SECTION-IVF

POLE STRUCTURE,
FOUNDATION AND ERECTION

TECHNICAL SPECIFICATIONS

SECTION-IVF

POLE STRUCTURE,
FOUNDATION AND ERECTION

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TECHNICAL SPECIFICATIONS

SECTION-IVF

POLE STRUCTURE, FOUNDATION AND ERECTION

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TECHNICAL SPECIFICATIONS

SECTION- IVF

POLE STRUCTURE, FOUNDATION AND ERECTION

1.0 Transmission Line Pole structure

1.1 General Description of Transmission Line Pole structure

1.1.1 The general description of poles structures applicable for the package and technical particulars thereof are indicated in ***Section–IA*** of this Specification. Outline diagram of pole structures are enclosed with the specifications.

1.1.2 **Extensions**

1.1.2.1 Pole structures shall be designed so as to be suitable for adding 3M, 6M, 9M extensions for maintaining adequate ground clearances without reducing the specified factor of safety in any manner. Also tapering ratio of these extension shall be kept same as that of tested pole and the design factor of safety of non-tested extension shall not be less than the factor of safety of tested pole in any case.

1.1.2.2 For +18/25m and higher extensions for 765kV , 400kV Multi-circuit (Twin-Twin) & 400kV D/C (Quad/Triple/Twin), Bidders may offer pole structures as Single/Twin/Triple/Quad poles. These structures shall be designed and tested for the Reliability level prescribed for the particular voltage level as per the provisions regarding testing of poles specified herein. If the full scale proto type of pole structure could not be tested due to limitation of testing facility in India, the contractor may offer design with Reliability level 3 and no recovery on account of pole not being tested shall be done. However, for profiling, stringing, design of foundation, wind pressure/wind load/Tension/etc. shall be corresponding to the reliability level as mentioned in the relevant section of technical specification for which the transmission line is designed.

1.1.3 **Spans**

1.1.3.1 **Normal Span**

The Design Span or Normal ruling span for the pole structure shall be as under:

Voltage level and Configuration Transmission Line	Normal design span (m)
765kV, 400 kV D/C(Quad), 400 kV D/C(Triple) and M/C(Twin-Twin)	200m (Angle pole structure) 250m (Tangent pole structure)
400kV D/C (Twin) & 400 kV S/C	200m (Angle pole structure)

	250m (Tangent pole structure)
220 kV &132 kV	250m

1.1.3.2 **Wind Span**

The wind span is the sum of two half spans adjacent to the support under consideration. For normal horizontal spans this equals to normal ruling span.

1.1.3.3 **Weight Span**

The weight span is the horizontal distance between the lowest points of the conductors on the two spans adjacent to a pole structure. For design of structures, maximum weight span limits given in table below shall be considered:

Sl. no.	Pole Type	Normal Condition		Broken wire condition	
		Maximum (m)	Minimum (m)	Maximum (m)	Minimum (m)
A)	**765kV , 400 kV D/C(Quad), 400 kV D/C(Triple) and 400kV M/C(Twin-Twin)**				
i)	PA	375	125	225	50
ii)	PB	300	0	180	(-)200
iii)	PC	300	0	180	(-)200
iv)	PD	300	0	180	(-)300
v)	Dead End condition for PD	150	0	30	(-)300
vi)	Dead End with Slack Span condition for PD	250	0	170	(-)300
B)	**400kV D/C (Twin) & 400 kV S/C**				
i)	PA	375	125	225	50
ii)	PB	300	0	180	(-)200
iii)	PC	300	0	180	(-)200
iv)	PD	300	0	180	(-)300
v)	Dead End condition for PD	150	0	30	(-)300
vi)	Dead End with Slack Span condition for PD	250	0	170	(-)300
C)	**220 kV and 132 kV**				
i)	PA	375	125	225	75
ii)	PB	375	0	225	(-)200
iii)	PC	375	0	225	(-)200
iv)	PD	375	0	225	(-)200
v)	Dead End condition for PD	187	0	40	0

vi)	Dead End with Slack Span condition for PD	300	0	210	(-)200

1.1.4 **Electrical Clearances**

1.1.4.1 **Ground Clearance**

The minimum ground clearance from the bottom conductor at maximum sag conditions i.e. at max. operating temperature and still air shall be as indicated in ***Section-1A*** of TS**.**

1.1.4.2 **Live Metal Clearance**

The minimum live metal clearance to be provided between the live parts and steel work of pole structure shall be as given in the table below:

A) <u>For 765kV transmission line:</u>

Wind pressure Condition	Minimum electrical clearance
A. For "I" Suspension Insulator Strings	
1. 0° Swing	6100 mm (For D/C) /5600 mm (For S/C)
2. 25°Swing	4400 mm
3. 55°Swing	1300 mm
B. For Jumpers in tension insulator strings (with or without Pilot)	
1. 0° Swing	6100 mm (For D/C) /5600 mm(For S/C)
2. 25° Swing	4400 mm
3. 55° Swing	1300 mm

Maximum two (2) nos of pilot insulator string to be used per phase (only on davit/cross arm where conductor/jumper is coming closer to pole body) for PD pole only.

B) <u>For 400kV transmission line:</u>

Wind pressure Condition	Minimum electrical clearance
A. For Single Suspension Insulator Strings	
1. 0^0 Swing	3050 mm
2. 22^0Swing	3050 mm
3. 44^0 Swing	1860 mm

B. For Jumpers in tension insulator strings	
1. 0^0 Swing	3050 mm
2. 25^0 Swing	3050 mm
3. 40^0 Swing	1860 mm
C. For Pilot insulator strings	
1. 0^0 Swing	3050 mm
2. 15^0 Swing	3050 mm

Maximum two (2) nos of pilot insulator string to be used per phase (only on davit/cross arm where conductor/jumper is coming closer to pole body) for PD pole only.

C) <u>For 220kV transmission line:</u>

Wind pressure Condition	Minimum electrical clearance
A. For "I" Suspension Insulator Strings	
1. 0^0 Swing	2130 mm
2. 15º Swing	1980 mm
3. 30º Swing	1830 mm
4. 45º Swing	1675 mm
B. For Jumpers in tension insulator strings	
Without Pilot	
1. Swing angle 0º	2130 mm
2. Swing angle 10º	2130 mm
3. Swing angle 20º	1675 mm
With Pilot	
1. Swing angle 0º	2130 mm
2. Swing angle 10º	2130 mm
3. Swing angle 15º	1980 mm

Not more than one pilot insulator string is to be used for PD pole only.

D) <u>For 132kV transmission line:</u>

Wind pressure Condition	Minimum electrical clearance
A. For "I" Suspension Insulator Strings	
1. Swing angle (15º)	1530 mm

2. Swing angle (30º)	1370 mm
3. Swing angle (45º)	1220 mm
4. Swing angle (60º)	1070 mm
B. For Jumpers in tension insulator strings (without Pilot)	
1. Swing angle (0º)	1530 mm
2. Swing angle (10º)	1530 mm
3. Swing angle (20º)	1070 mm
4. Swing angle (30º)	1070 mm

Pilot (s) is not to be considered for Jumper Swing

1.1.4.3 Bidder shall adopt same cross arm design where jumper is projecting outside of cross-arm for tension pole structure.

1.1.4.4 For computing the live metal clearances, the dimensions of insulator strings as indicated in technical specifications shall be considered. The design of the pole structure shall be such that it should satisfy all the above conditions when clearances are measured from any live point of the strings.

1.1.4.5 Cross arm projections for Dead end pole structures shall be fixed in such a way that it can accommodate a condition of 15 ^{o} deviation of conductors towards pole structure at both Left and Right-side cross arms on slack span side and 0-15 degrees deviation on line side.

1.1.4.6 For Dead End Tower design conditions, following wind span is to be considered:

Wind Span for Dead End

Tower Type	Normal Condition	Broken wire condition
765kV , 400 kV D/C(Quad), 400 kV D/C(Triple) and 400kV M/C(Twin-Twin)		
Dead End	100	20
Dead End with Slack Span	200	120
400 kV D/C (Twin) & 400kV S/C		
Dead End	100	20
Dead End with Slack Span	200	120
220kV & 132kV		
Dead End	125	25
Dead End with Slack Span	200	140

1.1.4.7 **Angle of Shielding**

The angle of shielding is defined as the angle formed by the line joining the centre lines of the earthwire/ OPGW and outer power conductor, in still air, at pole structure supports, to the vertical line through the centre line of the earthwire/ OPGW Bidders shall design the pole in such a way that the angle of shielding does not exceed the value given in the table below. For estimating the minimum angle of protection, the drop of earth wire suspension clamp along with shackle shall be taken as 150 mm.

Sl. No.	Voltage Level of Transmission Line	Angle of Shielding
A)	765 kV D/C line	10^0
B)	765 kV S/C and 400 kV line	20^0
C)	220 kV and 132 kV line	30^0

1.1.4.8 **Mid Span Clearance**

The minimum vertical mid span clearance between the earthwire and the nearest power conductor shall not be less than the value given below, which shall mean the vertical clearance between earthwire and the nearest conductor under all temperatures and still air condition in the normal ruling span. Further, the tensions of the earthwire/ OPGW and power conductor shall be so co-ordinate that the sag of earthwire/ OPGW shall be at least 10% less than that of power conductors under all temperature loading conditions: -

Sl. No.	Voltage Level of Transmission Line	Mid Span Clearance
A)	400 kV and 765 kV	9000 mm
B)	220 kV	8500 mm
C)	132 kV	6100 mm

1.1.4.9 **Phase to Phase Spacing**

The phase to phase spacing for conductors shall be not less than 15000 mm for 765 kV & 8000 mm for 400 kV vertically. For 220 kV & 132 kV, required vertical phase to phase spacing shall be governed by the pole design as well as minimum live metal clearances under different insulator swing angles.

