) 500mm internal diameter total weight of cover and frame to be not less than 116 kg (weight of cover 58 kg and weight of frame 58 kg) with FPS Bricks class designation 75.</p>

11.0 MATERIAL SPECIFICATION FOR ALL PRE-ENGINEERED BUILDINGS (PEB):

11.1 STRUCTURAL STEEL MEMBERS:

11.1.1 The structure for PCS, auxiliary systems & HT switchgear building shall be made of Pre-Engineered Buildings (PEB). The reference architectural and structural drawings of pre-engineered building are provided as tender drawings. Plinth area and layout of PEB shown in tender drawing are tentative and may change at the time of detailed engineering to suit project requirement. Bidder shall prepare the detailed fabrication and civil construction drawings based on tender drawing and submit to Employer for approval before the start of work. PEB shall be manufactured, supplied, and erected by the bidder/PEB agency. The PEB shall be made of structural steel construction with double skinned metal roofing and wall

cladding of approved profile. PEB shall be complete with painting, metal fascia, metal gutter, rainwater down comers, sunshades, openings, etc., along with associated structural steel, cladding and roofing work insulation, Trims & Flashings. Each item of PEB like panels, masonry, plastering, flooring, foundation, fittings etc. shall be suitable for the complete life of the solar plant. The construction methodology for PEB shall also be submitted for Employer's approval before the start of works. The layout of the PEB/Inverter room shall be designed so as to divert the heat generated from each inverter outside the room. The inverter room shall be designed for a life of 25 years. The PEB shall have a robust water tightness at all joints and connections. The building shall have a high-class durability and performance during the adverse weather conditions. The PEB supplied shall be complete in all respect meeting all the requirements of tender drawings and other technical and functional requirements like lighting, ventilation system etc. to ensure effective functioning. PEB length can be determined based on actual requirement, however, the grid spacing shall be maintained as per tender drawing.

- 11.1.2 Structure and material specification: The PEB structural members shall meet the requirements of tender drawings. All hot rolled primary structural members and Rod/Angle/Pipe bracing etc. shall conform to IS: 2062, minimum Grade E250 Quality A. Secondary members for Purlins and Girts shall conform to the specification of IS 811 or ASTM A1003-12 made from steel sheets conforming to ASTM A1011-12b Grade 50 having a minimum yield strength of 345 MPa. The minimum thickness of secondary members shall be 3mm. All other miscellaneous secondary members shall have the minimum yield strength of 250 MPa.

Insulated wall cladding or roofing shall consist of double skin metal cladding with Poly Urethane Foam (PUF). PUF must be made of continuous method PU foam and must be CFC free, self-extinguishing, fire retardant type with density 40 +/-2 kg/m³ and thermal conductivity 0.019-0.023 W/(m.K) at 10°C. The PUF panels shall be a factory-made item ready for installation at site.

- 11.1.3 Fasteners & Connections: Special coated self-drilling screws/fastener shall be used conforming to class 3 as per AS 3566.1 and AS 3566.2. Steel bolts, nuts and washers complying with AS 1112:2000. High Strength Bolts for Primary Connections IS 1367 (Part III) Gr. 8.8 / ASTM A325. Bolts for Secondary Connection IS 1367 (Part III) Gr. 4.6 / ASTM A307. Anchor/foundation Bolts shall conform to IS 5624 and relevant IS code. 2.2.3

- 11.1.4 Roof and Wall cladding: PUF panels shall be made of troughed permanently colour coated metal sheets of steel for roofing and side cladding shall conform to the requirements of Table-1 and IS: 513 for Hot dip Zinc coated or Al/Zn coated sheets. The insulation material thickness and details shall be as specified at the relevant para in the specification.

PUF insulated panels Metal Sheet for Roofing and side cladding consist of an external sheet as troughed permanently colour coated sheet & internal sheet as plain permanently colour coated sheet.

The chemical composition of Troughed permanently colour metal sheet for roofing and side cladding shall conform to the provisions of same reference code to which the mechanical properties conform to.

Plain permanently colour coated steel metal sheet for ridge and hips, flashing, trimming, closure for vertical and horizontal joints, capping etc. shall conform to the same requirements as those of troughed permanently colour coated metal sheet for roof and side cladding.

The maximum spacing of the fastener shall be 390 mm c/c along the length of purlins/runners. However exact spacing shall be as per the design done by the bidder of the fastener considering the wind load, self-load and other associated load. The minimum diameter of the fastener shall be 5.5 mm and at-least 3 nos. of fastener shall be used per sheet.

Fillers blocks as a trough filler shall be used to seal cavities formed between the profiled sheet and the support or flashing. The fillers blocks shall be manufactured from black synthetic rubber or any other material as approved by the Employer.

11.1.5 Roof Insulation and type: Both metal sheets shall have an under insulation of minimum 40 mm thick PUF with density 40 (+/- 2 kg/m³) and thermal conductivity 0.019-0.023 W/(m.K) at 10°C with gutters and down take pipes along with Flashing & Top cap of the required size and colour complete with all necessary hardware complete. The roof shall be projected at-least 300 mm from the wall.

Stiffening ribs / subtle fluting for effective water shedding and special male / female ends with full return legs on side laps for purlin support and anti-capillary flute inside lap shall be provided.

Both upper and lower sheets shall be separated through spacers and fastened through zinc /zinc-tin coated self-drilling screws. The fastener size shall be calculated as per the design or manufacturers recommendations.

11.1.6 Wall Insulation: All voids of external and internal metaled walls shall have an under insulation of minimum 40 mm thick PUF with density 40 (+/- 2 kg/m³) and thermal conductivity 0.019-0.023 W/(m.K) at 10°C with proper supports etc. as approved.

Both the walls should be separated by spacers system made up of cold-formed steel bars and fastened through zinc /zinc-tin coated self-drilling screws.

The external wall of Inverter room facing the transformer area shall be as per IS: 1646 - Code of practice for fire safety of buildings (general): electrical installations.

11.1.7 Doors Frames: Powder coated (minimum thickness of powder coating 50 micron) aluminium framework with glazing. All doors shall be provided necessary fittings like hinges, handles,

mortice locks, tower bolts, stopper, etc. of CP brass complete fixed to Pre-Engineered structure including necessary filling up of gaps at junctions with required PVC/neoprene felt etc. including hinges / pivots and double action hydraulic floor spring/ hydraulic door closer of approved brand and manufacture IS: 6315 marked, lock, handle and all necessary fittings as detailed in tender drawing or submitted by bidder in shop drawing and approved by Employer.

Bidder can also propose uPVC extruded casement/ sliding doors, with complete fitting, accessories, and panels as per items mentioned in DSR (latest revision).

11.1.8 Windows Frame: Aluminum powder coated section, frame shall be of 92x31 mm, minimum 16G thick as per approved design. Tinted glass and aluminum grill shall be provided.

The Bidder can also propose uPVC extruded casement/ sliding windows with complete fitting and accessories as per items mentioned in DSR.

11.1.9 Ventilators: Aluminum black powder coated frame of minimum size 62x25 mm and 16G thick as per approved design. Ventilators/duct shall be provided with bird guard. Size of opening at the wall for ducts shall be as per PCU manufacture and min 18-gauge GI sheet. Ducts shall be supported with suitable means, as approved during detail engineering.

All accessible ventilators and windows of all buildings shall be provided with min. 4mm thick float glass, tinted for preventing solar radiations. Suitable sunshades made out of approved colour sheet will be provided to all external windows and door. The minimum projection for the sunshades will be 450 mm and 300mm wider than the width of the opening.

11.1.10 Rolling shutter: Rolling shutter (Hand operated) shall be fabricated from 18 gauge steel and machine rolled with 75 mm rolling Shutter with effective bridge depth of 12 mm lath sections, interlocked with each other and ends locked with malleable cast iron clips to IS:2108 and shall be designed to withstand a wind load without excessive deflection. Metal rolling shutters and rolling grills as IS: 6248.

11.1.11 Plinth Protection: As per tender drawing

11.1.12 Floor Finish: Flooring, including preparation of the surface, cleaning etc. shall be of cement concrete flooring as per IS: 2571 with ironite hardener.

11.1.13 Paint and Coating: Metal sheet shall be colour coated with total coating thickness of 40 microns (nominal) dry film thickness (DFT) comprising of silicon modified polyester (SMP with silicon content of 30% to 50%) paint or Super Durable Polyester (XRW) paint of 20 microns (nominal) on one side (exposed face) on 5-micron (nominal) primer coat and 10 microns (nominal) SMP or Super Durable Polyester paint over 5-micron (nominal) primer coat on other side (internal face). SMP and polyester paints system shall conform to Product type 4 as per AS/ANZ 2728. The structural steel shall be hot-dipped galvanized, conform to IS: 4759 or relevant Indian standard.

11.1.14 Lighting: The inverter room shall be provided with electric light to achieve an average illumination level of 150 Lux. However, room should be designed to utilize maximum natural light during the day.

11.1.15 Descriptions of PEB Structures:

Primary Members: Primary structural framing shall include the transverse rigid frames, columns, corner columns, end wall wind columns, beams, truss member, base pate.

Secondary Members: Secondary structural framing shall include the purlins, girts, eave struts, bracing, flange bracing, base angles, clips, flashings and other miscellaneous structural parts. Suitable wind bracings sag rods to be reckoned while designing the structure.

Sealant: Sealant used for cladding shall be butyl based, two parts polysulphide or equivalent approved, non-staining material and be flexible enough not to interface with fit of the sheets.

