



Uhde India Limited

**SECTION-7  
TECHNICAL SPECIFICATIONS  
STRUCTURAL STEEL WORK**

DOC NO.:  
CI-UCH-016-07

Rev. :R0  
Page :1

Contents	Page
GENERAL	2
I.S.CODES	2
SCOPE	3
MATERIALS	5
FABRICATION	6
WELDING	9
BOLTING	11
ERECTION	13
HIGH STRENGTH FRICTION GRIP BOLTING.	16
HAND RAILING	16
TOLERANCES	16
ERECTION PROCEDURE - ROOF TRUSS	20
QUALITY CONTROL	21
CLEARANCES	22
GALVANISING	22
WELDED PLATE & CASTELLATED BEAMS	23
MODE OF MEASUREMENT	23

**Applicable Revision:**

Prepared:

Checked:

Approved:

Date:

Date:

Date:

First Edition: R0

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Date: 06.08.03

Date: 07.08.2003

Date: 7.8.2003

Server : \\KUMUS671\REFER\CIVIL\PRIVATE\DOCS\STD\TENDER\PART2  
File Name : TSP7.DOC

**7.1 GENERAL**

This specification covers the transportation of steel materials from stores to fabrication yard stacking them in good order straightening the warped/twisted members, fabrication, transportation to site and erection on prepared foundations or structural steel work with necessary field bolting / welding and covers columns, beams, flooring, stairs, gangways etc. for buildings, pipe racks, equipment supporting structures, platforms, etc.

**List of Indian Standards:**

- IS:800 - General design criteria for structural steel.
- IS:808 - Dimension for hot rolled steel beam, column, channel and angle section.
- IS:2062 - Structural Steel weldable quality
- IS:414 - Welding Electrodes
- IS:9595 - Welding procedures.
- IS:1239 - MS Tubes for hand railing.
- IS:2629 - Recommended practice for galvanising
- IS:7215 - Tolerances for fabrication of Steel Structures
- SP6(1) - IS Handbook of Steel Sections

7.1.1 Fabrication, erection and approval of steel structures shall be in compliance with :

- These General Specifications and IS:800
- Drawings and supplementary drawing to be supplied to the contractor during execution of the work.

Grouting of pockets for holding down bolt and below base plates, where required, shall be done by civil contractor who can be same as the contractor for structural work.

In case of conflict between the clauses mentioned here and Indian Standards, those expressed in this specification shall govern.

## **7.2**      **SCOPE**

The fabrication and erection of the steel work consist of accomplishing of all jobs herein enumerated including providing all labour, tools and plant, all materials and consumables such as welding electrodes, bolts and nuts, washers, oxygen and acetylene gases, oils for cleaning etc. of approved quality as per relevant I.S codes.

The work shall be executed according to the drawings, specifications, relevant codes, etc. in an expeditious and workman like manner, as detailed in the specifications and the relevant Indian Standard codes and standard practices and to the complete satisfaction of the Engineer.

### **7.2.1**      **Fabrication drawings**

If the contractor feels it necessary to prepare the regular shop fabrication drgs, he may do so at his option and discretion, but it is not mandatory. Such fabrication drgs., prepared by the contractor at his option shall comply with the design drawings in totality and with the standard practices for welding, bolting to achieve the desired strength at all connections, joints, splices and critical points and areas. The fabrication drawings if prepared by the contractor need not be sent to the consultants for their review and approval. Consultant's review, if carried out at their discretion, shall not absolve the contractor from his contractual responsibility of completing the structural work as per Design drawings, to the fullest satisfaction of the supervising engineers and as per standards, laid down codes, specifications and good engineering practices.

Fabrication drawings if prepared at contractor's option shall include the following:

- Marked-up key plan of structure / part of            structure which is being detailed.
  
- Member sizes and details.