1.2 Design of pole structures

The following clauses specify the minimum requirements for design of pole structures:

1.2.1 **Design Criteria**

a) The pole structure shall be designed to meet design requirements & design criteria stipulated in IS 802:2015, ASCE Manuals and reports on Engineering practice No. 72 and ASCE-48-19 "Design of Steel Transmission Pole Structures", & CBIP Manual as applicable except otherwise specified in this specification. Wind Zone to be considered for the design of pole structure shall be as per ***Section-IA*** of the TS.

b) Terrain category shall be considered as 2, unless otherwise mentioned in Section-1A.

c) Under broken wire condition, pole shall be designed considering transverse load based on maximum angle of deviation and longitudinal load based on minimum angle of deviation mentioned in Section-IA of Technical specifications.

d) For poles in coastal areas (wherever mentioned in BPS), an additional factor viz. K4 = 1.3 shall be considered for design of poles to take care of cyclonic wind conditions.

e) Reliability level shall be considered as 1 for 132kV, 220kV & 400 kV (twin bundle conductor) and 2 for triple & quadruple circuit poles and poles with more than two sub-conductors per phase upto 400 kV & 765 kV poles.

f) For 765kV, 400kV Multi-circuit (Twin-Twin) & 400kV D/C (Quad/Triple), bidders may offer pole structures as Twin/Triple/Quad poles. These structures shall be designed and tested for Reliability level prescribed for the particular voltage level. If the full scale proto type of pole structure could not be tested due to limitation of testing facility in India, the contractor may offer design with Reliability level 3 and no recovery on account of pole not being tested shall be done. However, for profiling, stringing, design of foundation, wind pressure/wind load/Tension/etc. shall be corresponding to the reliability level as mentioned in the relevant section of technical specification for which the transmission line is designed.

g) Contractor shall offer pole/ foundation design considering the type of conductor, being supplied by them under the package and the conductor, earthwire & OPGW properties as per those mentioned in the respective sections.

h) Deflection Criteria: 5% of height of pole @ultimate load condition and 2% of the height of pole @ everyday loading condition.

1.2.2 **Design Temperatures**

The following temperature range for the conductors and ground wires shall beadopted for transmission line design:

i) Minimum Temperature: Minimum Ambient Temperature as per Section IA

ii) Every day temperature : 32^0C

iii) Max. temperature of

a) Conductor (ACSR/ Al59/AAAC) : 85^0C

b) Conductor (HTLS) : Refer TS for HTLS conductor

c) Earthwire exposed to sun : 53^0C

1.2.3 Conductor and Earthwire/ OPGW Configuration

For single circuit poles, three phases shall be in vertical delta/vertical formation. Double circuit pole structures shall be in vertical formation. For voltage levels up to 220 kV Cross-arms of conductor phases coming over one another shall be suitably staggered as per IS 5613(Part-2/Section- 1) stipulations.

1.2.4 Maximum Tension

Maximum tension shall be based on either

a)at Minimum temperature with 36% full wind pressure or

b) at 32^0 C with full wind pressure whichever is more stringent

Sag tensions calculations are to be carried out by the contractor considering conductor & earthwire/ OPGW parameters & specified conditions and spans. As per Clause 15 of IS 802:2015 the initial tension at 32ºC and without wind shall not exceed 25% for below 400kV voltage levels and 22% for 400kv & above voltage levels of the ultimate tensile strength for the conductor and 20% of the ultimate tensile strength for the earthwire/ OPGW.

For normal poles, the value of final unloaded tension of conductor at everyday temperature considered for Pole Design under Safety Condition and Anti-cascading condition, shall not be less than 25% of the ultimate tensile strength of conductors for below 400kV voltage level transmission lines and not less than 22% of the ultimate tensile strength of conductors for 400 kV and higher voltage lines.

At ruling span, the final unloaded tension of conductor at everyday temperature of upper phase shall not be less than that of conductor in lower phase so as to maintain the phase-to-phase spacing.

As per Clause 12.1.2.1 (b) (2) of IS 802:2015 & AMENDMENT NO. 1 MARCH 2024, Under security condition for tension and dead-end poles, the transverse loads due to line deviation shall be the component of 100 percent mechanical tension of conductor and ground wire/ OPGW corresponding to 75% of design wind pressure at everyday temperature (unless otherwise mentioned in Section-1A) or 36% design wind pressure at minimum temperature after accounting for drag coefficient and gust response factor. Drag coefficient for wind on the pole body shall be as per following table: -

Member Shape	Drag Coefficient
16-sided Polygonal	0.9
12-sided Polygonal	1.0
8-sided Polygonal	1.4
6-sided Polygonal	1.4
Square, Rectangle	2.0

The cross section and polygon of the structure shall be so selected that it offers optimum weight of the structure using specified materials and also ease of fabrication and erection. For cross arms also, Polygonal Sections shall be used.

1.2.5 **Loading Conditions**

The Contractor shall calculate loads at structure, conductor & earthwire/ OPGW points under different loading conditions viz. Reliability Conditions (Normal Condition), Security Conditions (Broken Wire Condition), Safety Conditions, Anti-cascading condition etc. as per IS 802:2015 considering various combinations of design temperatures, wind loads and prepare loading trees/ diagrams/ charts. The loading trees/ diagrams/ charts shall be submitted to Employer for approval. The pole structure designs shall be developed by the contractor as per the approved loading trees/charts/ diagram.

1.2.6 **Design and Drawings**

1.2.6.1 The following design calculation and drawings are required to be furnished to the Employer:

a) Alongwith Bid:

Detailed design calculations and drawings for PA+0 & PD+0 type pole structure along with foundation.

b) After award of the Contract:

The Contractor shall submit detailed design of pole structures with all extensions along with foundation design/drawings of all type of pole

structures for soil type as per site requirement. The pole structure design shall be submitted along with the stress diagram/ computer output together with sample calculations etc., Anchor Bolt templates and loading/ rigging arrangement of pole structure testing (if applicable) to enable the Employer to make a preliminary check regarding structural stability of pole structure before fabrication

1.2.6.2 After design and testing (if applicable) of pole structures and subsequent approval of design, drawings and bill of materials, the Contractor shall furnish further copies to the Employer for necessary distribution:

a) Detailed design calculation and drawing for pole structures and foundations.

b) Detailed structural drawings indicating section size, length of members, sizes of plates along with hole to hole distance & joint details etc.

c) Bill of materials, indicating cutting and bending details against each member.

d) Shop drawings showing all details relevant to fabrication.

e) All the drawings for the pole structure accessories.

1.2.6.3 All the drawings shall have a proper name plate clearly displaying the name of EMPLOYER on right hand bottom corner. The exact format of the nameplate shall be handed over to the successful bidder for incorporation of the same on all the drawings. Also, all the drawings shall carry the following statement and shall be displayed conspicuously on the drawing:

WARNING: THIS IS PROPRIETORY ITEM AND DESIGN RIGHT IS STRICTLY RESERVED WITH POWERGRID. UNDER NO CIRCUMSTANCES THIS DRAWING SHALL BE USED BY ANYBODY WITHOUT PRIOR PERMISSION FROM THE EMPLOYER/OWNER IN WRITING.

1.2.6.4 The Contractor is required to submit four copies of the drawings for Employer's approval. While submitting the structural drawings, bill of materials, shop drawings and any other drawings pertaining to the subject transmission line, the Contractor shall clearly indicate on each drawing POWERGRID Specification No., Name of the specific Transmission line and project, letter reference no. and date on which the submission are made. The same practice is also to be followed while submitting distribution copies.

1.2.6.5 The pole structure accessories drawings like Number plate, Danger plate, phase plate, Circuit Plate, Step Bolt, Anti-climbing device, pole plate and Earthing Arrangement Bird Guard, D-shackle etc. shall be prepared by the Contractor and shall be submitted to the Employer for approval.

1.2.6.6 The drawings submitted by the Contractor shall be approved/ commented by the Employer as the case may be within fifteen (15) days of receipt of drawings in his office. If the designs/ drawings are commented by the Employer, the Contractor shall submit revised design/ drawings duly incorporating all comments within fifteen (15) days of date of issue of comments. The Contractor shall submit 15 copies of all pole structure drawings, BOM etc. for further distribution by the Employer.

1.2.6.7 Other than the items indicated above, some other drawings and documents, such as BOM, Shop drawings, structural drawings for pole structures/ extensions, which are required for the project, shall also be developed by the Contractor. However, no extra cost on this account shall be payable to the Contractor.

1.3 Materials

1.3.1 Pole structure Steel Sections

Steel of tested quality of conformity with IS 2062:2011 are to be used in pole structures. Not more than two grades of steel shall be permitted for use. The quality of steel shall be BR/BO. The Contractor can use other equivalent grade of steel plates conforming to latest International Standards. However, use of steel grade having designated yield strength more than that of IS:2062 grade E450 BR/ EN 10025 grade S450 JO/ ASTM 572 grade 65 (designated yield strength 450 MPa) is not permitted, unless otherwise indicated in this specification.

Steel plates below 6mm size exclusively used for packing plates/ packing washers produced as per IS 1079 (Grade-0) are also acceptable. However, if below 6mm size plate are used as load bearing plates viz gusset plates, joint splices etc. the same shall conform to IS 2062 or equivalent standard meeting mechanical strength/metallurgical properties corresponding to selected grade. Flats of equivalent grade, meeting mechanical strength/ metallurgical properties, may also be used in place of plates for packing plates/ packing washers.

SAILMA 350HI grade plate can also be accepted in place of HT plates (EN 10025 grade S355 JR/JO/ IS 2062:2011, grade E350, as applicable) provided SAILMA 350HI grade plate meet all the mechanical properties of plate as per EN 10025 grade S355 JR/JO (designated yield strength 355 MPa)/ IS 2062: 2011, grade E350.

During execution of the project, if any particular section/grade is not available, the same shall be substituted by higher section/grade. Any cost on account of the same shall be borne by the Contractor. However, design approval for such substitution shall be obtained from the Employer before any substitution and records of such substitutions shall be maintained by the Contractor.

1.3.2 Fasteners: Bolts, Nuts and Washers

1.3.2.1 All hexagonal bolts and nuts shall conform to IS 12427. They shall have hexagonal head and **nuts**, the heads being forged out of the solid, truly concentric, and square with the shank, which must be perfectly straight.

All bolts and nuts shall be galvanized as per IS 1367 (Part-13)/ IS 2629.