Closures: Solid or closed cell closures matching the profiles of the panel shall be installed along the eaves, rake and other locations

Flashing and Trim: Flashing and / or trim shall be furnished at the rake, corners, eaves, and framed openings and wherever necessary to provide weather tightness and finished appearance. Colour shall be matching with the colour of the wall. The material shall be 26 gauge thick conforming to the physical specifications of sheeting.

Gutters and Down Comers: Gutters shall be fabricated out of same metal sheet. Material shall be same as that of sheeting. Down comers shall be of galvanized steel pipes or PVC designed to ensure proper roof drainage system.

Group	Grade/Reference code	Yield strength (minimum) MPa	Tensile strength (minimum) MPa	Coating Class Designation	BMT (mm)	(+) ve Tolerance (mm)	Upper limit of BMT (mm)	(-) ve Tolerance (mm)	Lower Limit of BMT (mm)
I	G250/AS1397	250	320	Z275	0.6	.04	0.64	-0.04	0.56
	SS255/ASTM A653M	255	360						
	S250GD/EN10326	250	330						
II	G350/AS1397	350	420	AZ150	0.5	0.04	0.54	-0.04	0.46

	SS340 Class 4/ ASTM A792M	340	410						
	S350G D/ EN103 26	350	420						

All steel materials supplied by the Agency shall be in a sound condition, of recent manufacture, free from defects, loose mill scale, slag intrusions, laminations, pitting, flaky, rust, etc. and be of full weight and thickness specified.

12.0 VENDORS FOR PEB BUILDINGS

- 12.1 All the material required for pre-engineered (steel) building shall be procured from approved vendors as per list of compendium of vendors available on POWERGRID web site or any other reputed manufacturer for which prior approval shall be obtained from POWERGRID.
- 12.2 Shop/fabrication showing each and every detail along with bill of material for all members of structures, joints, nuts & Bolts, welding shall be prepared and approved by vendors as per standard practice of fabrication based on POWERGRID approved design and structural drawings. All materials brought for incorporation in works shall be of best quality as per IS unless specified otherwise.

13.0 GENERAL SPECIFICATION FOR BUILDINGS:

In case of CRB and PEB halls, most of the finishing items are explained in previous clauses, if any of items are missed or may be required for completion of the same, the below mentioned clauses may also be referred.

- 13.1 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.
- 13.2 Post constructional Anti termite treatment shall be carried out for all buildings as per DSR item no. 2.34 & 2.35. Anti termite chemical treatment shall be given to column pits, wall trenches, foundations of buildings, filling below the floors etc. as per IS: 6313 and other relevant Indian Standards.
- 13.3 Reinforced cement concrete with controlled water cement ratio as per IS-code shall be used for all underground concrete structures such as pump-house, tanks, and water retaining structures for achieving water-tightness.

- 13.4 FPS or Modular clay/fly ash-based Bricks having minimum 75 kg/cm² compressive strength can only be used for masonry work. Contractor shall ascertain himself at site regarding the availability of bricks of minimum 75 kg/cm² compressive strength before submitting his offer. However, Contractor can propose to use aerated concrete block or solid concrete blocks of compressive strength not less than 75kg/cm² without any cost implication to POWERGRID.
- 13.5 Full brickwork shall be provided with cement mortar 1:6 (1cement: 6 coarse sand). Half brick work masonry shall be provided with cement mortar 1:4 (1cement: 4coarse sand) and two no 6mm dia ms bar at every third course.
- 13.6 12mm cement plaster of mix 1:6 (1cement: 6 fine sand) shall be provided on the smooth side of internal walls. However rough side of walls shall be provided with 15mm cement plaster of mix 1:6 (1cement: 6 fine sand).
- 13.7 External plaster in two coats - 18mm Cement plaster in two coats under layer 12mm thick cement plaster 1:5 (1 cement: 5coarse sand) finished with a top layer 6mm thick cement plaster (1cement : 6 fine sand). External plastered surface shall be finished with white cement based putty of average thickness 1 mm, of approved brand and manufacturer to prepare the surface even and smooth. After putty the walls shall be finished with Premium Acrylic Smooth exterior paint of approved brand and manufacturer with Silicone additives of required shade (Two or more coats applied @ 1.43 ltr/ 10 sqm. over and including priming coat of exterior primer applied @ 2.20 kg/ 10 sqm).
- 13.8 6 mm thk. Cement plaster of mix 1:3 (1 cement: 3 fine sand) to RCC ceiling shall be done except areas where false ceiling are provided.
- 13.9 Internal walls shall be finished with Plaster of Paris putty of average thickness 2 mm, of approved brand and manufacture, over the plaster surface to prepare the surface even and smooth complete. In case plastered surface of buildings are covered under wall paneling, dado work, skirting etc. no putty and painting are required.
- 13.10 Internal walls shall be painted with minimum two coats of premium acrylic emulsion paint having VOC (volatile organic compound) content less than 50gm per litre of approved brand and manufacture including applying additional coats wherever required, to achieve even shade and colour over priming coat as per manufacturer specification/ recommendation.
- 13.11 Non - VOC premium acrylic emulsion paint having volatile organic compound content less than 50gm per litre of approved brand and manufacture shall be used wherever specified.
- 13.12 Painting with synthetic enamel paint of approved brand and manufacture of required colour to give an even shade shall be provided on the steel doors, flush doors and rolling shutters in various buildings or as specified in the drawings. Two or more coats over an under coat of suitable shade with primer paint of approved brand and manufacture.

- 13.13 Two or more coats of French spirit polishing with a coat of wood filler shall be provided on the wooden doors and frames.
- 13.14 Polished vitrified tiles in 60x60 cm size (thickness to be specified by the manufacturer) in flooring and skirting, with water absorption's less than 0.08% and conforming to IS: 15622 of approved make in all colours and shades, laid on cement mortar 20mm thick min. for flooring & 12mm thick for skirting 1:4 (1 cement: 4 coarse sand) including grouting the joints with white cement and matching pigments etc., complete.
- 13.15 Glazed Ceramic floor tiles 300x300mm (thickness to be specified by the manufacturer) of 1st quality conforming to IS:15622 of approved make in colours as approved by Engineer-in-charge in toilet and pantries area on 20mm thick min. cement mortar 1:4 (1 cement : 4 coarse sand) including grouting the joints with white cement and matching pigments etc., complete.
- 13.16 Granite stone of 18mm thick gang saw cut mirror polished pre-molded and pre-polished, machine cut for of required size of approved shade, colour and texture laid over 20mm thick base cement mortar 1:4 (1 Cement: 4 coarse sand) with joints treated with white cement, mixed with matching pigment, epoxy touch ups, including rubbing, curing molding and polishing to edge to give high gloss finish etc. complete for staircase.
- 13.17 Granite stone of flooring with 18mm thick gang saw cut mirror polished premoulded and prepolished, machine cut for of required size of approved shade, colour and texture laid over 20mm thick cement mortar 1:4. The joints are filled with jointing compound matching to the granite. Wherever granite is specified for the floor, 100mm granite skirting shall be provided with the walls. The granite outer surface shall be flushed to the plaster finish of the wall by molding / beveling of granite at top edge.
- 13.18 Granite counter of approved shade shall be provided and fixed with 18mm thick gang saw cut, mirror polished, premoulded and pre-polished, machine cut for pantry & kitchen platform facias and similar locations of required size, approved shade, colour & texture laid over 20mm thick base cement mortar 1:4 (1 cement : 4 Coarse sand) joints treated with white cement, mixed with matching pigment, epoxy touch ups, including rubbing, curing moulding and polishing to edges to give high gloss finish etc complete at all levels.
- 13.19 Ceramic glazed wall tiles of 1st quality conforming to IS: 15622 (thickness to be specified by the manufacture) of approved make in all colours, shades as approved by Engineer-inCharge in dados over 12mm thick bed of cement Mortar 1:3 (1 Cement: 3 Coarse sand) and jointing with grey cement slurry @ 3.3kg per sqm including pointing in white cement mixed with pigment of matching shade complete. Height of dado shall be 2.1m high in toilets, kitchen and pantry or elsewhere specified in the drawings or TS.

13.20 Rolling shutters shall be seamless galvalume motorized rolling shutters, with inclusion of features as under:

Slat material (Shutter curtain):	min. 1.0 mm steel slate (Galvalume)
Slat profiles	min. 100mm wide
Side guide	GI side guides min. 75mm Especially design guides with wind locks for high wind velocity exposed shutters. Nylofelt seals fitted on the shutter skin for frictionless movement within the guides.
Bottom profile	Aluminium bottom rail is provided with additional rubber seal for tight closing for prevention of dust entry.
Roller shaft	Roller shaft shall be heavy duty mild steel strong suspension tubular shaft without springs.
Side brackets	M.S. plate 3 mm to 10 mm as per the opening dimension.
Surface Finish & Painting	Primer and Duco paint (Matt finish)
Operations	Electrically operated with motor of suitable capacity along with manual operation by hand chain or hand crank for emergency

13.22 Circular/hexagonal M.S. sheet ceiling fan box shall be provided in the ceiling with clamp of internal dia. 140 mm, 73 mm height, 3 mm thick rim, top and bottom lid of 1.5 mm M.S. Sheet. Lids shall be screwed in to M. S. box by means of 3 mm round headed screws, clamps shall be made of 12 mm dia. M. S. bar bent to shape as per standard drawing with overall length as 80 cm.

