



Standard Technical Specification for SUBSTATION- STRUCTURES

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1.0 GENERAL

The scope of specification covers design, fabrication, proto assembly, supply, and erection of galvanized steel structures for towers, girders, lightning masts, and equipment support structures. Structures shall be lattice or Pipe type structure fabricated from structural steel conforming to relevant Indian standard Codes (IS Codes).

Contractor shall design and develop design/drawings for Towers, girders, Lightning mast, equipment support structures for required voltage class and get approved by Employer. The type of structure shall be Lattice type. The fabrication drawings, proto corrected drawings along with Bill of Material (BOM) for all the structures (Both Gantry and Equipment support structures) shall be prepared by the contractor during detailed engineering for submission to Employer for approval. Support structure for circuit breaker shall also be designed by the Contractor. Contractor is expected to design the equipment support structures with the provision of stool. Stools shall be provided by the Contractor between the equipment and its support structure to match the bus bar height. The top of stool shall be connected to the equipment and the bottom of the stool shall be connected to the Base support structure.

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, ground mounted marshalling boxes (AC/DC Marshalling box & equipment control cabinets), structure mounted marshalling boxes 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 and anchor/foundation bolts, fasteners (Nuts, bolts, washers) shall be fully galvanized as per relevant Indian standard Codes (IS Codes) . The weight of the zinc coating shall be at least 610 grams /sq. m for anchor bolts/foundation bolts and for structural members. One additional nut shall be provided below the base plate which may be used for the purpose of levelling. Contractor shall provide suitable arrangement on the equipment support structures wherever required to suit fixation of accessories such as marshalling boxes, MOM boxes, Control Cabinets, Junction box, surge counter, etc. in the equipment structure fabrication drawings.

2.0 DESIGN REQUIREMENTS FOR STRUCTURES

2.1 For design of steel structures loads such as dead loads, live loads, wind loads etc. shall be based on relevant Indian standard Codes (IS Codes). Wind speed to be considered as per Wind map in National Building Code – 2016 (Volume-I) for all built-up structures in substation.

2.2 For materials and permissible stresses, relevant Indian standard Codes (IS Codes). Shall be followed in general. However, additional requirements given in following paragraphs shall be also considered.

2.3 Minimum thickness of galvanized lattice structure member shall be as follows:

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

2.4 Maximum slenderness ratios for leg members, other stressed members and redundant members for compression force shall be as per relevant Indian standard Codes (IS Codes).

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

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

2.7 Step Bolts

To facilitate inspection and maintenance, the tower 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 diagonally opposite legs extending from about 0.5 meters above plinth level to the top of the tower. The step bolt shall conform to relevant Indian standard Codes (IS Codes). Ladders along with safety guard shall be provided for the Lightning Mast Tower.

2.8 Design Criteria

- a) All gantry structures shall be designed for the worst combination of dead loads, live loads, wind loads and Seismic forces as per relevant Indian standard Codes (IS Codes). (latest), 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. Relevant Indian standard Codes (IS Codes) 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 assume that stringing is done only on one side i.e., all the three (phase) conductors broken on the other side. Factor of safety of 2.0 under normal conditions and 1.5 under short circuit condition shall be considered on all external loads 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 considered for the purpose of design. Weight of man with tools shall be considered as 150 kgs. for the design of structures.
- d) The distance between terminal gantry and dead-end tower shall be taken as approximate 200 meters, However same need to be discussed with Employer before start of design. 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 girders / beams shall be connected with lattice/Tower columns by bolted joints.
- f) All equipment support structures shall be designed for the worst combination of dead loads, erection load. Wind load/seismic forces, short circuit forces and operating forces acting on the equipment and associated bus bars as per relevant Indian standard Codes (IS Codes).

- g) If luminaries are proposed to be fixed on gantries/towers, 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) The height of Lightning Mast shall be as per approved structural layout and designed for diagonal wind condition. The lightning mast shall be provided with platform for mounting of 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 approved drawings of electrical fixtures.

3.0 DESIGN, DRAWINGS, BILL OF MATERIALS AND DOCUMENTS

3.1 The Contractor shall submit design and line diagram of each structure for approval of Employer. Fabrication drawing based on approved line diagram shall be prepared by the contractor for approval of Employer. The BOM (Bill of Material) shall be prepared by the contractor based on approved fabrication drawing. The Proto corrected BOM and Shop drawing shall be submitted to the employer for their records. The Line diagram should indicate not only profile, but section, numbers and sizes of bolts and details of typical joints. In case Employer feels that any design or drawings are to be modified even after its approval, Contractor shall modify the designs & drawings and resubmit the same for approval.