1.3.2.2 The bolt shall be of 16/24/30/36 mm diameter and of property class 5.6 or 8.8 as specified in IS 1367 (Part-III) and matching nut of property class as specified in IS 1367 (Part-VI).

1.3.2.3 Bolts up to M16 and having length up to 10 times the diameter of the bolt should be manufactured by cold forging and thread rolling process to obtain good and reliable mechanical properties and effective dimensional control. The shear strength of bolts shall be as per applicable standard. Bolts should be provided with washer face in accordance with IS 1363 (Part-I) to ensure proper bearing.

1.3.2.4 Nuts for hexagonal bolts should be double chamfered as per the requirement of IS 1363 (Part-III). It should be ensured by the manufacturer that nuts should not be over tapped beyond 0.4mm oversize on effective diameter for size up to M16.

1.3.2.5 Fully threaded bolts shall not be used. The length of bolts shall be such that the threaded portion will not extend into the place of contact of the members.

1.3.2.6 All bolts shall be threaded to take the full depth of the nuts and threaded for enough to permit firm gripping of the members, but not further. It shall be ensured that the threaded portion of each bolt protrudes not less than 3mm and not more than 8mm when fully tightened. All nuts shall fit tight to the point where the shank of the bolt connects to the head.

1.3.2.7 Flat and tapered washers shall be provided wherever necessary. Spring washers shall be provided for insertion under all nuts. These washers shall be steel electro-galvanised, positive lock type and 3.5mm in thickness for 16mm dia bolt and 4.5mm for 24mm bolt.

1.3.2.8 To avoid bending stress in bolts or to reduce it to minimum, no bolt shall connect aggregate thickness of members more than three (3) times its diameter.

1.3.2.9 The bolt positions in assembled pole structures shall be as per structural drawing.

1.3.2.10 Bolts at the joints shall be so staggered that nuts shall be tightened with spanners without fouling.

1.3.2.11 To ensure effective in-process Quality control it is desirable that the manufacturer should have in house testing facility for all tests like weight of zinc coating, shear strength and other tests etc. The manufacturer should also have proper Quality

Assurance System which should be in line with the requirement of this specification and IS 9001 series Quality System Standard.

1.3.3 **Anchor bolts**

Anchor bolts shall generally conform to IS 5624. The size, grade & numbers of anchor bolts and its thread and nuts selection should be compatible with the required strength as per design.

1.4 **Pole structure Accessories**

Arrangement shall be provided for fixing of all pole structure accessories to the pole structure at a height between 2.5 meters and 3.5 meters above the ground level.

1.4.1 **Step Bolts & Ladders**

Each pole structure shall be provided with step bolts as per drawing enclosed in the section of drawing. The step bolts conforming to IS:10238 of not less than 16mm diameter and 175mm long shall be provided, spaced not more than 450mm apart and extending from 2.5 meters above the ground level to the top of the pole structure. However, the head diameter shall be 35mm as indicated in the enclosed drawing. The step bolt shall be fixed on two sides of polygon of the of the pole structures in alternate step arrangement. Each step bolt shall be provided with two nuts on one end to fasten the bolt securely to the pole structure and button head at the other end to prevent the feet from slipping away. The step bolts shall be capable of withstanding a vertical load not less than 1.5 KN. As an alternate to step bolts, ladders of suitable design may also be provided by the contractor. For horizontal access on cross arms, suitable designed hooks shall also be provided. Detailing for providing step bolts/ hooks/ ladders etc. shall be done so that all parts of pole structures are accessible and installation & maintenance of insulators, hardware assemblies, conductors etc. is possible.

1.4.2 **Insulator Strings and Earth wire Clamps Attachments**

a) For the attachment of suspension Insulator string, if required a suitable dimensioned swinging hanger on the pole structure shall be provided so as to obtain specified clearances under respective swinging condition of the strings. The hanger, extensions links, D-shackles etc. as required shall be of same rating/strength as that of corresponding rating/ Ultimate tensile Strength of Insulator string. The design and supply of hanger, D-shackles, strain plate, extension link etc. are also in the scope of Contractor.

b) At tension pole structures, strain plates of suitable dimensions under each cross-arm tip, shall be provided for taking the hooks or D-shackles of the tension insulator strings. Full details of the attachments shall be provided by the contractor. To achieve requisite clearances, if the design calls for providing extra D-shackles, link plate etc. before connecting the insulator string the same shall be supplied by the Contractor. These items shall be of same

rating/strength as that of as that of corresponding rating/ Ultimate tensile Strength of Insulator string.

c) D shackles, if required for attachment of Insulator strings, shall be supplied by the contractor from the identified and approved sub-vendor / supplier of Hardware fittings.

1.4.3 **Earth wire/ OPGW Clamps Attachments**

For Suspension and tension clamp for attachment of earthwire/ OPGW wherever required, the Contractor shall supply U–bolts, D–Shackles etc. for attachment of clamp to the pole structure. These items shall be of same rating/ strength as that of corresponding rating/ Ultimate tensile Strength of earthwire suspension/tension clamp.

1.4.4 **Anti Climbing Device**

Barbed wire type anti climbing device, shall be provided and installed by the Contractor for all pole structures. The barbed wire shall conform to IS 278 (size designation A1). The barbed wires shall be given chromating dip as per procedure laid down in IS:1340

1.4.5 **Danger, Number, Circuit and Phase plate**

Danger Plates, Circuit plates, Phase Plates and Number plates shall be provided and installed by the Contractor. These Danger/ Number/Phase/ Circuit Plate shall be as per the drawings enclosed in the section of drawing. The contractor shall submit distribution copies of the same endorsing the package details (i.e. line name, LOA No. etc.) and installed by the Contractor.

a) Each pole structure shall be fitted with a danger plate, number plate, circuit plate and two sets of phase plates for double circuit pole structure.

b) The letters, figures and the conventional skull and bones of danger plates shall conform to IS 2551 and shall be in a signal red on the front of the plate.

c) The corners of the danger, number and circuit plates shall be rounded off to remove sharp edges.

d) The letters of number and circuit plates shall be red enameled with white enameled background.

1.4.6 **Bird Guard**

To prevent birds perching immediately above the suspension insulator strings (I type) and fouling the same with dropping, suitable bird guards shall be provided on all suspension poles. In case of I string Bird Guard as per IS 5613 shall be

provided at cross arm tips. Suitable provision of cleat/ plate to be provided on all Suspension poles facilitating installation of bird guard after stringing.

1.4.7 **Aviation Requirements**

1.4.7.1 Painting of pole structures above the height of 45 m shall be carried out by the contractor conforming to IS 5613. The cost of painting shall be deemed to be included in the cost of pole structures and no separate payment shall be made in this regard.

1.5 **Pole Structure Fabrication**

The pole Structure along with cross arms, earthwire peaks, base plate and joints shall be fabricated by the Contractor as per the design prepared by the contractor and approved by the Employer. The fabrication of pole structure shall be in conformity with the following:

1.5.1 Except where hereinafter modified, details of fabrication shall conform to industry practices and relevant standards.

1.5.2 Joints shall be so designed and fabricated that eccentricity is avoided as far as possible. Connections by means of slip joints only are acceptable. Minimum overlap shall be as applicable ASCE standard.

1.5.3 The cross arms shall be connected to the pole by means of suitable flanges welded on the body and cross arms.

1.5.4 The pole structures shall be accurately fabricated to connect together easily at Site without any undue strain on the structure.

1.5.5 No sharp/rough edges shall be permitted in the entire structure.

1.5.6 On slip-in joints, diameter of the inner and outer part of the pole shall be controlled to ensure smooth assembly of the pole structure and its correct height after erection.

1.5.7 The structure shall be designed so that all parts shall be accessible for inspection and cleaning. Drain holes shall be provided at all points where pockets of depression are likely to hold water. The top end of the pole, earthwire peaks and cross arms shall be suitably sealed with cover plate welded to the structure.

1.5.8 The length of any individual segment shall be such that it can be easily transported and erected. All similar parts shall be made strictly inter-changeable. Pole segments, as far as possible, shall be fabricated in single piece. Higher diameter

pole segments may be fabricated in two or more parts and kept minimum. The maximum permissible parts shall be as per follows:

Sr no	Maximum Outer diameter (D) of pole segment (mm)	Max permissible no of fabricated parts per pole segment/seams
1	D<600	1
2	600≤ D<1200	2
3	1200≤D<1800	3
4	D≥1800	4

1.5.9 Suitable provisions shall be kept in the design and detailing of pole structures for easy erection at site using conventional as well as mechanized methods.

1.5.10 Design and detailing for providing step bolts/hooks/ladders etc. shall be done so that on provision of these, all parts of pole structures are accessible and installation & maintenance of insulators, hardware assemblies, conductors etc. is possible. Design detailing for provision of other accessories viz. Anti-climbing device, Danger plate, Number, Phase plate etc. shall also be done.

1.5.11 **Material Cutting, Forming & Bending**

1.5.11.1 The required material cutting, forming and bending operations shall be carried out generally in accordance with the relevant sections of ASCE Manuals and reports on Engineering practice No.72 and ASCE-48-11 “Design of Steel transmission Pole Structures”.

1.5.11.2 Before any cutting work is started, all steel plates shall be carefully straightened and trued by pressure and not by hammering. They shall again be trued after cutting & welding etc.

1.5.12 **Drilling and Punching**

1.5.12.1 Holes for bolts shall be drilled or punched with a jig but drilled holes shall be preferred. The tolerances regarding punch holes are as follows:

a) Holes must be perfectly circular and no tolerance in this respect is permissible.

b) The maximum allowable difference in diameter of the holes on the two sides of plates or angle is 0.8 mm i.e. the allowable taper in a punched hole should not exceed 0.8mm on diameter.

c) Holes must be square with the plates or angles and have their walls parallel.

1.5.12.2 All burrs left by drills or punch shall be removed completely. When the pole structure members are in position, the holes shall be truly opposite to each other. Drilling or reaming to enlarge holes shall not be permitted.

1.5.13 **Welding**

1.5.13.1 All welding shall be in accordance with the latest revision of American Welding Society Structural Welding Code (ANSI/AWS D1.1) or other equivalent National/ International standards. Welding terms and symbols should comply with the AWS definitions and symbols.