13.23 Powder Coated (minimum thickness 50 micron) aluminium work for doors, windows, ventilators and partitions shall be provided and fixed in building with extruded built up standard tubular and other sections of approved make conforming to IS:733 and IS : 1285, fixed with rawl plugs and screws or with fixing clips, or with expansion hold fasteners including necessary filling up of gaps at junctions at top, bottom and sides with required

PVC/neoprene felt etc and joined mechanically wherever required including cleat angle, Aluminium snap beading for glazing / panelling, C.P. brass/ stainless steel screws including glazing and fittings as specified.

- 13.24 All doors except for toilet shall have 100mm 6 lever CP Brass mortice lock . Anodized aluminum handles of ISI marked and approved size shall be provided for all doors and windows as per requirement and instruction of E.I.C.
- 13.25 Cylindrical keyless lock of 25 mm diameter and 50mm diameter knob on both sides (ISI marked) shall be provided for toilets.
- 13.26 Kitchen door shall have 250x16mm C.P. brass sliding door bolt.
- 13.27 Door shall be provided with anodized aluminum tower bolt (barrel type) 250x10mm wherever door closers are not provided.
- 13.28 All windows shall have aluminum tower bolt (barrel type) 150x10mm as per requirement.
- 13.29 Double action hydraulic floor spring of approved brand and manufacture confirming to IS: 6315 having brand logo embossed on the body/plate with double spring mechanism and door weight upto 125 kg, for doors shall be provided and fixed at the following door including cost of cutting floors as required, embedding in floors and cover plates with brass pivot and single piece MS sheet outer box with slide plate etc. as per the direction of Engineer-in-charge. With stainless steel cover plate minimum 1.25 mm thickness.
- a. Main Entrance to Control Room Building
 - b. Control Room
- 13.30 Aluminium extruded section body tubular type universal hydraulic door closer (having brand logo with ISI, IS : 3564, embossed on the body) with double speed adjustment with necessary accessories and screws etc. complete to be provided in doors of control room building
- 13.31 Plinth protection 50 mm thick of cement concrete 1:2:4 (1 cement : 2 fine aggregate : 4 graded stone) aggregate 20 mm nominal size) shall be laid over 75 mm bed of dry brick ballast 40 mm nominal size well rammed and consolidated and shall be grouted with fine sand including finishing the top smooth. Minimum width of plinth protection shall be 1000 mm.
- 13.32 G.S. corrugated sheets of 0.80 mm thick with zinc coating not less than 275 gm/m² roofing shall be provided and fixed with G, I, J or L hooks, bolts and nuts 8mm diameter G, I plain and bitumen washers complete excluding the cost of purlins, rafters and trusses for water tank.

13.33 Angles 50x50x6 mm (minimum) with lugs shall be provided for edge protection all round cut outs/openings in floor slab.

13.34 Items/ components of buildings not explicitly covered in the specification but required for completion of the project shall be deemed to be included in the scope.

14.0 EXTERNAL WATER SUPPLY FROM BORE-WELL TO FIRE WATER TANK/CONTROL BUILDING:

14.1 The drawing for the water supply from bore-well to fire water tank/CRB shall be developed by the Contractor. Bore wells and pumps for water supply are in the scope of Contractor meeting the day-to day requirement of the water supply. 80 mm dia CPVC pipe shall be provided by the Contractor from the bore-well to the fire water tank. The underground pipe line shall be laid as per CPWD Specification. The ball valve, NRV etc. shall be provided as per requirement. From this pipe line a 25 mm dia tap off shall be connected by the Contractor to the roof water tank provided for the control room building.

14.2 The Contractor shall carry out all the external plumbing/erection works required for supply of water to the control room building, firewater tank beyond the single point as given at 14.1.

14.3 A scheme shall be prepared by the Contractor indicating the layout and details of water supply which shall be got approved from the Employer before actual start of work including all other incidental items not shown or specified but as may be required for complete performance of the works.

14.4 One Bore well is in the scope of Contractor.

15.0 SUBMISSION:

The following information shall be submitted for review and approval to the Employer:

15.1 Editable Soft as well as hard copies of structural design calculations and structural drawings (including construction/fabrication) for all reinforced concrete and structural steel structures.

15.2 Fully, dimensioned concept plan including floor plans, cross sections, longitudinal sections, elevations and perspective view of each building. These drawings shall identify the major building components. Auto cad drawings shall also be submitted.

15.3 Fully dimensioned drawings showing details and sections drawn to scales of sufficient size to clearly show sizes and configuration of the building components and the relationship between them.

- 15.4 Product information of building components and materials, including walls partition flooring ceiling, roofing, door and windows and building finishes to be submitted to EIC.
- 15.5 A door & window schedule showing door types and locations, door lock sets and latch sets and other door hardware. Approval of the above information shall be obtained before ordering materials or starting fabrication or construction as applicable.
- 16.0 MISCELLANEOUS REQUIREMENTS:
- 16.1 All joints including construction and expansion joints for the water retaining structures (RCC tank for Fire Fighting and underground water tank) shall be made water tight by using PVC ribbed water stops with central bulb. The minimum thickness of PVC water stops shall be 5 mm and minimum width shall be 230 mm.
- 16.2 All mild steel parts used in the firefighting water tank and underground water tank shall be hot-double dip galvanised. The minimum coating of the zinc shall be 750 gm/sq. m. for galvanised structures and shall comply with IS:2628 and IS:2633. Galvanizing shall be checked and tested in accordance with IS: 2633. The galvanizing shall be followed by the application of an etching primer and dipping in black bitumen in accordance with BS: 3416. The structural steel provided for roofing shall have enamel paint of approved shade two or more coat to give even shade over steel primer.
- 16.3 Angles 50x50x6 mm (minimum) with lugs shall be provided for edge protection all round cut outs/openings in floor slab.
- 16.4 For sump pit of switch yard Horizontal type submersible type pump as per BOQ rating having level switch shall be provided.
- 16.5 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.
- 16.6 Items/ components of buildings not explicitly covered in the specification but required for completion of the project shall be deemed to be included in the scope.
- 16.7 **CABLE TRANSIT SYSTEM**
Modular multi-diameter cable sealing system consisting of frames, blocks and accessories shall be installed where the underground and over ground cables enter or leave concrete bay kiosks/switchyard panel room & control rooms. Cable transit system shall consist of multi-diameter type peel-able/adjustable blocks of different sizes to suit the various cables. It should be simple, easy and quick to assemble & re-assemble the cable sealing system. Solid blocks shall not be used on frame. Frames & stay-plate material shall be of galvanized steel and for compression single piece wedge with galvanized steel bolts shall be used. 30% spare

blocks of all sizes on the frame shall be provided for expansion in future. Cable sealing system should have been tested for fire/water/smoke tightness.

16.8 For communication Room GI Pipe of 40 mm dia shall be laid below floor to extend communication cable coming from switchyard via ACDB/DCDB Room.

17.0 INTERFACING:

The proper coordination & execution of all interfacing civil works activities like fixing of conduits in roofs/walls/floors, fixing of foundation bolts, fixing of lighting fixtures, fixing of supports/embedment, provision of cut outs etc. shall be the sole responsibility of the Contractor. He shall plan all such activities in advance and execute in such a manner that interfacing activities do not become bottlenecks and dismantling, breakage etc. is reduced to minimum.

18.0 STATUTORY RULES:

18.1 Contractor shall comply with all the applicable statutory rules pertaining to factories act (as applicable for the State), Fire Safety Rules of Tariff Advisory Committee, Water Act for pollution control etc.

18.2 Statutory clearance and norms of State Pollution Control Board shall be followed as per Water Act for effluent quality from plant.

18.3 Requirement of sulphate resistant cement (SRC) for sub structural works shall be decided in accordance with the Indian Standards based on the findings of the detailed soil investigation. In case sulphate resistant cement is used as per requirement, differential cost between sulphate resistant cement and PPC cement shall be payable as an extra item.

18.4 All building/construction materials shall conform to the best quality specified in CPWD specifications if not otherwise mentioned in this specification.

18.5 All tests as required in the standard field quality plans have to be carried out without any financial implication to employer.

19.0 CONTOURING AND SITE LEVELLING WORK

19.1 SCOPE OF WORK AND GENERAL CONDITION

This specification shall apply to contouring and site levelling works as are required to be executed under the Contract or otherwise directed by the Engineer-in-Charge. All testing shall be carried out as per standard field quality plan of POWERGRID.

Site levelling work shall consist of clearance of site, excavation in all kinds of soils, soft/disintegrated rock, hard rock, dewatering, transporting of excavated earth, filling, consolidation of earth, levelling benching, giving slopes and making formations, levelling operations, removal and satisfactory disposal of unsuitable materials necessary for achieving desired formation level, if required, in accordance with the requirements of the specifications and the lines, grades and cross-sections shown in the drawings or indicated by the Engineer-in-Charge. The work shall include the hauling and stacking of or the hauling to levelling site, of suitable materials as required, as also the disposal of unsuitable materials in specified manner; and the trimming and finishing of works.

This work also includes cutting of diversion channel to prevent the area from flooding and construction of kuchcha surface drains for drainage of the area.

The quality of work and materials shall comply with the requirements set forth in the succeeding sections. Where the drawings and Specifications describe a portion of the work only in general terms, and not in complete details, it shall be understood that only the best general practice is to prevail, materials and workmanship of the best quality are to be employed and the instructions of the Engineer-in-Charge are to be fully complied with.

The work to be performed under this specifications consists of providing all labour, supervision, materials, planking and strutting, power, fuel, construction equipments, tools and plants, supplies, transportation, blasting materials if required, storage, insurance, royalty and all incidental items not shown or specified by reasonably implied or necessary for successful completion of work including contractor's supervision and in strict accordance with drawing and specifications.