**SECTION-7  
TECHNICAL SPECIFICATIONS  
STRUCTURAL STEEL WORK**

- Types and dimensions of welds and bolts.
- Shapes and sizes of edge preparation for welding.
- Details of shop and field joints included in assemblies.
- Bill of materials.
- Quality of structural steels, welding electrodes, bolts, nuts and washers etc. to be used.
- Erection assemblies, identifying all transportable parts and sub-assemblies, associated with special erection instruction.
- Calculations , where asked for checking the drawings

Connections, splices and other details not specifically detailed in design drawings shall be suitably given on fabrication drawings considering normal detailing practices and developing full member strengths where asked for and calculations for the same shall also be submitted for approval.

Any alternate design or change in section shall be explicitly identified on fabrication drawing and will be allowed only when approved in writing by the engineer.

However, if any variation in the scheme is found necessary later, the contractor will be supplied with revised drawings. The contractor shall incorporate these changes in his shop drawings at no extra cost and resubmit for review.

The Engineer's review shall not absolve the contractor of his responsibility for the correctness of dimensions, adequacy of details and connections.

One reviewed copy with or without comments will be returned to the contractor for necessary action. In the former case further three copies of amended drawings shall be submitted by the contractor for final review and approval.

The contractor shall supply two prints each of the final reviewed drawing to the Engineer and one copy to the Owner within a week from the date of Approval at no extra cost for reference and records.

### 7.3 Materials

#### Rolled Sections

The following grades of steel shall be used for steel structures.

Structural steel shall generally be of standard quality conforming to IS:2062 Grade A. Whenever welded construction is specified plates of more than 20mm thick shall conform to IS:2062 Grade B.

Dimensions and masses for hot Rolled steel beams, columns, channels and angle sections shall conform to IS 808, superseding those given in SP6(1).

#### Welding Materials

Welding electrodes shall conform to IS:814.

Approval of welding procedures shall be as per IS:9595.

#### Bolts, Nuts and Washers

Bolts and nuts shall be as per IS:1367 class 4.6 (UNO) and tested as per IS:1608. It shall have a minimum elongation tensile strength of 44 kg/mm<sup>2</sup> and minimum elongation of 23% on a gauge of 5.65 x square root A (A original cross sectional area). Washers shall be as per IS 5369, 5370 for plain washers and IS:5372, 5374 for tape red washers.

All materials shall conform to their respective specification. The use of equivalent or higher grade or alternate materials will be considered only in very special cases subject to the approval of the Engineer in writing.

### 7.4 Receipt and storing of materials

Each rolled section must be marked for identification and each lot should be accompanied by manufacturer's quality certificates, confirming chemical analysis and mechanical characteristics.

All steel parts furnished by supplier shall be checked, sorted out, straightened, and arranged by grades and qualities in stores.

Structurals with surface defects such as pitting, cracks, laminations etc, shall be rejected if the defects exceed the allowable tolerances specified in relevant standards.

Welding wire and electrodes shall be stored separately by qualities and lots inside a dry and enclosed room, in compliance with IS:816 and as per instructions given by the Engineer.

Checking of quality of bolts of any kind as well as storage of same shall be made conforming to relevant standards.

Each lot of electrodes, bolts, nuts, etc. shall be accompanied by manufacturer's test certificate.

The contractor may use alternative materials as compared to design specification only with the written approval of the Engineer.

#### 7.5 Fabrication.

Fabrication shall be in accordance with IS:800 and IS:9595 in addition to the following:

Fabrication shall be done as per approved fabrication drawing adhering strictly to work points and work lines on the same. The connections shall be welded or bolted as per design drawings. Work shall also include fabricating built-up sections out of plates or out of a combination of rolled sections and plates.

Any faulty fabrication pointed out at any stage of work shall be made good by the Contractor at his cost.

#### 7.6 Preparation of Materials

Prior to release for fabrication, all rolled sections warped beyond allowable limit shall be pressed or rolled straight and freed from twists, taking care that a uniform pressure is applied.

Minor warpings, corrugations, etc. in rolled sections shall be rectified by cold working.

The sections shall be straightened by hot working where the Engineer so directs and shall be cooled slowly after straightening.

Warped member like plates and flats may be used as such, only if wave like deformation does not exceed  $L/1000$  but limited to 10mm ( $L = \text{Length}$ ).