1.5.13.2 Care should be exercised with respect to welding procedures, qualification of welders, operators and procedures, electrodes, preheat, notch toughness and minimum yield of the electrodes to ensure conformance with the requirements of the ANSI/AWS D1.1 code. Preheating shall be done according to the ANSI/AWS code or the steel producers' recommendations, or both. These details shall be included in MQP (Manufacturing Quality Plan) to be prepared and submitted by the Contractor.

1.5.14 **Erection mark**

1.5.14.1 Each individual member shall have erection mark conforming to the component number given to it in the fabrication drawings. The mark numbers shall be marked with marking dies of 16mm size before galvanizing and shall be legible after galvanizing.

1.5.14.2 Erection Mark shall be A-BB-CC-DDD

A = Employer's code assigned to the Contractors- Alphabet

BB = Contractor's Mark-Numerical

CC = Pole structure Type Alphabet.

DDD = Number mark to be assigned by Contractor - Numerical.

Erection mark for high tensile steel members shall be prefixed by the letter "H"

1.6 Quantities and weights

1.6.1 The provisional quantities required (including provisional spare pole structure quantity) are mentioned in the respective Schedules of BPS. Final quantities shall be determined after completion and approval of the detailed route survey. The final quantities of pole structure including spare pole structures shall be confirmed by the Employer/ Site-in-charge based on the requirement of quantities of various pole structures after completion of detailed survey.

1.6.2 The Employer reserves the right to order the final quantities including required quantities of spares for which the rates quoted in the Bid shall be valid. Regarding quantity variation, the provisions of relevant clauses of SCC shall apply.

1.6.3 Though fully galvanised pole structure parts are to be supplied, the weight of pole structure shall mean the weight of pole structure calculated by using the black sectional (i.e. ungalvanised) weight of steel members of the size indicated in the approved fabrication drawings and bill of materials, without taking into consideration the reduction in weights due to holes, notches and bevel cuts etc. but taking into consideration the weight of the D shackles, hangers, strain plates, pack plates, gusset plates, extension link/ plates and pack washers etc. The weight of strain plates, pack plates, extension link and gusset plates shall mean the weight of its circumscribing rectangle, without taking into considerations the reductions in weight due to holes, notches etc. The weight of D-shackles, hangers and pack washers shall be net actual weight taking into consideration reduction due to holes. For bolts and nuts along with spring washers and step bolts, the weight per pole structure shall be calculated from the bolt schedule applicable to each type of pole structures and body extensions as approved by the Employer. The rate quoted by the bidder for pole structure/ pole structure parts supply, is deemed to be inclusive of galvanising charges including the cost of zinc.

1.6.4 The contractor is permitted to get inspected and supply upto 2.5% extra fasteners to take care of losses during erection. No payment shall be admissible for these extra supplies.

1.6.5 Payment of the pole structures shall be made on per structure basis as per the unit rates in the contract irrespective of any change in weight of structure estimated by the bidder at the time of the bidding vis-à-vis weight of structure as per actual tested and approved design.

1.6.6 Design of Pole structure extensions, which are not specified in the Final BPS of the Contract Agreement, but required during execution of the project and authorised by the Employer, shall have to be carried out by the Contractor. No additional payment on account of Design charges shall be payable.

The payment for pole structure extensions, not specified in BPS, shall be on pro-rata basis derived from the rates indicated in price schedule of Contract Agreement and final approved weight of the corresponding standard (+0m) pole.

1.7 Galvanizing

1.7.1 **Fabricated pole structure Parts**

The pole structure parts and pack washers shall be hot dip galvanized. The galvanization shall be done as per requirements of IS 4759 after all fabrication work is completed. The contractor shall also take guidelines from the recommended practices for hot dip galvanizing laid down in IS 2629 while deciding and implementing galvanizing procedure. The mandatory requirements, however, are specified herein.

Unless otherwise specified, the fabricated pole structure parts shall have a minimum overall Zinc coating of 610 gm per sqm of surface area except for plates & sections below 5mm which shall have Zinc coating of 460 gm per sqm of surface area. The average zinc coating for all sections and plates 5 mm & above shall be maintained as 87 microns and that for plates & sections below 5 mm shall be maintained as 65 microns.

The zinc coating shall be adherent, reasonably uniform, smooth, continuous and free from imperfections such as black/ bare spots, ash rust strains, bulky white deposits/ wet storage strains and blisters.

The surface preparation for fabricated pole structure parts for hot dip galvanizing shall be carried out as indicated herein below:

(i) Degreasing & Cleaning of Surface: Degreasing and cleaning of surface, wherever required, shall be carried out in accordance with clause 4.1 of IS 2629-1985. After degreasing the article shall be thoroughly rinsed. However, if acidic degreasers are used rinsing is not required.

(ii) Pickling: Pickling shall be done using either hydrochloric or sulphuric acid as recommended at clause 4.3 of IS 2629:1985. The actual concentration of the acids and the time duration of immersion shall be determined by the Contractor depending on the nature of material to be pickled. Suitable inhibitors shall also be used with the acids to avoid over pickling. The acid concentration, inhibitors used, and maximum allowable iron content shall form part of plant standard to be formulated and submitted to employer along with Quality Assurance Program.

(iii) Rinsing: After pickling, the material shall be rinsed, preferably in running water to remove acid traces, iron particles or any other impurities from the surface. Two rinse tanks are preferable, with water cascading from the second tank to the first to ensure thorough cleaning. Wherever single tank is employed, the water shall be periodically changed to avoid acid contamination, and removal of other residue from the tank.

(iv) Fluxing: The rinsed article shall be dipped in a solution of Zinc ammonium chloride. The concentration and temperature of the flux solution shall be standardized by the contractor depending on the article to be galvanized and individual circumstances. These shall form part of plant standard to be formulated and submitted to employer along with Quality Assurance Program. The specific gravity of the flux solution shall be periodically monitored and controlled by adding required quantity of flux crystals to compensate for drag-out losses. Free acid content of the flux solution also shall be periodically checked and when it is more than two (2) grams of free acid per litre of the solution, it shall be neutralized. Alternatively, Ph value should be monitored periodically and maintained between 5.0 to 5.5.

(v) Drying: When dry galvanizing is adopted the article shall be thoroughly dried after fluxing. For the purpose of drying, the contractor may use hot plate, air oven or any other proven method ensuring complete drying of the article after fluxing and prior to dipping in the molten zinc bath. The drying process shall be such that the article shall not attain a temperature at which the flux shall get decomposed. The article thus dried shall be galvanized before the flux coating picks up moisture from the atmosphere or the flux layer gets damaged or removed from the surface. The drying procedure, time duration, temperature limits, time lag between fluxing, drying, galvanizing etc shall form part of plant standard to be formulated and submitted to employer along with Quality Assurance Program.

(vi) Quality of Zinc: Any one or combination of the grades of zinc specified in IS 209 or IS 13229 or other comparable international standard shall be used for galvanizing. The contractor shall declare the grade(s) of zinc proposed to be used by them for galvanizing. The molten metal in the zinc bath shall contain minimum 98.5 % zinc by mass. It shall be periodically measured and recorded. Zinc aluminum alloy shall be added as per IS 2629.

(vii) Dipping Process: The temperature of the galvanizing bath shall be continuously monitored and controlled. The working temperature of the galvanizing bath shall be maintained at 450 ± 10^0 C. The article should be immersed in the bath as rapidly as possible without compromising on safety aspects. The galvanizing bath temperature, immersion angle & time, time duration of immersion, rate of withdrawal etc. shall be monitored and controlled depending upon the size, shape, thickness and chemical composition of the article such that the mass of zinc coating and its uniformity meets the specified requirements and the galvanized surface is free from imperfections and galvanizing defects.

(viii) Post Treatment: The article shall be quenched in water. The quench water is to be changed/ drained periodically to prevent corrosive salts from accumulating in it. If water quenching is not done then necessary cooling

arrangements should be made. The galvanized articles shall be dipped in chromating solution containing sodium dichromate and sulphuric acid or chromic acid base additive at a predetermined concentration and kept at room temperature to retard white rust attack. The temperature of the chromate solution shall not exceed 65^0 C. The articles shall not be stacked immediately after quenching and dichromating. It shall be ensured that the articles are dry before any further handling operation.

(ix) Storing, Packing and Handling: In order to prevent white rust formation sufficient care should be exercised while storing handling and transporting galvanized products. The articles shall be stored in an adequately ventilated area. The articles shall be stored with spacers in between them and kept at an inclination to facilitate easy drainage of any water collected on the articles. Similar care is to be taken while transporting and storing the articles at site.

The Contractor shall prepare a detailed galvanizing procedure including Flow Chart with control parameters and all plant standards as required above and submit to POWERGRID for approval as part of Quality Assurance Plan.

In case of restriction due to the size of hot dip galvanising bath, pole segments having outer diameter more than 1m and upto 2.5m may be galvanized in two halves and then seamlessly welded. For pole segments having outer diameter more than 2.5m galvanizing shall be carried out in maximum four parts, and then seamlessly welded. After seamless welding of above parts, surface of the welded portion shall be cleansed and prepared. These welded portions shall be galvanized by metallizing using molten zinc technique. For metallizing, the process as per ANSI/AWS WCZ/D19.0-72 or other National/ International standard/Guidelines shall be followed. The thickness of zinc coating by metallizing shall not be less than the minimum specified for hot dip galvanizing.

1.7.2 Fasteners

For fasteners, the galvanizing shall conform to IS 1367(Part-13). The galvanizing shall be done with centrifuging arrangement after all mechanical operations are completed. The nuts, may however be tapped (threaded) or rerun after galvanizing and the threads oiled. The threads of bolts & nuts shall have a neat fit and shall be such that they can be turned with finger throughout the length of the threads of bolts and they shall be capable of developing full strength of bolts. Spring washers shall be electro galvanized as per Grade-IV of IS 1573.