The scope may however vary based on the specific requirement of various works/site, which shall be specified by the Owner.

The work shall be executed according to approved drawings with additions, alterations and modifications made from time to time as required or approved by the Engineer-in-Charge and also according to any other drawings that would be supplied to the Contractor progressively during the execution of the Contract.

Construction traffic shall not use the levelled area without prior permission of the Engineer-in-Charge. Any damage arising out of such use shall be made good by the Contractor at his own expense.

The words like Contract, Contractor, Engineer-in-Charge, Drawings, Owner, works, site used in this Specifications shall be considered to have the meaning as understood from the definition of these terms included in the General Conditions of Contract.

19.2 PRESERVATION OF PROPERTY/AMENITY:

The Contractor shall undertake all reasonable precautions for the protection and preservation of Trees, shrubs, any other plants, pole lines, fences, signs, monuments, buildings, pipelines, sewers or other subsurface drains, pipes, conduits and any other structures under or above ground, which may be affected by construction operations and which in the opinion of the Engineer-in-Charge shall be continued in use without any change.

The Contractor shall provide and install at his own expenses, suitable safeguards approved by the Engineer-in-Charge for this purpose. However, if any of these objects is damaged by reason of the Contractor's negligence, it shall be replaced or restored to the original condition without any financial implication to POWERGRID.

19.3 DISPOSAL OF MATERIALS:

All materials arising from jungle clearing, grubbing operation, all type of excavation etc. shall be the property of Power Grid and shall be disposed of by the Contractor as hereinafter provided or directed by the Engineer-in-Charge within a lead of 2000 m beyond the periphery of plot area. Also boulders, stones and other materials usable shall be neatly stacked.

All products of clearing and grubbing which in the opinion of the Engineer-in-Charge cannot be used or auctioned shall be cleared away to waste areas and burnt, if so desired, at locations away to a lead mentioned above in a manner as directed. Care shall be taken to see that unsuitable waste materials are disposed of in such a manner that there is no likelihood of these getting mixed up with the materials meant for filling.

Where the excavated material is directed to be used in the filling area, it shall be directly deposited at the required location complying with the total requirements. All disposed material other than hard material shall be spread in layers at the places within specified leads.

All hard materials, such as hard moorum, rubble, etc., not intended for use in the filling, shall be stacked neatly as directed by the Engineer-in-Charge, for future use.

Unsuitable and surplus materials not intended for use in any part of the works shall be disposed off.

19.4 SITE CLEARANCE

The work shall consist of numbering of trees, removing and disposing of all materials such as trees, bushes, woods, shrubs, grass, stumps, rubbish, rank vegetation, roots, foreign materials, etc., which in the opinion of the Engineer-in-Charge are unsuitable for incorporation in the works, from within the limits and areas as may be specified by the Engineer-in-Charge.

As directed by the Engineer-in-Charge all trees measured at one metre above the ground level shall also be cut and useful portion of the trees so cut shall be stacked at a suitable place as directed by the Engineer-in-Charge and shall be considered incidental to clearing and grubbing operations.

The roots of trees shall be dug up to 60 cm below the ground level or 15 cm below formation level whichever is deeper and after removal of all vegetable and organic matter from the holes so formed by removal of the roots, holes and hollows shall be filled with good earth in layer of 20 cm, well rammed, consolidated and levelled.

The serviceable and unserviceable materials obtained from the site clearance shall be removed from the area and disposed of to a place as per the directions of the Engineer-in-Charge.

Clearing and grubbing item is not payable and the same shall be deemed to be included in the earth work in excavation and filling.

19.5 CLASSIFICATION OF EXCAVATED MATERIALS:

All materials involved in excavation shall be classified in the following groups:

19.5.1 ALL KIND OF SOILS AND SOFT/DISINTEGRATED ROCK

The material which can be quarried/excavated with pick, shovels, jumpers, scarifiers, crowbars etc. and other mechanical implements. All materials involved under this classification are as below:

All kind of soils includes various types of soils, plain concrete, shingle and river or nallah bed boulders, soling of road, paths and hard core, macadam surface of any description, stone masonry below the ground level, soft conglomerate and laterite stone which can be detached from the matrix with picks and shovel.

Soft/disintegrated Rock (Not requiring blasting): Rock and boulders which may be quarried and split with crow bars and other mechanical implements etc. It includes limestone, sandstone, hard conglomerate.

19.5.2 HARD ROCK:

All kind of rocks which can be excavated by machines and requires blasting chiselling in edging or in another agreed method. This can be classified under the following categories:

a) Hard Rock (Requiring Blasting)-This shall comprise:

- i) Any rock for the excavation of which the use of mechanical plant or blasting is required;

- ii) Reinforced cement concrete (reinforcement cut through but not separated from the concrete) below ground; and
- iii) Boulder requiring blasting.

b) Hard Rock (Blasting Prohibited)

Hard rock requiring blasting as described under (a) above but where blasting is prohibited for any reason and excavation has to be carried out by chiselling, wedging or any other agreed method.

19.5.3 AUTHORITY FOR CLASSIFICATION EXCAVATION:

The classification of excavation shall be decided by the Engineer-in-Charge and his decision shall be final and binding on the Contractor. Merely the use of explosives in excavation will not be considered as a reason for higher classification unless blasting is clearly necessary in the opinion of the Engineer-in-Charge.

19.6 SITE LEVELLING OPERATIONS:

19.6.1 SETTING OUT AND MARKING PROFILES.

After the site has been cleared, the limits of site levelling shall be set out true to lines, curves, slopes, grades and sections as shown on the drawings or as directed by the Engineer-in-Charge. The Contractor shall provide all labour, survey instruments and materials such as strings, pegs, nails, bamboos, stones, lime, mortar, concrete, etc., required in connection with the setting out of works and establishment of bench marks. A grid system of co-ordinates shall be established by the Contractor at the site. The Contractor shall be responsible for the maintenance of permanent reference pillars, bench marks and other marks and stakes as long as in the opinion of the Engineer-in-Charge they are required for the work. All such marks/pillars shall be removed by the Contractor at his own cost as soon as the purpose is over.

Masonry pillars shall be erected at suitable places in the area to serve as bench marks for the execution of the work. These bench marks shall be connected with G.T.S. of any other permanent bench mark approved by the Engineer-in-Charge. Necessary profiles with pegs, bamboos and strings or "Burgeis" shall be made to show the correct formation levels before the work is started and the same shall be approved by the Engineer-in-Charge. The contractor shall supply all labour, tools, equipment, materials, safeguards and incidentals necessary for setting out and making profiles and burgeis & pillars for the work at his own cost. The profiles and burgeis shall be maintained during the execution of the work.

Marks/pillars shall invariably be diagonal unless otherwise directed, and should be such that their average height is representative of average depths. Payments will be made on the basis

of volume measurement after with-holding the amount corresponding to 5% of the volume of earth work on account of non-removal of marks/pillars.

The Contractor shall have to remove the marks/pillars and utilise the earth spoils as per the directions of the Engineer-in-Charge. The withheld amount as stated in the above paragraph may be paid after certification of the Engineer-in-Charge; regarding his full satisfaction and to the effect that the mark/pillars, etc. have been removed and soils/earth thereof has been utilised as directed by him.

If the contractor fails to remove, partly or fully the marks/pillars in the manner and within the period as aforesaid double the amount spent by the owner for removal of marks/pillars will be recovered from dues payable to the contractor.

19.6.2 EXCAVATION AND FILLING

All excavations shall be carried out in conformity with the directions laid herein under and in a manner approved by the Engineer-in-Charge. The work shall be so done that the suitable materials available from excavation are satisfactorily utilised as decided upon before disposal.

While planning or executing excavation, the Contractor shall take all adequate precautions against soil erosion, water pollution, air pollution etc.

The excavations shall conform to the lines, grades, side slopes and levels shown on the drawings or directed with a negative tolerance of 100mm. The Contractor shall not excavate outside the slopes or below the established grade or loosen any material outside the limits of excavation. Subject to the permitted tolerances, any excess depth excavated below the specified levels shall be made good at the cost of the Contractor with suitable material of similar characteristics and compacted to the required density and to the satisfaction of the Engineer-in-Charge.

All debris and loose material on the slopes of cuttings shall be removed.

Cutting shall be done from top to bottom. Under no circumstances undermining or undercutting shall be allowed. Final surface shall be neatly dressed. The earth from cutting shall be directly used for filling and no extra claim for double handling of earth shall be admissible to the contractor.

If cutting be taken deeper, it shall be brought to the required level as per the instructions, by filling it with the earth and duly consolidating at the Contractor's cost.

Filling shall be done in regular horizontal layers not exceeding 20 cm. in depth. The earth shall be free from all roots, grass, rubbish and humps and clods exceeding 80mm in any direction shall be broken. Each layer shall be consolidated by breaking clods and Compacting each layer with wooden /steel rammer or movement of dozers, trucks or 8/10 tonne power

road rollers, sheep foot roller and vibratory compactors etc. so that compaction of 95% of the maximum dry density is achieved at optimum moisture content. The surface finished shall be neatly dressed to the required formation levels with tolerance of (\pm) 100 mm.

Tests for Compaction are to be performed as per the procedures laid down in the relevant I.S. Codes of practice and Standard Field Quality Plan of POWERGRID. In cases of compaction below the stipulated percentage, the contractor shall adopt proper techniques as directed by the Engineer in-Charge and to his satisfaction to ensure the specified degree of compaction. The cost of tests to be performed shall be borne by the Contractor.