Surface of members that are to be jointed by lap of fillet welding or bolting shall be even, so that temporary fastening alignment should not allow passage of a 0.2 mm thick filler gauge more than 20 mm deep from members edge.

### 7.7 Marking

Marking of members shall be on horizontal pads, or on appropriate racks or supports in order to ensure horizontal and straight placement of such members.

Marking accuracy shall be at least  $\pm 1$  mm.

### 7.8 Cutting

Members shall be cut preferably by mechanical means like saw or shear. Cutting by oxyacetylene flame shall be done with prior permission of the Engineer.

All sharp, rough or broken edges, and all edges of joints which are subjected to tensile or oscillating stresses, shall be ground smooth.

No electric metal arc cutting shall be allowed.

All edges cut by oxyacetylene process shall be cleaned of impurities and slag prior to assembly.

Cutting tolerances shall be as follows :

- a) For members connected at both ends  $\pm 2$  mm
- b) Elsewhere  $\pm 3$  mm.

The edge preparation for welding of members more than 12mm thick shall be done by flame cutting and grinding. Cut faces shall not have cracks or be rough.

Edge preparation shall be as per IS:9595.

### 7.9 Drilling

Bolts holes shall be drilled.

Drilling shall be carried out to the diameter specified in drawings.

No enlarging of holes by filling, handrailing or oxyacetylene flame shall be allowed.

Allowed variations for holes (out of roundness, eccentricity, plumbline deviation) shall be as per IS:800.

- Maximum deviation for spacing of two holes on the same axis shall be  $\pm 1$  mm.
- Two perpendicular diameters of any oval hole shall not differ by more than 1mm.

Drilling faults in holes may be rectified by reaming holes to the next upper diameter, provided that spacing of new hole centres and distance of hole centres to the edges of members are not less than that allowed and that the increase of hole diameter does not impair the structural strength. Hole reaming shall be allowed if the number of faulty holes does not exceed 15% of the total number of holes for joint.

### 7.10 Preparing of Members shall be made with proper jigs and fixtures to ensure correct positioning of members (angles, axes, nodes, etc.).

Sharp edges, rust of cut edges, notches, irregularities and fissures due to faulty cutting shall be chipped off, ground off filed over the length of the affected area, deep enough to remove faults completely.

Edge preparation for welding shall be carefully and accurately made so as to facilitate a good joint.

Generally no special edge preparation shall be required for members under 8mm thick.



Edge preparation (beveling) denotes cutting of the same so as to result in V,Y,K of U shapes as per IS:9595.

The members to be assembled shall be clean and dry on the welding edges. Under no circumstances shall wet, greasy, rust or dirt covered parts be assembled. Joints shall be kept free from any foreign matter, likely to get into the gaps between members to be welded.

Before assembly the edges to be welded as well as adjacent areas extending for atleast 20 mm shall be cleaned (until metallic polish is achieved).

When assembling members, proper provision shall be considered for shrinkage and distorting during welding, as the drawing dimensions cover finished dimensions of the structures.

The elements shall be checked and approved by the engineer or his authorised representative before assembly.

The permissible tolerances for assembly of members preparatory to welding shall be as per IS:9595.

After the assembly has been checked, temporary tack welding in position shall be done by electric welding keeping in view finished dimensions of the structure.

#### 7.11 Welding Procedures

Welding shall be carried out only by fully trained and experienced welders as tested and approved by the Engineer. It shall be the right of the Engineer or his representative to carry out any required test on the welders and the cost involved thereon shall be borne by the contractor.

Qualification tests for welders as well as tests for approval of electrodes will be carried out as per IS:9595. The nature of test for performance qualification of welders shall be commensurate with the quality of welding required on the job as judged by the Engineer.

The steel structures shall be automatically, semi-automatically or manually welded.

Welding procedures and welders tests for skill shall be conducted as per IS:9595 and approved by the Engineer.

The welder shall mark with his identification mark each element welded by him.