1.8 Earthing

Each pole structure shall be earthed. The pole structure footing resistance shall not exceed 10 ohms. The Contractor shall measure the pole structure footing resistance (TFR) of each pole structure during dry weather after it has been erected and before the stringing of the earth wire. Pipe type earthing and counter poise type earthing shall be done as required in accordance with the following standards:

IS 3043 Code of practice for Earthing

IS 5613 Code of practice for Design, Installation and maintenance (Part-II/Section-2) of overhead power lines

1.8.1 The drawings for pipe & counterpoise type earthing are enclosed with these specifications.

1.8.2 For counterpoise type earthing, the earthing will vary depending on soil resistivity. For soil resistivity less than 1500 ohms-meter, earthing shall be established by providing 4 lengths of 30 m counterpoise wire. Otherwise, for soil resistivity greater than 1500 ohms meter earthing shall be established by providing 4 length of 70 m counterpoise wire.

1.8.3 The provisional quantities for pipe type earthing and counterpoise earthing are indicated in the BPS. The bidders are required to quote unit rates for the same in appropriate schedule of BPS. The quoted price shall include fabrication, supply and installation of earthing material including supply of coke, salt etc. In case of counterpoise type earthing, the unit rates shall correspond to 120/ 280 meters of counterpoise wire per pole structure.

1.9 Testing of pole structure

1.9.1 General

1.9.1.1 Bidder shall offer single circuit/ double circuit pole structures which have already been designed & proto type tested conforming to minimum specified requirement stipulated in this specification. In case of non-availability of tested design of pole structures with the Contractor, design, optimization and prototype testing of that type of pole structures shall be required to be carried out by the Contractor at their own cost.
For design of other pole structures with extensions, the factor of safety in the design shall not be less than the factor of safety considered in the design of above proto tested pole structures.

1.9.1.2 The pole structures shall be proto type tested with the extension mentioned in the following table by the contractor at any testing station having facilities to test

the structures. The proto type pole structures after inspection by employer shall be transported to the test bed by the Contractor. Testing of pole structure shall generally conform to IS 802 (Part-III). The employer shall depute their representative at their own expense to witness the tests. The responsibility for design and successful proto type testing shall solely lie with the Contractor. At the time of proto-assembly and/ or proto testing, if any modification is required to be carried out, the same shall be carried out by the Contractor without financial implication to employer. These modifications, if any, shall also be incorporated on the fabrication shop drawings and/ or on the structural drawings.

Sl. no.	Voltage Level of Transmission Line	Extension
1	765kV	Normal pole
2	400kv D/C (Quad)	
3	400kv D/C (Triple)	
4	400kV M/C (Twin-Twin)	
5	400kV D/C (Twin), 400kv S/C	Normal Pole+9m
6	220kV	
7	132kV	

1.9.1.3 A galvanized A galvanized pole structure of each type complete with specified extension shall be subjected to design and destruction tests by first applying test loads in a manner as approved by the Employer. The pole structure shall withstand these tests without showing any sign of failure or permanent distortion in any part. Thereafter, the pole structure shall be subjected to destruction by increasing the loads further in an approved manner . The pole structure shall be tested specified loading conditions as approved by employer. The Contractor shall submit to the Employer, for approval, the detailed programme and proposal for testing the pole structures showing the methods of carrying out the tests and manner of applying the loads. After the Employer has approved the test procedures and programmes the Contractors will intimate the Employer about carrying out the tests at least 30 days in advance of the scheduled date of tests during which the Employer will arrange to depute his representative to be present at the time of carrying out the tests. Six copies of the test reports shall be submitted. The Contractor shall submit one set of shop drawings alongwith the bill of materials at the time of prototype pole structure testing for checking the pole structure material. Further, at the time of submission of test report, the contractor has to submit the final drawings, shop drawings and Bill of materials for Employer's reference and record.

1.9.1.4 In case of premature failure, the pole structure shall be retested and steel already used in the earlier test shall not be used again. However, in case of minor failures, the contractor can replace the members with higher section and carry out the testing. The Contractor shall provide facilities to the Employer or their representatives for inspection of materials during manufacturing stage and also

during testing of the same. In case of any premature failure even during waiting period, the pole structure is to be retested with rectified members. However, if the failures are major in nature and considerable portion of pole structure is to be re-erected, in such cases all the tests which has been carried out earlier are required to be re-conducted again in compliance with Specification.

1.9.1.5 No part of any pole structure subject to test shall be allowed to be used on the line.

1.9.1.6 The Contractor shall ensure that the specification of materials and workmanship of all pole structures actually supplied conform strictly to the pole structures which have successfully under gone the tests. In case any deviation is detected, the Contractor shall replace such defective pole structures free of cost to the Employer. All expenditure incurred in erection, to and fro transportation and any other expenditure or losses incurred by Employer on this account shall be full borne by the Contractor. No extension in delivery time shall be allowed on this account.

1.9.1.7 Each type of pole structure to be tested shall be a full-scale prototype galvanized pole structure and shall be erected vertically on rigid foundation. The pole structure erected on test bed shall not be out of plumb by more than 1 in 360.

1.9.1.8 All the measuring instruments shall be calibrated in systematic/ approved manner with the help of standard weight/ device. Calibration shall be done before commencing the test of each pole structure upto the maximum anticipated loads to be applied during testing.

1.9.1.9 The tension pole structure is to be tested with strain plate as per approved design/ drawings.

1.9.1.10 The sequence of testing shall be decided by the Employer at the time of approving the rigging chart/ test data sheet.

1.9.1.11 The Employer may decide to carry out the tensile test, bend test etc. as per the relevant IS/ DIN on few members of the test pole structure after completion of the test or in case of any premature failure. The Contractor shall make suitable arrangement for the same without any extra cost to the Employer.

1.9.1.12 Prefix ‘T’ shall be marked on all members of test pole structure in addition to the Mark No. already provided.

1.9.2 **Method of Load Application**

1.9.2.1 Loads shall be applied according to the approved rigging arrangement through normal wire attachments angles on bent plates.

1.9.2.2 The various types of loads, transverse, vertical and longitudinal shall be applied in such a way that there is no impact loading on the pole structure due to jerks from the winches.

1.9.2.3 All the loads shall be measured through a suitable arrangement of strain devices or by using weights. Positioning of the strain devices shall be such that the effect of pulley friction is eliminated. In case the pulley friction cannot be avoided, the same will be measured by means of standards weights and accounted for in the test loads.

1.9.3 **Pole structure Testing Procedure**

The procedure for conducting the pole structure test shall be as follows:

1.9.3.1 **Bolt Slip & joint adjustment test**

In a bolt slip test, the test loads shall be gradually applied up to the 50% of design loads under normal condition, kept constant for two (2) minutes at that loads and then released gradually.

For measurement of deflection the initial and final readings on the scales (in transverse & longitudinal directions) before application and after the release of Loads respectively shall be taken with the help of theodolite. The difference between readings gives the values of the bolt slip.

1.9.3.2 **Normal Broken Wire Load Tests**

All the loads, for a particular load-combination test, shall be applied gradually upto the full design loads in the following steps and shall also be released in the similar manner:

25 percent,

50 percent,

75 per cent,

90 percent,

95 percent and

100 percent

1.9.3.3 **Observation Periods**

Under normal and broken wire load tests, the pole structure shall be kept under observation for sign of any failure for two minutes (excluding the time of adjustment of loads) for all intermediate steps of loading upto and including 95 percent of full design loads.

For normal, as well as broken wire tests, the pole structure shall be kept under observation for five (5) minutes (excluding the time for adjustment of loads) after it is loaded upto 100 percent of full design loads.

While the loading operation are in progress, the pole structure shall be constantly watched, and if it shows any tendency of failure anywhere, the loading shall be immediately stopped, released and then entire pole structure shall be inspected. The reloading shall be started only after the corrective measures are taken.

Full design loads for five (5) minutes, with no visible local deformation after unloading (such as bowing, buckling etc.) and no breakage of elements or constitute parts. The structure shall be considered to be satisfactory, if it is able to support the specified.

Ovalization of holes and permanent deformation of bolts shall not be considered as failure.

Further, for pole the maximum deflection during testing shall not exceed 8% of the height of the pole being tested for test load cases.

1.9.3.4 **Recording**

The deflections of the pole structure in transverse and longitudinal directions shall be recorded at each intermediate and final stage of normal load and broken wire load tests by means of a theodolite and graduated scale. The scale shall be of about one metre long with marking upto 5 mm accuracy.

1.9.3.5 **Destruction Test**

The destruction test shall be carried out under normal condition or broken wire condition. Under which load condition the destruction test is to be carried out shall be intimated to the contractor at the time of approving rigging chart/ test data.

The procedure for application of load for normal/broken wire test shall also be applicable for destruction test. However, the load shall be increased in steps of five (5) per cent after the full design loads have been reached till the load value reaches as specified in approved rigging chart or pole fails (whichever is earlier).

1.10 Standards

1.10.1 The design, manufacturing, fabrication, galvanising, testing, erection procedure and materials used for manufacture and erection of pole structures, design and construction of foundations shall conform to the following Indian Standards (IS)/ International Standards which shall mean latest revisions, with amendments/ changes adopted and published, unless specifically stated otherwise in the Specification. In the event of supply of material conforming to Standards other than specified, the Bidder shall confirm in his bid that these Standards are equivalent to those specified. In case of award, salient features of comparison between the Standards proposed by the Bidder and those specified in this document will be provided by the Contractor to establish their equivalence.

1.10.2 The material and services covered under these specifications shall be performed as per requirements of the relevant standard code referred hereinafter against each set of equipment and services. Other internationally acceptable standards which ensure equal or higher performance than those specified shall also be accepted.