During the execution of work, natural drainage of the area shall be maintained by the contractor.

19.6.3 HARD ROCK EXCAVATION

Hard Rock, when encountered during excavation, shall be removed up to the finished ground level or as indicated on the drawings. In all cases, the excavation operations shall be so carried out that at no point on cut formation the rock protrudes above the specified levels, provided, however, that a negative tolerance of 150 mm shall be permissible.

Slopes in rock cutting shall be finished to uniform lines corresponding to slope lines shown on the drawings or as directed by the Engineer-in-Charge. Notwithstanding the foregoing, all loose pieces of rock on excavated slope surface which move when prised by a crowbar shall be removed.

Blasting shall be carried out as per relevant clause mentioned elsewhere in this specification and all precautions indicated therein to be observed.

19.6.4 DEWATERING

If water is met with in the excavation due to stream flows, springs, seepage, rain or other causes, it shall be removed by suitable diversions, pumping or bailing out and other excavation kept dry whenever so required or directed by the Engineer-in-Charge, Care shall be taken to so discharge the drained water as not to cause damage to the works, crops or any other property. No extra payment shall be admissible to the contractor on this account.

19.6.5 FINISHING OPERATIONS

Finishing operations shall include the work of properly shaping and dressing all excavated surfaces. When completed, no point on the slopes shall vary from the designated slopes by more than 150 mm measured at right angles to the slope, except where excavation is in rock where no point shall vary more than 600 mm from the designated slope. In no case shall any portion of the slope encroach on the road way.

19.7 EARTH FILL MATERIAL:

19.7.1 SUITABLE MATERIAL

The borrowed earth used in filling shall be free from all roots, grass, shrubs, rank vegetation, brush wood, tree sapling and rubbish.

19.7.2 UNSUITABLE MATERIAL

Unsuitable material shall mean materials unsuitable for placing as fill in the works and shall comprise:

- a) Material from swamps, marshes and bogs;
- b) Peat, logs, stumps and perishable materials;
- c) Material susceptible to spontaneous combustion;
- d) Any natural material or industrial and domestic produce which will adversely affect other materials in the work;
- e) Clay with liquid limit exceeding 80% and/or plasticity index exceeding 55%.
- f) Boulders having sizes more than 80mm.

19.7.3 SPREADING AND COMPACTION OF FILLING

For the earth works contractor shall satisfy the Engineer-in-Charge that the entire specified requirement regarding compaction can be achieved. Testing shall be carried out as per standard field quality plan of POWERGRID.

The Final formation shall be correct in level and profile after compaction.

In the case of earth work consolidated under optimum moisture conditions, each layer of earth shall be carefully moistened to give field moisture content of about + 1% to - 2% of the optimum moisture content (OMC). The OMC shall be determined according to IS: 2720 (Pt.VII & VIII) Methods of Tests for Soils.

Each layer shall then be compacted by rolling with wooden/ steel rammer or movement of dozers, trucks, 8/10 tonnes power road roller, sheep foot roller and vibratory compactors/roller. The required amount of water shall be added during consolidation to keep the moisture content of the soil at the optimum as per test. The density to be achieved for each layer of the material shall not be less than 95% of the density obtained in the laboratory (Proctor Method).

Control on compaction in the field shall be exercised through frequent moisture content and density determinations. A systematic record of these shall be maintained. At all times during construction the top of the embankment shall be maintained at such cross fall as will shed water and prevent pounding.

19.8 BLASTING OPERATIONS.

19.8.1 GENERAL

Blasting shall be carried out only with the written permission of the Engineer-in-Charge. All the statutory laws, regulations, rules, Indian Standards, etc., pertaining to the acquisition, transport, storage, handling and use of explosives shall be strictly followed.

The Contractor may adopt any method or methods of blasting consistent with the safety and job requirements, after approval from the Engineer-in-Charge and shall muffle the blasting adequately to the satisfaction of the Engineer-in-Charge. Blasting should be carried out as far as possible with the help of Ammonium Nitrate mixed with proper proportions of fuel oil which is a safer method. However, in the event of its nonavailability the convenient practice of using gelatine with detonators can be resorted to.

The magazine for the storage of explosives shall be built to the designs and specifications of the Explosives Department concerned and located at the approved site. No unauthorised person shall be admitted into the magazine which when not in use shall be kept securely locked. No matches or inflammable material shall be allowed in the magazine. The magazine shall have an effective lightning conductor. The following shall be hung in the lobby of the magazine.

- a) A copy of the relevant rules regarding safe storage both in English and in the language with which the workers concerned are familiar,
- b) A statement of up to date stock in the magazine,
- c) A certificate showing the last date of testing of the lightning conductor,
- d) A notice that smoking is strictly prohibited.

In addition to these, the Contractor shall also observe the instructions in following clauses and any further additional instructions which may be given by the Engineer-in-Charge and shall be responsible for damage to property and any accident which may occur to workmen or the public or the materials on account of any operations and blasting. The Engineer-in-Charge shall frequently check the Contractor's compliance with these precautions.

19.8.2 MATERIALS, TOOLS AND EQUIPMENT.

All the materials, tools and equipment used for blasting operations shall be of approved type and shall be arranged by the contractor from any authorised dealer of such approved material. Necessary assistance in the form of approval for procurement of the material shall be given by the Corporation. The contractor shall be fully responsible for entering into the agreement with any authorised magazine contractor in respect of rates, regularity of supply, etc. the Engineer-in-Charge may specify the type of explosives to be allowed in special cases. The fuse to be used in wet locations shall be sufficiently water-resistant as to be unaffected when immersed in water for 30 minutes. The rate of burning of the fuse shall be uniform and definitely known to permit such a safe length being cut as will permit sufficient time to the firer to reach safety before explosion takes place. Detonators shall be capable of giving effective blasting of the explosives. The blasting powder, explosives, detonators fuses, etc.,

shall be fresh and not damaged due to damp, moisture or any other cause. They shall be inspected before use and damaged articles shall be discarded totally and removed immediately.

19.8.3 PERSONNEL

The blasting operation shall remain in the charge of competent and experienced supervisor and workmen who are thoroughly acquainted with the details of handling explosives and blasting operations.

19.8.4 BLASTING OPERATIONS.

The blasting shall be carried out during fixed hours of the day preferably during the midday lunch hour or at the close of the work as ordered in writing by the Engineer-in-Charge. The hours shall be made known to the people in the vicinity. All the charges shall be prepared by the man in charge only. Proper precautions for safety of persons and property shall be taken.

Red danger flags shall be displayed prominently in all directions during the blasting operations. People, except those who actually light the fuse shall be prohibited from entering this area. The flags shall be planted 200 metres from the blasting site in all directions and all persons including workmen shall be excluded from the flagged area at least 10 minutes before the firing, a warning whistle being sounded for the purpose. The charge holes shall be drilled to required depths and in suitable places. Blasting should be as light as possible consistent with thorough breakage of the material necessary for economic loading and hauling. Any method of blasting which leads to overshooting shall be discontinued.

When blasting is done with powder, the fuse cut to the required length shall be inserted into the hole and the powder dropped in. The powder shall be gently tamped with copper rods with rounded ends. The explosive powder shall then be covered with tamping material which shall be tamped lightly but firmly.

At a time, not more than 10 such charges will be prepared and fired. The man in charge shall blow a whistle in a recognised manner for cautioning the people. All the people shall then be required to move to safe distances. The charges shall be lighted by the man in charge only. The man in charge shall count the number of explosions. He shall satisfy himself that all the charges have been exploded before allowing the workmen to go back to the work site. When blasting is to be carried out in the proximity of other existing structures, sand/earth bags, etc. shall be used on the top of the blast holes to prevent the rock fragment from causing damage to the structures.

However, when blasting is prohibited for any reasons the excavation shall be carried out by chiselling, wedging or any other agreed method.

19.8.5 MISFIRE

In case of misfire, the following procedure shall be observed:

- i) Sufficient time shall be allowed to account for the delayed blast. The man in charge shall inspect all the charges and determine the missed charges.
- ii) If it is the blasting powder charge it shall be completely flooded with water. A new hole shall be drilled at about 45 cm. from the old hole and fired. This should blast the old charge. Should it not blast the old, the procedure shall be repeated till the old charge is blasted.
- iii) If a misfire has been found to be due to defective detonator, the whole quantity in the box from which defective article was taken must be sent to the authority directed by the Engineer-in-Charge for inspection to ascertain whether all the remaining materials in the box are also defective.

19.8.6 ACCOUNT.

A careful and day to day account of the explosives shall be maintained by the Contractor in an approved register and manner which shall be open to inspection by the Engineer-in-Charge at all times.

19.9 RECORDING OF MEASUREMENTS

The ground levels shall be taken at every 5 metres distance and at closer distances where pits, undulations, etc. are met with. The ground level shall be recorded in field book, plotted on plans and shall be signed by contractor and the Engineer-in-Charge before the earth work is started.

The levels of the area after excavation shall be recorded in the field book duly signed by the Engineer-in-Charge and contractor. The labour, materials, tools, equipment, safeguards and incidentals required for taking levels shall be supplied by the contractor at his own cost.

All measurements shall be made in the metric system. Different items of work shall be measured in accordance with the procedures set forth in the relevant sections.