When welding is carried out in open air, steps shall be taken to protect the place of welding against wind or rain. The electrodes, wire and parts being welded shall be dry.

Before beginning the welding operation, each joint shall be checked to assure that the parts to be welded are clean and root gaps provided as per IS:9595.

For continuing the welding of seams discontinued due to some reason, the end of the discontinued seam shall be melted in order to obtain a good continuity. Before resuming the welding operation, the groove as well as the adjacent parts shall be well cleaned for a length of approx. 50 mm.

For single butt welds (in V,  $\frac{1}{2}$  V or U) and double butt welds (in K, double U, etc.) the rewelding of the root is mandatory but only after the metal deposit on the root has been cleaned by back gouging or chipping.

The welding seams shall be left to cool slowly. The contractor shall not be allowed to cool the welds quickly by any method.

For multi-layer welding, before welding the following layer, the formerly welded layer shall be cleaned metal bright by light chipping and wire brushing. Backing strips shall not be allowed.

The order and method of welding shall be so that:

- No unacceptable deformation appears in the welded parts.
- Due margin is provided to compensate for contraction due to welding to avoid any high permanent stresses.

The defects in welds must be rectified according to IS:9595 as per instruction of Engineer.

**7.12**      Weld Inspection

The weld seams shall satisfy the following :

- Shall correspond to design shape and dimensions.
  
- Shall not have any defect such as cracks, incomplete penetration and fusion, under-cuts, rough surfaces, burns, blow holes and pitting etc. beyond permissible limits.

During the welding operation and approval of finished elements, inspections and tests shall be made as per relevant IS codes.

The mechanical characteristics of the welded joints shall be compliance with IS:9595.

**7.13**      Preparation of Members for Bolting

The members shall be assembled for bolting with proper jigs and fixtures to sustain the assemblies without deformation.

Before assembly, all sharp edges, shavings, rust, dirt, etc. shall be removed.

Before assembly, the mating surfaces of the members shall be cleaned and given a coat of primer as per specification or IS:2074 (UNO)

The members which are bolt assembled shall be set according to drawings and temporarily fastened with erection bolts (minimum 4 nos.) to check the coaxiality of the holes.

The members shall be finally bolted after the deviations have been corrected, after which there shall not be gaps through which 0.02 mm filler gauge may pass for depth more than 20 mm.

Before assembly, the members shall be checked and got approved by the Engineer.

The difference in thickness of the sections that are butt assembled shall not be more than 3% or maximum 0.8mm whichever is less if the difference is larger, it shall be corrected by grinding or filling.

Reaming of holes to final diameter or cleaning of these, shall be done only after the parts have been check assembled.

As each hole is finished to final dimensions (reamed, if necessary) it shall be set and bolted up. Erection bolts shall not be removed before other bolts are set. Holes in Secondary members such as purlins, grits, lacings may be punched full size through material not over 12 mm thick. Where several parts are to be connected to very close tolerances, such parts shall be first assembled, tightly clamped together and drilled through.

### Bolting up

Final bolting of the members shall be done after the defects have been rectified and approval of joints obtained.

The bolts shall be tightened starting from the centre of the joint towards the edge.

### Planning of Ends

Planning of ends of members like column ends shall be done by grinding when so specified in the drawing.

Planning of butt welded members shall be done after these have been assembled, the sharp edges shall be removed with grinding machines or files.

The following tolerances shall be permitted on member that have been planed;

- On the length of the member having both ends planned, maximum  $\pm 2$  mm with respect to design.
- Level differences of planned surfaces, maximum 0.3 mm
- Deviation between planned surface and member's axis, maximum 1 in 500

### Holes for Field Joints

Holes for field joint shall be drilled in the shop to final diameters and tested in the shop, with trial assemblies.

When three-dimensional assembly is not possible in the shop, the holes for field joints may be drilled in shop and reamed on site after erection, and on approval by the Engineer.

For bolted steel structures, trial assembly in shop is mandatory.

The tolerances regarding dimensions, geometrical shapes and sections of steel structures, shall be as per relevant I.S. Code if not specified in the Drawing.