Sl. No.	Indian Standard	Title	International Standard
1	IS 209:1992	Specification for Zinc	
2	IS 278:1991	Galvanised Steel Barbed wire	
3	IS 800:1991	Code of Practice for General Building Construction in Steel	
4(a)	IS 802(Part 1) Sec 1-2015 Sec 2-2015	Code of Practice for General Building Construction in Steel in Overhead Transmission Line Pole: Materials, loads and Permissible Stress Section-1: Materials and loads Section-2: Permissible stresses.	
4(b)	IS 802(Part 2): 1990	Code of Practice for use of structural steel in Overhead Transmission Line: Fabrication, Galvanising, inspection & Packing	
4(c)	IS 802(Part 3): 1990	Code of Practice for use of structural steel in Overload Transmission Line: Pole testing	

Sl. No.	Indian Standard	Title	International Standard
5	IS 808:1991	Dimensions for Hot Rolled Steel Beam, Column, Channel and Angle Sections.	
6	IS 875:1992	Code of Practice for Design Loads (other than Earthquakes) for Buildings and Structures.	
7	IS 1363:1990	Hexagon Nuts (size range M5 to M36)	
8	IS 1367:1992	Technical Supply Conditions for Threaded Steel/ Fasteners	
9	IS 1477:1990	Code of practice for Painting of Ferrous Metals in Buildings: Part-I: Pre-treatment Part-II: Painting.	
10	IS 1573:1991	Electro-Plated Coatings of Zinc on iron and Steel	
11	IS 1852:1993	Rolling and Cutting Tolerances of Hot Rolled Steel Products	
12	IS 1893:1991	Criteria for Earthquake Resistant Design of Structures	
13	IS 2016:1992	Plain Washers	
14	IS 2062:1992	Steel for general structural purposes	
15	IS 2074:1992	Ready Mixed Paint. Air Drying, Oxide. Zinc Chrome, Priming Specification.	
16	IS 2551:1990	Danger Notice Plates	
17	IS 2629:1990	Recommended Practice for Hot Dip Galvanising of iron and steel.	
18	IS 2633:1992	Method of Testing Uniformity of Coating of Zinc Coated Articles	
19	IS3043:1991	Code of Practice for Earthing	

Sl. No.	Indian Standard	Title	International Standard
20	IS 3063:1994	Single coil Rectangular section Spring Washers for Bolts, Nuts Screws	
21	IS 3757: 1992	High Strength Structural Bolts	
22	IS:4759-1990	Specification for Hot zinc coatings on structural steel and other Allied products	
23	IS 5369:1991	General Requirements for Plain Washers	
24	IS 5613:1993	Code of Practice for Design installation and Maintenance of Overhead Power Lines Section-1: Design Part 2, Section-2: Installation and Maintenance	
25	IS 6610:1991	Specification for Heavy Washers for Steel structures	
26	IS 6623:1992	High Strength Structural Nuts	
27	IS 6639:1990	Hexagon Bolts for Steel Structure.	
28	IS 6745:1990	Method for Determination of weight of Zinc coated iron and Steel Articles.	
29	IS 8500:1992	Specification for Weldable Structural Steel (Medium & High Strength Qualities)	
30	IS 10238:1989	Step Bolts for Steel Structures	
31	IS 12427:1988	Bolts for Transmission Line Poles	
32	Publication No. 19(N)/700	Regulation for Electrical Crossing of Railway Tracks	
33		Design of Steel Transmission Pole Structures.	ASCE 48-11
34		Design of Steel Transmission Pole Structures.	ASCE Manuals and reports on

Sl. No.	Indian Standard	Title	International Standard
			Engineering practice No. 72

The standards mentioned above are available from

Reference Abbreviation	Name and Address
BIS/IS	Beureau Of Indian Standards. Manak Bhavan, 9, Bahadur Shah Zafar Marg, New Delhi - 110001 INDIA
ISO	International Organisation for Standardization. Danish Board of Standardization Danish Standardizing Sraat, Aurehoegvej-12 DK-2900, Heeleprup, DENMARK
CSA	Canadian Standard Association 178, Rexadale Boulevard, Rexdale (Ontario) Canada, M9W 1R3
DIN	Deutsches Institute fiir Normung, Burggrafenstrassee 4-10 Post Farh 1107 D-1000, Berlin 30 GERMANY
ASTM	American Society for testing and Material 1916 Race Street Philadelphia. PA 1903-1187 USA
Indian electricity Rules Regulation for electricity crossing of railway Tracks	Kitab Mahal Baba Kharak singh Marg New Delhi-110001 INDIA
ASCE	American Society of civil Engineers 345 East 47th Street New York, NY 10017-2398 USA

IEEE	Institute of Electrical and Electronics Engineers 445 Hoes LanePiscataway, NJ 0085-1331, USA
IEC	International Electro technical Commission, Bureau Central de la Commission, electro Technique international, 1 Rue de verembe, Geneva, SWITZERLAND

2.0 Foundations

2.1 General

2.1.1 The scope of work for foundation shall include soil investigation, design, supply of materials such as cement, sand aggregates, reinforcement steel as well as all items of work related to supply and installation of foundations such as form work, excavation, anchor bolt/ stub setting, concreting, placement of reinforcement, shoring, shuttering, dewatering, stock piling, dressing, curing, backfilling etc. and any activity related to completion of foundation work.

2.1.2 The contractor shall carry out geotechnical investigation at every pole location. The price of geotechnical investigation at pole location is deemed to be included in the lump sum quoted price of foundation in BPS.

2.1.3 The bidder is required to quote in the relevant schedules of Bid Proposal Sheets, the composite rate of foundation per pole structure for the foundations listed in the Bill of quantities. The composite rate quoted shall deem to include the complete scope of work as indicated above.

2.1.4 For the foundation types/ classifications listed in Bill of Quantities, the respective composite rate only shall be payable to the contractor irrespective of change in approved design volumes/ quantities in comparison to the estimated volumes/ quantities furnished at the time of bidding.

2.1.5 Design and Casting of Foundations which are not specified in the Final BPS of the Contract Agreement, but required during execution of the project and authorised by the Employer, shall have to be carried out by the Contractor. No additional payment on account of Design charges shall be payable. Payment for execution of such foundations shall be made on mutually agreed rates to be derived on the basis of rates available in the Contract during execution stage.

2.2 Type of Foundations

The foundation shall generally be either pier type or pile or screw pile type for pole structures. However, for 132kV and 220kV pole structure, open cast type foundation is also permitted. The payment of foundation shall be restricted to the lump sum quoted price of foundation in BPS, irrespective of the type of foundation

2.2.1 Classifications of Open Cast Foundations

Classification of foundations and design of foundation depend upon the type of soil, sub- soil water level and the presence of surface water which have been classified as follows:

2.2.1.1 **Normal dry**

To be used for locations where normal dry cohesive or non-cohesive soils are met. Foundations in areas where surface water encountered from rain runoff shall also be classified as normal dry.

2.2.1.2 **Sandy Dry Soil**

To be used for locations where cohesion less pure sand or sand with clay content less than 10% met in dry condition. If the clay content is more than 10 % met in dry condition, the foundation shall be classified as Normal Dry.

2.2.1.3 **Wet**

To be used for locations where sub-soil water table is met between 1.5 meters from ground level and the depth of foundation below the ground level.

2.2.1.4 **Wet Cultivated**

To be used for locations where there is no sub-soil water within the foundation depth but which are in surface water for long period with water penetration not exceeding one meter below the ground level e.g. paddy fields/cultivated field. However, if water penetration due to surface water is more than one meter below ground level, the adoption of suitable foundation shall be decided by site In-charge in consultation with corporate engineering department.

2.2.1.5 **Partially Submerged**

To be used at locations where sub-soil water table is met between 0.75 meter and 1.5metre below the ground level.

2.2.1.6 **Fully Submerged**

To be used at locations where sub-soil water table is met at less than 0.75 meter below the ground level.

2.2.1.7 **Black Cotton Soil**

To be used at locations where soil is clayey type, not necessarily black in colour, which shrinks when dry and swells when wet, resulting in differential movement. For designing foundations, for such locations, the soil is considered submerged in nature.

2.2.1.8 **Fissured Rock**

To be used at locations where decomposed or fissured rock, hard gravel, kankar, limestone, laterite or any other soil of similar nature is met. Under cut type foundation is to be used for fissured rock locations.

In case of fissured rock locations, where water table is met at 1.5M or more below ground level, wet fissured rock foundations shall be adopted. Where fissured rock is encountered with subsoil water table less than 1.5 meter below ground level, submerged fissured rock foundations shall be adopted. In case of dry locations dry fissured rock foundations shall be adopted.

2.2.1.9 **Hard Rock**

The locations where chiseling, drilling and blasting is required for excavation for monolithic rock for a particular leg/ pole, Hard rock type foundations are to be used. For these locations rock anchoring is to be provided to resist uplift forces. For quoting prices of Hard Rock foundations, Rock level shall be assumed at 1.5 meters below the ground level. Due to change in Rock level, no extra payment shall be payable on account of increase in concrete volume, excavation volume and weight of reinforcement. Also, no recovery shall be made if the actual volume of concrete, excavation and weight of reinforcement are less than that quoted in Schedule of prices. However, for design purpose, Rock level shall be considered at ground level and no over burden soil weight shall be considered for resisting the uplift.

2.2.2 The sub-soil water table is not constant and its level changes during different seasons due to various factors. In case during soil investigation/ trial pit or during excavation, if wet soil/ fissures rock is encountered within the foundation depth, it is to be considered that water table has been encountered (considering that water table had reached that level sometime in past) and accordingly type of foundation shall be classified.

2.2.3 Where soil is of composite in nature, classification of foundation shall be according to the type of soil predominant in the foundation pit**.**

2.2.4 The foundation classification at any particular location shall be based on the type of soil (clay/ sandy/ silt/ fissured rock etc.) and water table, presence of surface water, etc. at the location. However, in case of locations which are in vicinity of rivers, depending upon case to case, type of foundation is to be decided considering other aspects also e.g. in case RL (reduced level) of a location in comparison to the HFL is lower and there is possibility of submergence at the time of floods due to absence of river bunds/ protection etc., FS type foundation with suitable raised chimney/ Pedestal/ pier is to be adopted. Further in case there is a possibility of change in river course, considering the nature and turbulence of

probable water flow and subsequent scouring of soil, pile type or special foundation may be considered for these locations.

2.2.5 Design Parameters for Open Cast Foundations

2.2.5.1 The foundation designs shall depend upon the type of soil, soil properties, sub soil water level. Design of foundations for all pole structures and pole structures with extensions shall be developed by the contractor based on the typical soil properties as indicated below in the table.