All measurements and computations, unless otherwise indicated, shall be carried nearest to the following limits:

- | | |
|---------------------------------------|--------------------------|
| a) Length and breadth | -- 10 mm |
| b) Height, depth or thickness of work | -- 5 mm |
| c) Area | -- two places of decimal |
| d) Cubical qty. | -- two places of decimal |

20.0 MODE OF MEASUREMENT (if applicable)

Mode of measurement for different items is given below, however, in case of any ambiguity relevant part of IS: 1200 (latest) shall be referred.

20.1 EARTHWORK

This shall include excavation in all kinds of soil including rock, all leads and lifts including back filling, compacting, dewatering (if required) and disposal of surplus earth/ rock to a suitable location within a lead up to two km. Excavation or dismantling of lean concrete shall be measured under this item. The quantity of excavation for foundations of towers, equipment structures, all transformers, firewall, cable trenches, water tank, reactors, buildings, marshalling kiosks, underground water tanks and covered car parking shall only be measured. The quantity of excavation for roads, rail cum road, drains, culverts, rainwater harvesting, septic tank, soak pit, external water supply system, site surfacing, chain link fencing (including gate) shall not be measured separately and shall be deemed to be included in the composite rates quoted by the bidder for the respective works. All other excavation required for the completion of the work including fixing of lamp posts/ electric poles, plinth protection, flooring, sewerage system, manholes, pipes, earth mat, pipe support etc. shall also not be paid for. The measurement of excavation for all concrete works shall be made considering dimension of the pit keeping 150mm gap around the base pad (lean concrete) or actually excavated pit, whichever is less. For hard rock excavation, the volume of hard rock shall be computed on the basis of stacks of excavated rubble after making 50% deduction for voids. The unit of measurement shall be in cubic meter. The unit rate shall include stacking, disposal of excavated material for leads up to 2000 meters beyond the levelling boundary.

The quantity shall be measured in cubic meters as per following details:

- a) Excavation in all kind of soil including soft/ disintegrated rock, PCC, WBM, Brickwork/ stone masonry etc (excluding hard rock).
- b) Excavation in hard rock (required blasting)

20.2 PLAIN CEMENT CONCRETE (PCC)

Providing and laying Plain Cement Concrete of all types and at all locations including all leads and lifts. The quantity shall be measured in cubic meters as per lines and levels indicated in the drawings.

20.2.1 PCC 1:2:4 (1 cement : 2 fine aggregate : 4 coarse aggregate 20 mm nominal size) shall be measured in flooring of buildings, plinth protection, fencing, transformer foundation, reactor foundation, rail track, drain, culverts, septic tank, chain link fencing, gate etc. as indicated in the drawings.

20.2.2 PCC 1:3:6 (1 cement : 3 fine aggregate : 6 stone aggregate, 40mm nominal size) shall be measured below all foundations including buildings, underground water tanks, covered car parking cable trench, roads, under flooring, rail-cum-road, transformer foundation, reactor foundation, drain, water tank, culverts, gate, tower/equipment etc. as indicated in the drawings.

20.2.3 PCC 1:4:8 (1 cement : 4 fine aggregate : 8 stone aggregate, 40mm nominal size) shall be measured below all foundations including buildings, underground water tanks, covered car parking cable trench, roads, under flooring, rail-cum-road, transformer foundation, reactor foundation, drain, water tank, culverts, gate, tower/equipment etc. as indicated in the drawings.

20.2.4 PCC 1:5:10 (1 cement: 5 fine aggregate: 10 brick aggregate/ stone aggregate 40mm nominal size) shall be provided for site surfacing in switchyard. This shall include providing and laying cement slurry in case of site surfacing in switchyard.

All other PCC required for the completion of the work including hold fasts of doors/windows/rolling shutters, fixing of plumbing pipes, bedding concrete for sewer lines, embedment of electrical conduits, water proofing of roof etc. shall not be measured and deemed to be included in the composite rates quoted by the bidder for respective works. Water proofing compound wherever specified shall be added without any extra cost.

20.3 RCC

Measurement of reinforced cement concrete at all locations shall be made and shall include all leads, lifts, formwork, grouting of pockets and underpinning. This shall also include pre-cast RCC work and addition of water proofing compound & admixtures wherever required for which no additional payment shall be made. The quantity shall be measured in cubic meters as per lines and levels indicated in the drawings. No deduction shall be made for volume occupied by reinforcement/inserts/sleeves and for openings having cross-sectional area up to 0.1 sq.m.

20.4 REINFORCEMENT STEEL

Reinforcement shall be measured in length (actual or theoretical as per drawing whichever is less) including hooks, if any, separately for different diameters as actually used in work, excluding overlaps. From the length so measured, the weight of reinforcement shall be calculated in tons on the basis of sectional weights as adopted by Indian Standards. Wastage, overlaps, couplings, welded joints, spacer bars, chairs, stays, hangers and annealed steel wire or other methods for binding and placing shall not be measured and cost of these items shall be deemed to be included in the rates for reinforcement.

20.5 STONE FILLING

Measurement of stone (40-60mm size) for transformer/ reactor foundations shall be made as per theoretical volume of the space to be filled in the transformer foundation as per drawings. This shall be measured in cu.m. no voids shall be deducted.

20.6 MISCELLANEOUS STRUCTURAL STEEL

Measurement for Supply, fabrication, transportation and erection of all miscellaneous structural steel work for mono rails (RS joists), rails for transformers/ reactors, trusses, frame work, purlins, gratings including factory made electro forged gratings, steel tubes, built up sections along with all other steel fittings and fixtures, inserts and embedment in concrete

shall be made as per drawings. The unit rate for this item shall be inclusive of cutting, grinding, drilling, bolting, welding, pre- heating of the welded joints, applying a priming coat of steel primer / anti corrosive bitumastic paint/ synthetic enamel paint etc. wherever specified (For gratings and its supports epoxy zinc phosphate primer shall be used) setting of all types of embedment in concrete, etc. Steel required for foundation bolts & fasteners (other than towers and equipment support structures), doors, windows, ventilators, louvers, rolling shutters, chain link fencing, gratings in drains, soil pipes, plumbing pipes, floor traps, embedment's required for rainwater harvesting, septic tank, soak pit, roof truss and purlins required for fire water tank, steel structures of PEB buildings, etc. shall not be considered for payment and measurements. Quantity shall be measured in MT.

20.7 ROADS

20.7.1 The measurement for the concrete road shall be made on the basis of area in square meter (M²) of top concrete completed surface of the road and shall be deemed to include all items such as earth work (excavation, disposal etc.), compaction, rolling, watering, WBM, Kerb stone, grating, shoulder, 100mm dia RCC Hume pipe to be provided at every 100M etc where ever indicated complete as per drawing. Concreting all type and reinforcement shall be measured and paid separately under relevant items mentioned else where in this specification. Usage of WMM in place of WBM shall be done with approval of employer without any additional financial implication.

20.7.2 The measurement of bituminous road shall be made on the basis of area in square meter (M²), of the top bituminous completed surface of the road and shall include all items such as earth work (excavation, disposal etc.), compaction, rolling, watering, WBM, Kerb stone, grating, shoulder, 100mm dia RCC Hume pipe to be provided at every 100M etc where ever indicated complete as per drawing including premix carpet etc complete .Usage of WMM in place of WBM shall be done with approval of employer without any additional financial implication.

20.7.3 Interlocking concrete tiles required to be provided on the shoulders of the road shall be measured in square meter (M²) and paid separately under relevant item.

20.8 ANTIWEED TREATMENT

The measurement shall be done for the actual area in square metres of antiweed treatment which will include supplying required chemicals and doing the treatment complete in all respect as per the specification for the specified area.

20.9 STONE SPREADING IN SWITCHYARD

The measurement shall be done for the actual area in square meters of stone spreading in the switchyard which will include supplying and laying of 100mm thickness of stone aggregate as per specification for the specified area.

20.10 CHAIN LINK FENCING AND GATE

The measurement shall be made in running metres of the fence provided as per drawing. The rate shall be inclusive of post, wire mesh, MS Flat etc. complete. All concrete shall be measured and paid under relevant item. The gate shall be measured in numbers.

20.11 CABLE TRENCH CROSSING AND ROAD CULVERTS THROUGH HUME PIPES

Cable trench crossings and road culverts shall be measured by length (in running meters) of individual Hume pipe which will be laid as per the drawings. The item shall be inclusive of earth work (excavation, backfilling, disposal etc.), laying, back filling, jointing, brickwork, plastering etc complete in all respect but excluding concrete (all type) which will be measured and paid separately under respective items.

20.12 BUILDINGS:

20.12.1 RCC FRAMED STRUCTURE BUILDINGS:

Payment for item shall be made on plinth area basis. However, the quantity of earth work (excavation, backfilling, disposal etc.), concrete (all type), reinforcement steel shall be measured and paid as per relevant clauses as described above. The rest of the entire work (including internal & external finishing), stone soling for flooring, plinth protection, drain along plinth protection, electrical conduit & junction boxes, fan boxes, cable transit system etc. required to complete the building in all respect as per the drawings furnished by the Employer shall be deemed to be included in the plinth area rate. Plinth area shall be calculated based on IS 3861-2002.

20.12.2 PRE-ENGINEERED STEEL BUILDINGS:

The quantity of earth work (excavation, backfilling, disposal etc.), concrete (all type), reinforcement steel shall be measured & paid separately as per relevant clauses as described above. Plinth area shall be calculated based on IS 3861-2002. However, payment for remaining finishing items a), b) & c) shall be made on plinth area basis for each building including internal foundations, cable trenches, internal & external finishes, stone soling for flooring, plinth protection, drain along plinth protection, electrical conduit & junction boxes, fan boxes, cable transit system, miscellaneous structural steel required for seating of equipments, cable supports in cable trenches, chequered plates etc inside building. complete in all respect.