### 7.14 Erection

The erection work shall be permitted only after the foundation or other structure over which the steel work is to be erected, is accepted and is ready for erection.

The Contractor shall satisfy himself about the levels, alignment etc. for the foundations well in advance, before starting the erection. Minor chipping, cleaning of foundation etc. shall be carried out by the Contractor at his expense.

Any faulty erection done by the Contractor shall be made good at his own cost.

Approval of the Engineer at any stage of work does not relieve the Contractor of any of his required guarantees of the contract.

Erection in general shall be carried out as required and approved by the Engineer.

Positioning and levelling of the structure, alignment and plumbing of the stanchion and fixing every member of the structure shall be in accordance with the relevant drawings and to the complete satisfaction of the Engineer.

Chequered plates shall be fixed to supporting members by tack welding or by counter sunk bolts as shown/specified in relevant drawings and/or as directed by the Engineer.

The following checks and inspection shall be carried out before, during and after reaction:

- Damages during transportation.
- Accuracy of alignment of structures.
- Erection according to drawings and specifications.
- Progress and workmanship.

In case there be any deviations regarding positions of foundations or anchor bolts, which would lead to erection deviations, the Engineer shall be informed immediately. Minor rectifications, in foundations, orientation of bolt holes etc. shall be carried out as a part of the work, at no extra cost.

The various parts of the steel structures shall be so erected as to ensure stability against inherent weight, wind and erection stresses.

The structure shall be anchored and final erection joint completed after plan and elevation positions of the structural members have been verified with corresponding drawings and approved by the Engineer.

The bolted joints shall be tightened so that the entire surface of the bolt heads and nuts shall rest on the member. For parts with sloping surfaces, tapered washers shall be used.

#### 7.15 The Method and sequence of erection

The method and sequence of erection shall have the prior approval of the Engineer. Erection shall be carried out by safest method, subject to the requirements of the structure.

Engineer may require the contractor to prepare special erection drawings in case of complicated structure or where special precautions need to be taken.

##### 7.15.1 Temporary bracing

Unless adequate bracing is included as a part of the permanent framing, the erector during erection shall install, free of cost to the Owner, temporary guys and bracings where needed to secure the framing against loads such as wind or seismic forces comparable in intensity to that for which the structure has been

designed, acting upon exposed framing as well as loads due to erection equipment and erection operations.

If additional temporary guys are required to resist wind or seismic forces acting upon components of the finished structure installed by others during the course of the erection of the steel framing, arrangement for their installation by the erector shall be made free of cost to the Owner.

The responsibility of the Contractor in respect of temporary bracings and guys shall cease when the structural steel is located, plumbed, levelled, aligned and grouted within the tolerances permitted under the specification and guyed and braced to the satisfaction of the Engineer.

The temporary guys, braces, false work and cribbing shall not be the property of the Owner and they may be removed immediately upon completion of the steel erection unless other agreed arrangements are made.

#### 7.15.2 Temporary floors for buildings

It shall be the responsibility of the Contractor to provide free of cost packing and to cover such floors during the work in progress as may be required by any Act of Parliament and/or bylaws of state, Municipal or other local authorities.

#### 7.16 Painting

After steel has been erected, all bare and abraded spots, field welds, bolt holes and nuts shall be spot painted with primer. Before paint is applied, the surface shall be dry and free from dust, dirt, scale and grease. All surfaces inaccessible after erection shall receive two coats of the approved paint before erection. For specification of painting system refer relevant specification under the chapter of painting.

#### 7.17 Final Acceptance and Handing Over of Structure

At acceptance, the contractor shall submit the following documents:

- Fabrication drawings if prepared and approved either in tracing or reproducible.
- Bill of material, section wise for each structure.

- Quality certificates for structurals, plates, etc.
- List of certified welders who worked on erection of structure.

Approval by the Engineer at any stage of work does not relieve the contractor of any of his required guarantee of the contract.