Soil Properties for open Cast type foundation

Sl. No	Properties of Soil	Ultimate Bearing Capacity in KN/M^2 (Kg/M^2)	Angle of Repose (Degree)
1	**For Normal Soil (UP, Uttarakhand, Haryana, Delhi, Bihar, Jharkhand, WB, MP, Chhattisgarh, Kerala, J&K, Ladakh, Assam, Andhra Pradesh, Telangana, Tamil Nadu)**		
	Normal Dry Soil	268 (27350)	30
	Wet Soil Due to Presence of Subsoil/ Surface Water	134 (13675)/ 268(27350)	15
	Black cotton Soil Due to Presence of Subsoil/Surface water and dry condition	134 (13675)	0
	Sandy Soil	268 (27350)	20
2	**For Normal Soil (Rajasthan)**		
	Normal Dry Soil	268 (27350)	25
	Wet Soil Due to Presence of Subsoil/ Surface Water	134 (13675)/ 268(27350)	10
	Black cotton Soil Due to Presence of Subsoil/Surface water and dry condition	134 (13675)	0
	Sandy Soil	268 (27350)	20
3	**For Normal Soil (Maharashtra)**		
	Normal Dry Soil	490(50000)	30
	Wet Soil Due to Presence of Subsoil/ Surface Water	122.5 (12500)/ 490(50000)	10
	Black cotton Soil Due to Presence of Subsoil/ Surface Water and dry condition	122.5 (12500)	0
4	**For Normal Soil (Himachal Pradesh)**		
	Normal Dry Soil	196 (20000)	30
	Wet Soil Due to Presence of Subsoil/ Surface Water	98 (10000)/ 196 (20000)	15
	Black cotton Soil Due to Presence of Subsoil/ Surface Water and dry condition	98 (10000)	0
	Sandy Soil	196 (20000)	20

5	**For Normal Soil (Karnataka)**		
	Normal Dry Soil	214.5 (21870)	30
	Wet Soil Due to Presence of Subsoil/ Surface Water	107.2 (10935)/ 214.5 (21870)	15
	Black cotton Soil Due to Presence of Subsoil/ Surface Water and dry condition	107.2 (10935)	0
	Sandy Soil	214.5 (21870)	20
6	**For Normal Soil (Odisha)**		
	Normal Dry Soil	256.5 (26175)	30
	Wet Soil Due to Presence of Subsoil/ Surface Water	183.8 (18750)/ 256.5 (26175)	15
	Black cotton Soil Due to Presence of Subsoil/ Surface Water and dry condition	183.8 (18750)	0
	Sandy Soil	256.5 (26175)	20
7	**For Normal Soil (Punjab)**		
	Normal Dry Soil	264.6 (27000)	30
	Wet Soil Due to Presence of Subsoil/ Surface Water	132.3 (13500)/ 264.6 (27000)	15
	Black cotton Soil Due to Presence of Subsoil/ Surface Water and dry condition	132.3 (13500)	0
	Sandy Soil	264.6 (27000)	20
8	**For Normal Soil (Gujarat)**		
	Normal Dry Soil	268 (27350)	30
	Wet Soil Due to Presence of Subsoil/ Surface Water	134 (13675)/ 268(27350)	15
	Black cotton Soil Due to Presence of Subsoil/ Surface Water and dry condition	107.8 (11000)	0
	Sandy Soil	268 (27350)	20
9	Fissured Rock		
	a) Fissured rock in dry portion	613 (62500)	20
	b) Fissured rock in presence of water	613 (62500)	10
10	Hard Rock	1225.83 (125000)	
11	Weight of earth for normal soil and black cotton soil	UNIT	VALUE
	a) Dry	KN/M3 (Kg/M3)	14.12 (1440)
	b) In presence of Surface Water	KN/M3 (Kg/M3)	14.12 (1440)
	c) In presence of Subsoil Water	KN/M3 (Kg/M3)	9.22 (940)
12	Weight of Fissured Rock		
	a) Dry	KN/M3 (Kg/M3)	14.12 (1440)

	b) In presence of Subsoil Water	KN/M3 (Kg/M3)	9.22 (940)
13	Ultimate bond between Steel & Rock for Hard Rock foundations	KN/M2 (Kg/M2)	0.147 (15)

2.2.5.2 Type of foundation to be adopted for a particular location shall be decided based on above foundation design parameters and geotechnical investigation. Further, in case the soil parameters as per the geotechnical report are inferior, the same shall be adopted for design of foundation. However, no extra payment shall be payable to contractor and the payment of foundation shall be restricted to the lump sum quoted price of foundation in BPS.

2.2.6 **Loads on Foundations**

2.2.6.1 The foundations shall be designed to withstand the specific loads of the superstructure and for the foundation reactions obtained from the structural stress analysis in conformity with the relevant factors of safety.

2.2.6.2 The reactions on the foundation shall be composed of the following type of loads for which these shall be required to be checked:

a) Max. Tension or uplift loads.

b) Max. Compression or down-thrust loads.

c) Max. Horizontal shear or side thrust.

d) Max. Bending moment/ Overturning moment

2.2.6.3 **Overload factor for Foundation loads**:

The overload factor for foundation loads shall be considered as 1.1 i.e. the reaction on the foundations shall be increased by 10 percent.

2.2.6.4 **Stability analysis**

In addition to the strength design, stability analysis of the foundation shall be done to check the possibility of failure by over-turning, uprooting, sliding and tilting of the foundation.

2.3 Design of Foundations

2.3.1 Structural design of foundation shall be done by limit state method as per IS-456: 2010.

2.3.2 Pier type foundation, proposed to be adopted by bidder, shall be designed & constructed as per IS-456, IS-491 and prudent utility practices and applicable

national/ international standards/ practices so as to withstand all loads/ reactions due to pole structures. The soil strength factor shall be considered as 0.7.

2.3.3 Design & Construction of Pile type foundation shall conform to IS 2911.

2.3.4 In case of Screw anchor type foundations, design shall be as per applicable international standards and prudent utility practices. Detailed design calculations shall be submitted by the Contractor for approval of the Employer.

2.3.5 The construction drawings/ working drawings along with design calculation of foundations shall be submitted by the contractor for approval before execution.

2.4 Properties of Concrete

2.4.1 For open cast type foundations:

The cement concrete used for the foundations shall generally be of grade of M20. All the properties of concrete regarding its strength under compression, tension, shear, punching and bending etc. as well as workmanship will conform to IS 456.

2.4.1.1 The Quantity of minimum cement to be used per unit quantity of consumption shall be 400 kg for 1:1.5:3 nominal mix concrete. In this regard utilization record is to be maintained at site.

Weigh batching in place of volumetric batching (1:1.5:3) as an alternative may be adopted. Further, use of self loaders viz Ajax Fiori / small portable weigh batcher may be permitted for batching and mixing of concrete, subjected to compliance of following: -

(i) Weight of cement, sand and aggregate equivalent to that of nominal mix of proportion 1:1.5:3 by volume basis shall be calculated. For finalisation of weight, average of 5 samples of cement, sand and aggregates shall be taken from measurement boxes. The volumetric conversions to the weight shall be noted and the same conversion shall be applied to the entire location.

(ii) For every change in source of sand/ aggregates, the weights shall be recorded.

(iii) The minimum cement content shall remains same i.e. 400 kg/m3.

(iv) Calibration certificate of self-loader/concrete producing equipment shall be checked before start of concreting works. The accuracy of the measuring equipment shall be within +/- 2% of the quantity of cement and within +/-3% of the quantity of aggregate.

(v) 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.

(vi) Necessary modification in weight of fine aggregate due to bulkage may be taken care in weigh batching. Water cement ration due to moisture content shall be suitably adjusted.

(vii) Concreting using RMC (Ready Mix Concrete) may also be carried out with weight ratio to be calculated as per S.No. (i) above.

2.4.1.2 Alternatively, Ready Mix concrete from batching plant as per IS 4925 can also be used with no extra payment and without any recovery. However, Cement content shall be as per IS 456. The ready-mix concrete shall conform to IS 4926. The selection and use of Materials for the ready-mix concrete shall be in accordance with IS:456. The concrete shall be of M25 grade design mix as per IS 456. However, minimum cement content shall not be less than 330 kg/m3. The transport of concrete and transportation time shall be as per IS 4926.

2.4.1.3 Use of small batching machines/ self-loading mixers may be allowed after verification of cement consumption and mix by Employer site in-charge. The equipment shall have facility of checking the proportion of ingredients of concrete being made. The records of mix shall be maintained at site. The calibration of equipment shall be done at regular intervals.

2.4.2 For Pier/ Pile type foundations:

2.4.2.1 Concrete for Pile/ Pier type foundation shall be M25 grade design mix as per IS 456 or readymade mix as specified in 2.4.1.2. However, minimum cement content shall not be less than 330 kg/m3.

2.4.3 The Cement used shall be ordinary Portland Cement, unless mentioned otherwise, conforming to the latest Indian Standard Code IS 269 or IS 8112 or IS 12269.

Alternatively, other varieties of cement other than ordinary Portland Cement such as Portland Pozzolana Cement conforming to IS 1489 (latest edition) or Portland Slag Cement conforming to IS 455 (Latest edition) can also be used. The Contractor shall submit the manufacturer's certificate, for each consignment of cement procured, to the Employer. However, Employer reserves the right to direct the Contractor to conduct tests for each batch/ lot of cement used by the Contractor and Contractor will conduct those tests free of cost at the laboratory so directed by the Employer. The Contractor shall also have no claim towards suspension of work due to time taken in conducting tests in the laboratory. Changing of brand or type of cement within the same structure shall not be permitted without the prior approval of the Employer. Sulphate Resistant Cement shall be used if Sulphate content is more than the limits specified in IS:456, as per Geotechnical investigation report.

Ordinary Portland Cement (OPC) and Portland Pozzolana Cement (PPC) or Portland Slag Cement are Technically Equivalent and there would not be any financial implication / or recovery to be borne by Employer / Contractor. However, the minimum cement content shall be as per above table for nominal mix concrete.

2.4.4 Coarse and fine aggregates shall confirm to IS 383:2016.

2.4.5 The water used for mixing concrete shall be fresh, clean and free from oil, acids & alkalis, organic materials or other deleterious substances.