20.12.3 EXTENSION OF RCC /PEB BUILDINGS:

The quantity of earth work (excavation, backfilling, disposal etc.), concrete (all type), reinforcement shall be measured and paid as per relevant clauses as described above. Plinth area shall be calculated based on IS 3861-2002. However, payment for above items a), b) & c) shall be made on plinth area basis for each building including internal foundations, cable trenches, internal & external finishes, stone soling for flooring, plinth

protection, drain along plinth protection, electrical conduit & junction boxes, fan boxes, cable transit system wall dismantling works, miscellaneous structural steel required for seating of GIS equipments, cable supports in cable trenches, chequered plates etc inside GIS building complete in all respect.

20.12.4 INTERNAL ELECTRIFICATION AND FIRE FIGHTING:

Payment for internal electrification as well as internal firefighting works is not included in items covered in clauses above and shall be paid as per relevant clauses and BPS. However, conduit, junction boxes, surface boxes for electrification, cable transit system is deemed to be included in the building items.

20.13 RAIN WATER HARVESTING

This is a lump sum item. The Contractor shall be required to complete the work in all respect as per drawings furnished by the Employer. All the items including earth work (excavation, backfilling, disposal etc.), miscellaneous steel, brick work, fillings of boulders, gravel, sand, pipes etc. shall be deemed to be included in this lump sum rate. However, the concrete (all types) and the reinforcement shall be measured and paid under the relevant clauses as mentioned above.

20.14 RAIL CUM ROAD

The measurement for the rail cum road shall be made in square metres of top concrete completed surface of the rail cum road and shall include all items such as earth work (excavation, backfilling, disposal etc.), compaction, rolling, watering, WBM etc. complete as per drawing but excluding concrete (all type), reinforcement, structural steel and rails. Usage of WMM in place of WBM shall be done with approval of employer without any additional financial implication.

20.15 SEPTIC TANK AND SOAK PIT

This is a lump sum item. The Contractor shall be required to complete the work in all respect as per drawings furnished by the Employer. All the clause including earth work (excavation, backfilling, disposal etc.), masonry work, all types of fillings, all types of pipes including plumbing and vent pipes, all type of fittings etc. shall be deemed to be included in this lump sum rate. However, the concrete (all types) and the reinforcement shall be measured and paid under the relevant clauses mentioned above.

20.16 FIRE WATER TANK

This is a lump sum item. The Contractor shall be required to complete the work in all respect as per drawings furnished by the Employer. All the items including, compaction, brick work, roof truss, purlins, roofing, all types of miscellaneous steel, internal and external plastering,

painting etc. shall be deemed to be included in this lump sum cost. However, concrete (all types) and reinforcement shall be measured and paid under the relevant clauses as mentioned above.

20.17 EXTERNAL WATER SUPPLY FROM BORE-WELL TO FIRE WATER TANK, CONTROL ROOM BUILDING:

The external water supply from Bore-well shall be measured in running meters of pipe of various diameters. It shall include all the items such as earth work (excavation, backfilling, disposal etc.), piping, pipe fittings, painting, brickwork, sand filling, concrete, valves, chambers cutting chases in walls, openings in RCC and repairs, etc. required to complete the job.

20.18 EXTERNAL SEWERAGE :

Sewage System of the shall be measured diameter wise in running meters. It shall include all the items such as earth work (excavation, backfilling, disposal etc.), piping, pipe fittings, manholes, gully trap, gully chamber, encasing in concrete and repairs etc required to complete the job. Any modification in the existing sewage system, if required, shall be done by the Contractor without any financial implication to Employer.

20.19 CABLE TRENCHES:

Various items like earth work (excavation, backfilling, disposal etc.), concrete (all type), reinforcement steel and miscellaneous steel required for construction of cable trenches shall be measured and paid under respective clauses mentioned above.

20.20 DRAINS:

The item Concrete (all type) & Reinforcement for drains shall be measured under relevant clauses as mentioned above. All other items required for completion of drains shall be deemed to be included in the rate of items quoted for the drain. The quantity for each type of drain section shall be measured in meters along the centre line of drain.

20.21 SOIL TREATMENT :

CNS or sand filling or boulder packing with interstices filled with sand under or sides of the foundations, roads, cable trenches, drains etc shall be measured in cubic meters.

20.22 PILE FOUNDATION:

20.22.1 For payment purpose pile of different diameter shall be measured separately in length (running meter) from bottom of pile cap to the lowest point of pile. The rate shall include

boring, providing and installation including temporary casing as applicable etc. complete in all respect except for concrete and reinforcement steel which will be paid separately under relevant items of BPS. Initial and routine test for vertical load and lateral load shall be payable under respective items of BPS.

20.22.2 In case pile foundation is not envisaged originally in the LOA then concrete and reinforcement steel shall be measured and paid as per items mentioned under relevant clauses as mentioned above. Boring installation including temporary casing, bentonite treatment, initial and routine tests etc of pile will be paid as an extra item. In case extra quantity of cement is required to meet the provisions of IS: 2911, it will be paid as an extra item.

20.23 CONTRACTOR DESIGNED FOUNDATIONS: Contractor designed foundations shall be measured {quantity of earth work (excavation, backfilling, disposal etc.), PCC, RCC, reinforcement} and paid as per relevant clauses as mentioned above, unless otherwise specified.

20.24 Billing break up of Lump sum items for payment purpose shall be decided at site by Engineer in charge for the work.

20.25 Civil works for Pipe supports and deluge valve housing for firefighting shall be deemed to be included in the items for firefighting and shall not be paid under civil works.

20.26 BOUNDARY WALL:
The measurements of boundary wall shall be in running meter of finished work. The rate shall be inclusive of earth work (excavation, backfilling, disposal etc.), concrete (all type), Reinforcement, MS steel, brick masonry, plastering barbed wire/ concertina coil, painting etc. complete required for completion of boundary wall. Nothing extra shall be payable on this account.

20.27 SITE LEVELLING:

20.27.1 EARTH WORK IN EXCAVATION AND FILLING

The quantity of excavation in all types of soil and soft/disintegrated rock shall be worked out by using initial and final levels. No void deduction shall be made to calculate net quantity of earth work. Only Excavation/cutting will be measured for payment purpose. The unit of measurement shall be in cubic metre.

In case hard rock is encountered during excavation, the level of rock surface before start and completion of rock excavation shall be recorded for calculating the quantity of excavation of hard rock. The volume of hard rock shall be computed on the basis of stacks of excavated rubble after making 50 % deduction for voids. The item of excavation in hard rock shall be payable separately.

The quantity of earth work in excavation in all kinds of soil & soft/disintegrated rock shall be arrived by reducing quantity of hard rock from the gross excavated quantity.

The unit rate shall include all lifts and all leads within levelling boundary. It also includes disposal of surplus earth and stacking of unusable material up the lead of 2000 meters beyond the levelling boundary. Rate of item shall include all operations specified in the respective clause of technical specification.

20.27.2 EARTH WORKS IN EXCAVATION IN ALL TYPES OF SOILS AND SOFT /DISINTEGRATED ROCKS, HARD ROCKS AND DISPOSAL.

Quantity of excavation in all type of soils and soft/disintegrated rocks shall be worked out based on initial level before start of excavation and final levels after excavation. No void deduction shall be made to calculate net quantity of earth work in excavation. The excavated soil and soft/disintegrated rock shall be used for filling in lower areas of the plot. The unit rate shall include disposal of excavated material for leads up to 1000 meters beyond the levelling boundary.

For hard rock excavation, the volume of hard rock shall be computed on the basis of stacks of excavated rubble after making 50% deduction for voids. The unit of measurement shall be in cubic meter. The unit rate shall include stacking, disposal of excavated material for leads up to 2000 meters beyond the levelling boundary.

Where soil, soft/disintegrated rock and hard rock are mixed, the quantity of earth work in excavation in all kinds of soil & soft/disintegrated rock shall be arrived by reducing quantity of hard rock from the gross excavated quantity. Rate of item shall include all operations specified in the respective clause of technical specification.

20.27.3 FILLING USING EARTH BORROWED FROM OUTSIDE THE BESS yard

For borrowed earth, the measurement shall be based on levels of area under filling only. The quantity of earth shall be worked out based on initial and final levels of levelling area. No void deduction shall be made to calculate net quantity of earth work. The unit of measurement shall be in cubic meter. The rate shall include arrangement of borrow area, payment of royalty, transportation, laying compaction, all leads and lifts etc. Rate of item shall include all operations specified in the respective clause of technical specification.

21. SECTION: STRUCTURES

21.1.0 GENERAL

The scope of specification covers fabrication, proto-assembly, supply and erection of galvanized steel structures for towers, beams, lightning masts and equipment support structures. The structures shall be of lattice type. Lattice structures shall be fabricated from structural steel conforming to IS: 2062 (latest).

The fabrication drawings along with BOMs of structure necessary to suit the layout for a particular substation to complete the work in all respects shall be designed by contractor at detailed Engineering stage.

The scope shall include supply and erection of all types of structures including bolts, nuts, washers, step bolts, inserts in concrete, gusset plates, equipment mounting bolts, structure earthing bolts, foundation bolts, spring washers, fixing plates and any other items as required to complete the job.