#### 7.18 HIGH STRENGTH FRICTION GRIP BOLTING

High strength friction grip (HSFG) bolts and nuts shall be of Class 8.8 or 10.9 conforming to IS:3757/IS:4000 & or BS:3139 and / or ASTM A 325.

Load indicating bolts or load indicating washers may be used if so approved by the ENGINEER in writing.

Inspection after tightening of bolts shall be carried out as stipulated in the appropriate standards depending upon the method of tightening and the type of bolt used.

#### 7.19 Hand Railing

Supply, fabrication and erection of hand-railing as per drawings, inclusive of clamps, fittings, threading, welding, painting etc. complete.

M.S tubes and fittings shall conform to IS:1239 and shall be of medium grade or as specified in the drawings. All screwed pipes shall be threaded as per IS:554.

All pipes shall either be directly welded or jointed with screwed couplings/insert plates. Care shall be taken to remove burrs from the ends of the pipe. The pipe shall be fixed to pipe or angle uprights by means of suitable clamps or by means of welding. After fixing, the pipe shall be painted with synthetic enamel paint system as described in this section.

Toe angles / toe plates shall be of M.S. conforming to IS:2062.

#### 7.20 Tolerance

Tolerances as per IS:800 shall be achieved after the entire structure or part thereof is in line, level and plumb. The tolerances specified below do not apply to



steel structures where the deviations from true positions are intimately linked with and directly influence technological process. In such cases the tolerances on erected steel structures shall be as per recommendations of process technologists/suppliers which will be indicated in the drawings.

### COLUMNS

- 7.20.1 Deviation of column axes at foundation top level with respect to true axes :
- a) In longitudinal direction  $\pm 5\text{mms.}$
  - b) In lateral direction  $\pm 5\text{mms.}$
- 7.20.2 Deviation in the level of surface of columns at foundation top with respect to true level.  $\pm 5\text{ mms of bearing}$
- 7.20.3 Out of plumbness (verticality) of column axis from true vertical axis, as measured at column top.
- (a) For column upto and including 15 metres in height.  $\pm 1/1000$  of column height in mms or  $\pm 15\text{ mms}$  whichever is less.
  - (b) For columns exceeding 15 metres in height.  $\pm 1/1000$  of column height in mms or  $\pm 20\text{ mms}$  whichever is less.
- 7.20.4 Deviation in straightness in longitudinal and transverse planes of column at any point long the height.  $\pm 1/1000$  of column height in mms or  $\pm 10\text{ mms}$  whichever is less.
- 7.20.5 Difference in erected position of adjacent pairs of columns along length or across width of building prior to connecting trusses/beams with respect to true distance.  $\pm 10\text{ mms}$

7.20.6	Deviation in any bearing or seating level with respect to true level.	± 5 mms
7.20.7	Deviation in difference in bearing levels of a member on adjacent pair of columns both across and along the building.	± 10 mms
<u>TRUSSES AND BEAMS</u>		
7.20.8	Shift of the top chord member at the centre of span with respect to the vertical plane passing through the centre of bottom chord.	± 1/250 of height of truss in mms or ± 15 mms whichever is less
7.20.9	Lateral shift of top chord of truss at the centre of span the vertical plane passing through the centre of supports of the truss.	± 1/1500 span of truss in mms or ± 15 mms whichever is less
7.20.10	Lateral shift in location of truss from its true vertical position.	± 10 mms truss from
7.20.11	Lateral shift of purlin from true location	± 5 mms purlin true
7.20.12	Deviation in difference of bearing levels of trusses or beams.	I. ± 20mm for trusses ii. For beams : Depth <1800 mms ± 6 mms Depth >1800 mms±10 mms
7.20.13	Deviation in sag in chords and diagonals of truss between node points.	1/1500 of length in mms or 10mms whichever is less.
7.20.14	Deviation in sweep of trusses, beams etc. in the horizontal plane.	1/1000 of span in mms subject to a maximum of 10mms.