3.2 The 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. The fabrication drawing and bill of material based on design/line diagram shall be submitted to Employer for approval. Approved bill of materials prepared on the basis of fabrication drawing shall be the basis for payment.

3.3 Such approvals shall, however, not relieve the contractor of his responsibility for safety and durability of the structure and good connection and any loss occurring due to defective fabrication, design or workmanship shall be borne by the contractor.

3.4 The contractor shall submit editable soft copy of all designs preferably in Staad / excel form and drawings in AutoCAD to Employer. The list of Indian standard codes relevant to steel structures have been given in Civil section of technical specification, the list is illustrative but not exhaustive. The contractor shall submit the copy of relevant portion of IS codes referred to Employer for reference if necessary, during detailed engineering stage.

4.0 FABRICATION AND ERECTION

4.1 The fabrication and erection works shall be carried out generally in accordance with relevant Indian standard Codes (IS Codes). All materials shall be completely shop fabricated and finished with proper connection material and erection marks for ready assembly in the field.

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.

4.3 Sample towers, beams and lightning masts and equipment support structures may be proto assembled in the fabrication shop to ensure fitment of various members and to avoid problems during erection. It is the sole responsibility of contractor to ensure the member fitment at site.

4.4 For all structures, BOM along with fabrication drawings in hard and editable soft copies shall be submitted to Employer as document for information. The responsibility of correctness of such fabrication drawing and BOM shall be fully with the contractor.

4.5 Approval of fabrication drawings and BOM 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.

4.6 The Contractor should arrange on his own all plant and equipment, welding set, tools and tackles, scaffolding, trestles equipment's 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 Employer.

5.0 BOLTING

- a) 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.
- b) In case of fasteners, the galvanizing shall confirm to relevant Indian standard Codes (IS Codes). The spring washer shall be electro galvanized as per relevant Indian standard Codes (IS Codes).

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 relevant Indian standard Codes (IS Codes). Welding shall be carried out in accordance with relevant Indian standard Codes (IS Codes) /

7.0 FOUNDATION BOLTS

7.1 Foundation bolts for the towers and equipment supporting structures and elsewhere 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.

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

7.3 All foundation bolts for lattice structure, pipe structure is to be supplied by the Contractor.

7.4 All foundation bolts shall be fully galvanised so as to achieve minimum 610 grams Per Sq. m. of Zinc Coating as per relevant Indian standard Codes (IS Codes).

7.5 All foundation bolts and its material shall conform to relevant Indian standard Codes (IS Codes). All foundation bolts shall be provided with two number standard nuts, one check nut, one plain washer and MS plate at the bottom of foundation bolt.

8.0 STABILITY OF STRUCTURE

The Supplier 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.

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. No additional payment for grouting shall be admissible.

10.0 GALVANISING

10.1 All structural steel works (Gantry structures, Equipment support structures) and foundation bolts shall be galvanized after fabrication. The galvanization shall be done as per requirement relevant Indian standard Codes (IS Codes).

10.2 Zinc required for galvanizing shall have to be arranged by the Contractor/manufacturer. Purity of zinc to be used shall be 99.95% as per relevant Indian standard Codes (IS Codes).

10.3 The Contractor shall be required to make arrangement for frequent inspection by the Owner / Employer as well as continuous inspection by a resident representative of the Owner / Employer, if so desired for fabrication work.

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 of Employer before erection.

12.0 INSPECTION BEFORE DISPATCH

Each part of the fabricated steel work shall be inspected as per approved quality plans and certified by 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.

13.0 TEST CERTIFICATE

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

14.0 MODE OF MEASUREMENT

The measurement of the structure, fasteners (Nuts, Bolts, and Washers) and foundation bolts including its nuts washers and MS Plate at bottom shall be done as per Bid price schedule (BPS). The weight of all structural members, fasteners, step bolts and foundation bolts (Bolt, Nuts, washer, and MS steel plates welded at bottom of bolt) shall be measured under one head in Metric Tonne.

15.0 SAFETY PRECAUTIONS

The Contractor shall strictly follow all precautions at all stages of fabrication, transportation, and erection of steel structures. The stipulations contained in relevant Indian standard Codes (IS Codes) for Safety during erection of structural steel work shall also be adhered to.

16.0 MANUFACTURING QUALITY PLAN

The material specification shall also be as per relevant Indian standard Codes (IS Codes). The Contractor shall prepare the manufacturing quality plan to accept/check the material, galvanization, and welding as per relevant IS codes within 1 month after award of work and submit the same to Employer for approval.