The connection of all structures to their foundations shall be with base plates and embedded anchor/foundation bolts. All steel structures including anchor/foundation bolts shall be fully galvanized. The weight of the zinc coating shall be at least 610 gm/sq.m . Zinc coating for coastal areas, if defined in section – Project shall not be less than 900gm/sq.m Suitable modification shall be carried out in the drawings of equipment support structures by the Contractor in order to suit fixation of accessories such as marshalling boxes, MOM boxes, Control Cabinets, Junction box, surge counter, etc. in the structure fabrication drawings. .

21.2.0 DESIGN REQUIREMENTS FOR STRUCTURES

21.2.1 For design of steel structures loads such as dead loads, live loads, wind loads etc. shall be based on IS:875, Parts I t o V.

21.2.2 For materials and permissible stresses IS: 802, Part-I, Section-2 shall be followed in general. However, additional requirements given in following paragraphs shall also be considered.

21.2.3 Minimum thickness of galvanized tower member shall be as follows:

Members	Minimum thickness (mm)
Leg members, Ground wire	
Peak members/Main members	5
Other members	4
Redundant members	4

Size and thickness of gusset plate, pack washer and pack plate shall be as per requirement.

21.2.4 Maximum slenderness ratios for leg members, other stressed members and redundant members for compression force shall be as per IS -802.

21.2.5 Minimum distance from hole center to edge shall be 1.5 x bolt diameter. Minimum distance between center to center of holes shall be 2.5 x bolt diameter.

21.2.6 All bolts shall be M16 or higher as per design requirement.

21.2.7 Step Bolts

In order to facilitate inspection and maintenance, the structures shall be provided with climbing devices. Each tower shall be provided with M16 step bolts 175mm long spaced not more than 450mm apart, staggered on faces on one leg extending from about 0.5 meters above plinth level to the top of the tower. The step bolt shall conform to IS: 10238.

a) All structures shall be designed for the worst combination of dead loads, live loads, wind loads as per code IS:875, seismic forces as per code IS:1893, loads due to deviation of conductor, load due to unbalanced tension in conductor, torsional load due to unbalanced vertical and horizontal forces, erection loads, short circuit forces including "snatch" in the case of bundled conductors etc. Short circuit forces shall be calculated considering a fault level of 40 kA, 50kA, 63 kA or as applicable. IEC -60865 may be followed for evaluation of short circuit forces.

b) Switchyard gantry structures shall be designed for the two conditions i.e. normal condition and short circuit condition. In both conditions the design of all structures shall be based on the assumption that stringing is done only on one side i.e. all the three (phase) conductors are broken on the other side. Factor of safety of 1.5 under normal conditions and 1.2 under short circuit condition shall be considered for the design of switchyard structures.

c) Vertical load of half the span of conductors/string and the earth wires on either side of the beam shall be taken into account for the purpose of design. Weight of man with tools shall be considered as 150 kgs. for the design of structures.

d) Terminal/line take off gantries shall be designed for a minimum conductor tension of 9 metric tonnes per phase for 765kV, 4 metric tonnes per phase for 400k V, 2 metric tonnes per phase for 220kV and 1 metric tonne per phase for 132 kV or as per requirements whichever is higher. The distance between terminal gantry and dead-end tower shall be taken as 200 metres for 765/400/220 kV and 100m for 132KV. The design of these terminal gantries shall also be checked considering +/- 30 deg deviation of conductor in both vertical and horizontal planes. For other gantries the structural layout requirements shall be adopted in design.

e) The beams shall be connected with towers/ columns by bolted joints.

g) If luminaries are proposed to be fixed on gantries, then the proper loading for the same shall be considered while designing. Also holes for fixing the brackets for luminaries should be provided wherever required.

h) Foundation bolts shall be designed for the loads for which the structures are designed.

i) Height of Lightning masts shall be as per approved structure layout and designed for diagonal wind condition. Lightning masts shall be provided with platforms for mounting lighting fixtures and a structural steel ladder within its base up to the level of platform. The ladder shall be provided with protection rings. The platforms shall also have protection railing. The details of lighting fixtures would be as per the approved drawings.

21.3.2 STRUCTURES DESIGNED DURING DETAILED ENGINEERING:

21.3.2.1 In case design of structure is to be done by employer, only line diagram of the structure shall be provided to the contractor and fabrication drawing shall be prepared by contractor based on line diagram and submitted for approval.

21.3.2.2 Design of structure is covered in the scope of contractor, the contractor shall submit design along with line diagram for approval and based on approved line diagram, fabrication drawing shall be prepared and submitted for employers' approval. The line diagram should indicate not only profile, but section, numbers and sizes of bolts and details of typical joints.

21.3.2.3 The fabrication drawings to be prepared and furnished by the Contractor shall be based on the line diagram provided by employer or the design approved by the employer. These fabrication drawings shall indicate complete details of fabrication and erection including all erection splicing details and typical fabrication splicing details, lacing details, weld sizes and lengths. Bolt details and all customary details in accordance with standard structural engineering practice whether or not given by the employer. The fabrication drawings and bill of material based on fabrication drawing shall be submitted to the employer for approval. Approved bill of material prepared based on fabrication drawing shall be the basis for payment.

21.3.3 Such approval shall, however, not relieve the Contractor of his responsibility for the safety and durability of the structure and good connections and any loss or damage occurring due to defective fabrication, design or workmanship shall be borne by the Contractor.

21.4.0 FABRICATION AND ERECTION

21.4.1 The fabrication and erection works shall be carried out generally in accordance with IS 802. A reference, however, may be made to IS 800 in case of non-stipulation of some

particular provisions in IS 802. All materials shall be completely shop fabricated and finished with proper connection material and erection marks for ready assembly in the field.

21.4.2 The component parts shall be assembled in such a manner that they are neither twisted nor otherwise damaged and shall be so prepared that the specified camber, if any, is provided. In order to minimize distortion in member the component parts shall be positioned by using the clamps, clips, dogs, jigs and other suitable means and fasteners (bolts and welds) shall be placed in a balanced pattern. If the individual components are to be bolted, paralleled and tapered drifts shall be used to align the part so that the bolts can be accurately positioned.

21.4.3 Sample towers, beams, lightning masts and equipment support structures may be trial assembled in fabrication shop in order to ensure fitment of various members and to avoid problems during erection.

21.4.4 The Contractor should arrange on his own all plant and equipment, welding set, tools and tackles, scaffolding, trestles equipments and all other accessories and ancillaries required for carrying out erection without causing any stresses in the members which may cause deformation and permanent damage. Minor modification, if any, required during erection shall be done at site with the approval of Engineer – in-charge.

21.5.0 BOLTING

- i) Every bolt shall be provided with a washer under the nut so that no part of the threaded portion of the bolt is within the thickness of the parts bolted together.
- ii) In case of fasteners, the galvanizing shall conform to IS -1367(Part 13). The spring washer shall be electro galvanized as per Grade IV of IS -1573.

21.6.0 WELDING

The work shall be done as per approved fabrication drawings which shall clearly indicate various details of joints to be welded, type of weld, length and size of weld, Symbols for welding on erection and shop drawings shall be according to IS:813. Welding shall be carried out in accordance with IS:816.

21.7.0 FOUNDATION BOLTS

21.7.1 Foundation bolts for the towers and equipment supporting structures shall be embedded in first stage concrete while the foundation is cast. The Contractor shall ensure the proper alignment of these bolts to match the holes in the base plate.

21.7.2 The Contractor shall be responsible for the correct alignment and leveling of all steel work on site to ensure that the towers/structures are plumb.

21.7.3 All foundation bolts for lattice structure, pipe structure are to be supplied by the Contractor.

21.7.4 All foundation bolts shall be provided with two no. standard nuts of class 5 conforming to IS :1363/ 1367 /6639, one check nut of class 4 conforming to IS:1364, one anchor plate at the bottom of foundation bolt and one plain washer.

21.7.5 All foundation bolts shall conform to IS 5624, however, the material, shall be MS conforming to IS:2062 / SAE:1018.

21.8.0 STABILITY OF STRUCTURE

The Contractor shall be responsible for the stability of the structure at all stages of its erection at site and shall take all necessary measures by the additions of temporary bracings and guying to ensure adequate resistance to wind and also to loads due to erection equipment and their operations.

21.9.0 GROUTING

The method of grouting the column bases shall be subject to approval of employer and shall be such as to ensure a complete uniformity of contact over the whole area of the steel base plate. No additional payment for grouting shall be admissible.

21.10.0 GALVANISING

All structural steel works, equipment support structures and foundation bolts shall be galvanized after fabrication. The galvanization shall be done as per requirement of IS 4579. Purity of zinc to be used shall be 99.95% as per IS:209.

21.11.0 TOUCH -UP PAINTING

Minor defects in hot dip galvanized members shall be repaired by applying zinc rich primer and two coats of enamel paint to the satisfaction the employer before erection.

21.12.0 INSPECTION BEFORE DISPATCH

Each part of the fabricated steel work shall be inspected as per approved quality plans and certified by the employer or his authorized representative as satisfactory before it is dispatched to the erection site. Such certification shall not relieve the Contractor of his responsibility regarding adequacy and completeness of fabrication.

21.13.0 TEST CERTIFICATE

Copies of all test certificates relating to material procured by the Contractor for the works shall be submitted during inspection.

21.14.0 SAFETY PRECAUTIONS

The Contractor shall strictly follow at all stages of fabrication, transportation and erection of steel structures, raw materials and other tools and tackles, the stipulations contained in Indian Standard Code for Safety during erection of structural steel work -IS:7205.

21.15.0 All tests mentioned in standard field quality plans shall have to be carried out and conformity of materials and workmanship shall be ascertained.