GANTRY GIRDERS & RAILS

7.20.15	Shift in the centre line of rail with respect to centre line of web of	± 5mms
7.20.16	Shift in plan of alignment of crane rail with respect to true axis of crane rail at any point.	± 5mms
7.20.17	Difference in alignment of crane rail in plain measured between any two points 2 meters apart along rail	± 1mm
7.20.18	Deviation in crane track with respect to track gauge. (a) For track gauge upto and including 15 metres.  (b) For track gauges more than 15 metres.	± 1mm ± 5mm  ± [5 + 0.25 (S-15)] where S is track gauge in metres
7.20.19	Deviation in the centre rail level at any point from true level.	1/1200 of the gauge distance or ± 10 mms whichever it less.
7.20.20	Difference in the crane rail actual levels between any two points 2 metres apart along the rail length.	± 2 mms
7.20.21	Difference in levels between crane track rails at :	
	(a) Supports of gantry	± 15mm
	(b) Mild span of gantry	± 20mm

7.20.22 Relative shift of crane rail surfaces at a joint in plan and elevation. 2 mm subject to grinding of surfaces for smooth transition.

7.20.23 Relative shift in the location of crane stops (end buffers) along the crane tracks with track gauge S in mms. 1/1000 of track gauge S in mm subject to maximum of 20mms.

#### CHIMNEY AND TOWERS

7.20.24 Out of plumbness (vertically) from the true vertical axis. 1/1000 of the height of the chimney or towers.

#### BUNKERS

7.20.25 Deviation in length of bunker from the length. 1/1000 of length in mms.

7.20.26 Deviation in width of bunker from true width. 1/1000 of width in mms.

7.20.27 Deviation in height of bunker from true height. 1/1000 of height in mms.

7.20.28 Deviation in diagonal length in any horizontal cross section from the true diagonal length. 1/500 of diagonal length in mms.

#### 7.21 RECOMMENDED SEQUENCE OF ERECTION PROCEDURE FOR ROOF TRUSSES.

Structural Steel columns shall be bolted firm on the foundation. Further erection steps for roof trusses shall be as detailed in the standard drawings.

**7.22**      Quality Control

The Contractor shall establish and maintain quality control procedures for different items of work and materials to the extent he deems necessary to ensure that all work is performed in accordance with the specification. In addition to the Contractor's quality control procedures, materials and workmanship at all times shall be subjected to inspection by the Engineer or Engineer's representative. As far as possible, all inspection by the Engineer's or Engineer's representative shall be made at the Contractor's fabrication shop whether located at Site or elsewhere. The Contractor shall co-operate with the engineer or Engineer's representative in permitting access for inspection to all places where work is being done and in providing free of cost all necessary help in respect of tools and plants, instrument, labour and materials required to carry out the inspection. The inspection shall be so scheduled as to provide the minimum interruption to the work of the Contractor.

The Contractor shall maintain all documents of quality control, inspection in good order to ensure easy accessibility.

Materials or workmanship not in reasonable conformance with the provisions of this Specifications may be rejected at any time during the progress of the work.

The quality control procedure shall cover but not be limited to the following items of work:-

<u>Item</u>	<u>Quality Control requirements</u>
1) Steel	Test certificates, test reports of representative samples of materials from stocks.
2) Rivets, Bolts Nuts & Washers	Manufacturer's certificate dimension checks, material testing.
3) Electrodes	Manufacturer's certificate, thickness and quality of flux coating.
4) Welders	Qualifying tests
5) Welding sets	Performance tests
6) Welds	Visual inspection, DP & Ultrasonic test

7) Paints

Manufacturer's certificate, physical inspection reports.

8) Galvanising

Tests as per IS:2633 - Method of testing uniformity of coating on Zinc Coated Articles and IS : 4579 - Specification for Hot Dip Zinc coatings on Structural Steel and other allied products.

#### 7.22.1 Clearances

The erection clearance for cleat ends of members connecting steel to steel shall preferably be not greater than 2 mm at each end. The erection clearance at ends of beams without web cleats shall be not more than 3 mm at each end, but where, for practice reasons, greater clearance is necessary, suitably designed cleatings shall be provided.