2.4.6 Reinforcement shall confirm to IS 1786 for high strength steel bars (Fe 500/ Fe500D). If mentioned in BPS, epoxy coated reinforcement conforming to IS 13620 shall be used. Thermo Mechanically Treated (TMT) bars (equivalent grade) in place of cold twisted bars are also accepted. Hard drawn steel wire shall conform to IS 432. All reinforcement shall be clean and free from loose mill scales, dust, loose rust and coats of paint, oil or other coatings, which may destroy or reduce bond. Contractor shall supply, fabricate and place reinforcement to shapes and dimensions as indicated or as required to carry out the intent of approved foundation drawings and Specifications. The contractor may also use pre-fabricated/assembled reinforcement cage conforming to shape, dimension, size as per approved foundation drawing. Spacers, chairs, stays, hangers, overlaps and annealed steel wire for binding etc. as may be necessary, should be used for proper completion of the foundation job as per requirement. Spacers or chairs should be placed at a maximum spacing of 1m and closer spacing shall be provided wherever necessary.

2.4.7 Use of crushed stone in place of natural sand, in case of non-availability or restriction by local authority, may be allowed by Employer site in-charge subject to sieve analysis meeting acceptance criteria as per relevant IS and complying of other requirement as per standard field quality plan.

2.4.8 For foundation in coastal areas or creek or aggressive soil areas or under marine environment, if mentioned in BPS, Ready Mix Concrete of M30 Grade shall be used to avoid use of locally available saline water. However, design mix concrete of M30 Grade conforming to IS 456 with potable water can be used at locations where transportation of ready-mix concrete is not feasible. Minimum cement content in any case shall not be less than 330kg/m3. The surface of the reinforcement steel shall be treated with epoxy based coating to enhance corrosion performance of foundation. Use of epoxy coated reinforcement in foundation shall be as per IS 13620. In addition, 02 (two) numbers of coats of bituminous painting of minimum 1.6 kg/m2 per coat shall be applied on all the exposed faces of the foundation (i.e. pedestal & base slab). Double coat 20 mm thick cement plaster shall be provided on all exposed concrete surface as well up to 300 mm below ground level to give protection to concrete surface from environmental and saline effect. Before coping of chimney top portion, three coats of anti-corrosive paint of minimum 30-35 microns dry film thickness each shall be applied on the stub in the 50 mm coping portion as well as up to 350mm above CL portion. Cost of the above shall be deemed to be included in the rates quoted.

2.5 Construction of pole structure Foundation,

The contractor shall submit detailed methodology for construction of foundation for pole structures to Employer's site in-charge. The construction methodology shall conform to applicable standards and prudent utility practices and safety norms.

2.6 Setting of Anchor bolt

2.6.1 The anchor bolts shall be set correctly in accordance with approved method at the exact location & alignment and precisely at correct levels with the help of anchor bolt setting templates, if required, and leveling instrument. Anchor bolts shall be set in the presence of Employer's representative available at site and for which adequate advance intimation shall be given to the Employer by the Contractor.

2.6.2 Setting of anchor bolts at each location shall be approved by the Employer's representative

2.7 Mixing, Placing and Compacting of Concrete

2.7.1 The concrete shall be mixed in the mechanical mixer. However, in case of difficult terrain, hand mixing may be permitted at the discretion of the Employer. The water for mixing concrete shall be fresh, clean and free from oil, acids and alkalis. Saltish or blackish water shall not be used.

Alternatively, Ready Mix concrete from batching plant as per IS 4925 can also be used used with no extra payment and without any recovery. However, Cement content shall be as per IS 456. The ready-mix concrete shall conform to IS 4926. The selection and use of Materials for the ready-mix concrete shall be in accordance with IS:456. The concrete shall be of M25 grade design mix as per IS:456. The transport of concrete and transportation time shall be as per IS 4926. Record of delivery ticket information as per Annexure-G of IS 4926 has to be maintained.

2.7.2 Mixing shall be continued until there is uniform distribution of material and mix is uniform in colour and consistency, but in no case the mixing be carried out for less than two minutes. Normal mixing shall be done close to the foundation but exceptionally, in difficult terrain**,** the concrete may be mixed at the nearest convenient place. The concrete shall be transported from the place of mixing to the place of final deposit as rapidly as practicable by methods which shall prevent the segregation or loss of any ingredient. The concrete shall be placed and compacted before setting commences.

2.7.3 If minor defects in concrete surface is found after the form work has been removed, the damage shall be repaired with a rich cement sand mortar to the satisfaction of the Employer before the foundation is back filled.

2.8 **Curing**

The concrete shall be cured by maintaining the concrete wet for a period of at least 10 days after placing. Once the concrete has set for 24 hours the pit may be backfilled with selected moistened soil. The exposed concrete shall also be kept wet by wrapping gunny bags around it and wetting the bags continuously during the initial 10 days period.

2.9 **Benching**

When the line passes through undulated terrain, levelling the ground may be required for casting of pole structure foundations. All such activities shall be termed benching and shall include cutting of excess earth and removing the same to a suitable point of disposal as required by Employer. Benching shall be resorted to only after approval from Employer. Volume of the earth to be cut shall be measured before cutting and approved by Employer for payment purposes.

3.0 Pole structure Erection

3.1 General

3.1.1 The scope of erection work shall include the cost of all labour, tools and plant such as mechanized rope way, wherever required, for hilly areas for transportation of materials and all other incidental expenses in connection with erection work.

3.1.2 The Contractor shall be responsible for transportation to site of all the materials to be supplied by the Contractor as well as proper storage and preservation of the same at his own cost, till such time the erected line is taken over by the Employer. Similarly, the Contractor shall be responsible for transportation, proper storage, safe custody, and loss or damage of all Employer's supplied items for incorporation in the lines and shall maintain and render proper account of all such materials at all times. The Contractor shall reimburse the cost of any of the materials lost or damaged during storage and erection over and above specified and permitted in the technical specifications.

3.1.3 Contractor shall set up required number of stores along the line and the exact location of such stores shall be discussed and agreed upon with the Employer. Employer during the kick off meeting at site supplied items shall be dispatched to the stores set up by the Contractor.

3.2 Treatment of Minor Damage

Minor defects in hot-dip galvanized members shall be repaired by applying zinc rich paint to the satisfaction of the Employer before erection.

3.3 Assembly

The Contractor shall give complete details of the erection procedures he proposes to follow.

3.3.1 The method for the erection of pole structures shall ensure the following:

a) Straining of the members shall not be permitted for positioning. It may, however, be necessary to match hole positions at joints using tommy bars not more than 450mm in length

b) The bolt positions in assembled pole structures shall be as per IS 5613 (Part II/Section 2);

c) Pole structure shall be fitted with number, danger, Bird guard, circuit plate, pole plate and phase plates as well as anti-climbing device, as described;

d) After complete erection of the pole structure, all blank holes, if any, are to be filled by bolts and nuts of correct size.

e) The pole structures shall not be out of vertical by more than 1 in 360 before stringing is carried out.

3.4 Tightening of Bolts and Nuts

3.4.1 All nuts shall be tightened properly using correct size spanner and preferably using torque wrench. Before tightening, it will be verified that filler washers and plates are placed in relevant gap between members, bolts of proper size and length are inserted, and one spring washer is inserted under each nut. In case of step bolts, spring washers shall be placed under the outer nuts. The tightening shall progressively be carried out from the top downwards, care being taken that all bolts at every level are tightened simultaneously. The threads of bolts projecting outside the nuts shall be punched at their position on the diameter to ensure that the nuts are not loosened in course of time. If, during tightening, a nut is found to be slipping or running over the bolt threads, the bolt together with the nut shall be replaced.

3.4.2 The threads of all the bolts projected outside the nuts shall be welded at two diametrically opposite places; the circular length of each welding shall be at least 10 mm. The welding shall be provided from ground level up to waist level for pole structures subject to maximum 30 m height from ground level. After welding the surface of welding shall be cleaned, dried and made free of oil, grease and corrosion product and on this surface Zinc Rich Paint shall be applied by means of a brush according to the paint manufacturer's recommendations. Zinc Rich Paint, Pre- mixed type paint, based on organic/ inorganic binders specially formulated for steel surfaces may be used. The dried film of Zinc Rich Paint should contain a minimum of 92 percent Zinc Dust by mass. The cost of welding and paint including application of paint shall be deemed to be included in the erection price.

3.5 Final checking, Testing and Commissioning

After completion of the works, final checking of the line shall be carried out by the Contractor to ensure that all foundation works and pole structure erection have

been done strictly according to the specifications and as approved by the Employer. All the works shall be thoroughly inspected in order to ensure that:

a) Sufficient backfilled earth covers each foundation pit and is adequately compacted;

b) Concrete chimneys and their copings are in good condition and finely shaped.

c) All pole structure members are used strictly according to final approved drawing and are free of any defect or damage whatsoever.

d) All bolts are properly tightened, punched, tack welded and painted with zinc rich paint;

e) All other requirements for completion of works such as fixing of danger plate, phase plate, number plate, anti-climbing device and aviation signal have been fulfilled.

f) Wherever required, that proper revetment (erosion protection) is provided;

g) The original tracings of profile and route alignment as well as pole structure design, structural drawings, bill of material and shop drawings of all pole structures are submitted to the *Employer* for reference and record.

h) All pole structures are properly grounded.

3.5.1 The contractor should also fulfill the requirements of pre-commissioning procedure as given in ***Appendix–I of Section -IVC*** to this Specification

4.0 Field Quality Plan

The Contractor shall execute the work in accordance with the Field Quality Plan which is available on the POWERGRID Website 7 (seven) days prior to the actual date of bid opening. In this Standard Field Quality plan, the word “pole” as mentioned shall be treated as Pole structures.

5.0 Manufacturing Quality Plan

Manufacturing quality plan of pole structure shall be submitted by the contractor to Employer’s QA&I department pole structure manufacturing shall be carried out in accordance with Manufacturing Quality plan approved by the employer prior to manufacturing of pole structures. In this Manufacturing Quality Plan, the word “pole” as mentioned shall be treated as pole structures.