#### 7.23 Galvanising

##### 7.23.1 General

Structural steel work for switchyard or other structures as may be specified in the Contract shall be hot dip galvanised in accordance with the American Society for Testing and Materials Specification ASTM-A 123 or IS:2629 - Recommendation practice for Hot Dip Galvanising of Iron and Steel. Where the steel structures are required to be galvanised the field connection materials bolts, nuts and washers shall also be galvanised.

##### 7.23.2 Surface Preparation

All members to be galvanised shall be cleaned, by the process of pickling of rust, loose scale, dirt, oil, grease, slag and spatter of welded areas and other foreign substances prior to galvanising. Pickling shall be carried out by immersing the steel in an acid bath containing either sulphuric or hydrochloric acid at a suitable concentration and temperature. The concentration of the acid and the temperature of the bath can be varied, provided that the pickling time is adjusted accordingly.

The pickling process shall be completed by thoroughly rinsing with water, which should preferably be warm, so as to remove the residual acid.

### 7.23.3 Procedure

Galvanising shall be carried out by hot dip process in a proper and uniformly heated bath. It shall meet all the requirements where tested in accordance with IS:2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS:4759 - Specification for Hot-dip zinc coatings on Structural Steel and other allied products.

After finishing the threads of bolts, galvanising shall be applied over the entire surface uniformly. The threads of bolts shall not be clogged with zinc. The threads of nuts may be tapped after galvanising but care shall be taken to use oil in the threads of nuts during erection.

The surface preparation for galvanising and the process of galvanising itself, shall not adversely affect the mechanical properties of the materials to be galvanised. Where members are of such lengths as to prevent complete dipping in one operation, great care shall be taken to prevent warping.

Materials on which galvanising is damaged shall be acid stripped and re-galvanised unless otherwise directed, but if any member becomes damaged after having been dipped twice, it shall be rejected. Special care shall be taken not to injure the skin on galvanised surfaces during transport, handling and erection. Damages, if occur, shall be made good in accordance with the provisions of this Specification or as directed by the Engineer.

### 7.24 Welded Plate Girders and Castellated Beams

The cutting of plates for built-up beams and plate girders and webs of perforated or castellated beams shall be done in a controlled manner so as to prevent bending during cutting. The welding shall be done in a controlled sequential manner and by clamping the members on a jig. Staggered welding technique shall be adopted to prevent warping and accumulation of thermal stresses.

### 7.25 Mode of Measurement

#### 7.25.1 Structural Steel Work

The payment for steel work shall be made on basis of IS:808 and admissible weight of the structure accepted, the weight being determined as described.

The rate for fabrication and erection shall include transporting from owner's stores to contractor's fabrication yard, fabrication and erection as per specifications, including the cost of all tools and tackles, temporary supports, consumables, nuts and bolts, shim plates etc.

The weight for payment will be assessed from the approved fabrication drawings and the respective bill of materials prepared by the contractor and approved by the engineer. The weight of structural material / plate shall be calculated wherever necessary on the basis of IS Handbook SP6(1). If sections are different from IS Section, then manufacturer's Handbook shall be adopted.

Sections built out of plates shall be paid on the actual weight incorporated except for gussets which will be paid on the weight of the smallest circumscribing rectangle.

Gratings shall be paid on square meter basis. Full deduction shall be made for all openings above 300 mm size and skews.

Welds, bolts, nuts, washers, etc., shall not be measured. Rate for structural steel work shall be deemed to include the same.

#### 7.25.2 M.S. Tube Hand Railing

The payment shall be on RM basis of full railing, (and not on the basis of each pipe in railing) consisting of top rail, mid rail, toe guard, vertical post etc. The rate shall include for all material,( In case materials are in the scope of supply of contractor) fabrication, fixing, labour, tools and tackles complete as specified.

Painting shall be paid for separately. Measurement for the purpose of payment shall be same as for Hand railing. The rate shall include all pipe rails, toe guards, vertical posts etc. complete including supply / fabrication / erection and fixing, one coat of red oxide shop paints, transport, labour, tools and tackles complete as specified in the drawings.