

- 3.2.4 Welding wires and electrodes (packed in their original cartons) shall be stored separately by quality and lots inside a dry and enclosed room in compliance with IS 9595 and as per the instructions given by the Engineer-in-Charge. Electrodes shall be kept perfectly dry to ensure satisfactory operation and weld metal soundness.
- 3.2.5 Each lot of electrodes, bolts, nuts etc. shall be accompanied by manufacturer's quality/test certificates.
- 3.2.6 All bolts (including nuts & washers) shall be checked, sorted out and arranged diameter-wise by grade and quality in the store.

3.3 Material Tests

- 3.3.1 The Contractor shall submit manufacturers' quality certificates for all the materials supplied by him. In case, quality certificates are not available or are incomplete or when material quality differs from standard specifications, such materials shall not be used in the construction. However, the Contractor shall get all appropriate tests conducted in approved test houses for such materials as directed by the Engineer-in-Charge, at no extra cost, and submit the same to Engineer-in-Charge for his approval. The Engineer-in-Charge may approve the use of such materials entirely at his discretion.
- 3.3.2 The Contractor shall ensure that all materials brought to site are duly approved by the Engineer-in-Charge. Rejected materials shall not be used and shall be removed from site forthwith. Any material of doubtful quality for which specific tests are to be carried out as per the instruction of the Engineer-in-Charge shall be separately stacked and properly identified and shall not be used. These shall be removed from site forthwith.

4.0 FABRICATION DRAWINGS

- 4.1 Fabrication and erection drawings shall be prepared by the Contractor on the basis of "Approved for Construction" (AFC) design drawings, EIL Standards issued to the Contractor. These drawings shall be prepared by Contractor or by an agency engaged by the contractor using TEKLA or AUTODESK Advance Steel or equivalent 3D Modeling software and approved by the Engineer-in-Charge.
- 4.2 Fabrication and erection drawings shall be thoroughly checked, stamped "Approved for Construction" and signed by the Contractor's own responsible Engineer irrespective of the fact that such drawings are prepared by the Contractor or his approved agency, to ensure accuracy and correctness of the drawings. Unchecked and unsigned drawings shall not be used for the purpose of proceeding with the work. The Contractor shall proceed with the fabrication and erection work only after thoroughly satisfying himself in this regard.
- 4.3 All fabrication and erection drawings shall be issued for construction by the Contractor directly to his work- site. Six copies of such drawings shall simultaneously be submitted to the Engineer-in-Charge who may check/ review some or all such drawings at his sole discretion and offer his comments for incorporation in these drawings by the Contractor.

However, the Contractor shall not proceed with the fabrication of such structures whose fabrication drawings are required to be reviewed before taking up the fabrication work as noted on "Approved for Construction (AFC)" design drawings issued to the Contractor or as conveyed by the Engineer-in-Charge. The fabrication of such structures shall be done only as per the reviewed fabrication drawings.

The review of such drawings by EIL shall be restricted to the checking of the following only:

- i) Structural layout, orientation and elevation of structures/members.
- ii) Sizes of members.
- iii) Critical joint details.

4.4 Fabrication drawings shall be drawn to scale and shall convey the information clearly and adequately. Following information shall be furnished on such drawings:

- i) Reference to design drawing number (along with revision number) based on which fabrication drawing has been prepared.
- ii) Structural layout, elevations & sections (with distinct erection marking of all members).
- iii) Framing plans, member sizes, orientation and elevations.
- iv) Layout and detailing of rain water pipes and gutters showing all necessary levels, connections and provisions wherever required.
- v) Detailing of shop/field joints, connections, splices, for required strength and erection.
- vi) Location, type, size and dimensions of welds and bolts.
- vii) Shapes and sizes of edge preparation for welding.
- viii) Details of shop and field joints/welds.
- ix) Bill of materials/D.O.D. Lists.
- x) Quality of structural steel, plates etc., welding electrodes, bolts, nuts and washers to be used.
- xi) Erection assemblies identifying all transportable parts and sub-assemblies with special erection instructions, if required.
- xii) Method of erection and special precautions to be taken during erection as required.
- xiii) Details of holes and fittings in components necessary for safe lifting and erection purpose.

4.5 The Contractor shall additionally ensure accuracy of the following and shall be solely responsible for the same:

- i) Provision for erection and erection clearances.
- ii) Marking of members
- iii) Cut length of members
- iv) Matching of joints and holes.

v) Provision kept in the members for other interconnected members.

vi) Bill of materials/D.O.D. Lists.

4.6 Connections, splices and other details where not shown on the design drawings shall be suitably designed and shown on the fabrication drawings based on good engineering practice developing full member strength. **Design calculations for such connections/splices shall be submitted to the Engineer-in-Charge along with the fabrication drawings.**

4.7 Any substitution or change in section shall be allowed only when prior written approval of the Engineer-in-Charge has been obtained. Fabrication drawings shall be updated incorporating all such substitutions/changes by the Contractor at no extra cost to the Owner.

4.8 In case during execution of the work, the Engineer-in-Charge on review of drawings considers any modifications/ substitutions necessary to meet the design parameters/ good engineering practice, these shall be brought to the notice of the Contractor who shall incorporate the same in the drawings and works without any extra cost to the owner. The Contractor will be totally responsible for the correctness of the detailed fabrication drawings and execution of the work.

4.9 Contractor shall incorporate all the revisions made in the design drawings during the course of execution of work in his fabrication drawings, and resubmit the drawings at no extra cost to the Owner. All fabrication shall be carried out only as per the latest AFC design drawings and corresponding fabrication drawings.

4.10 The Contractor shall supply two prints each of the final/as built drawings along with their native soft file to Engineer-in-Charge for reference and record. The rates quoted shall include for the same.

5.0 FABRICATION

5.1 General

5.1.1 Fabrication of structures shall be done strictly as per "Approved for Construction" fabrication drawings (prepared by the Contractor based on the latest design drawings) and in accordance with IS 800, 9595 & other relevant BIS Codes.

5.1.2 Prior to commencement of structural fabrication, undulations in the fabrication yard, if any, shall be removed and area levelled and paved by the Contractor.

5.1.3 Any defective material used in the work shall be replaced by the Contractor at his own expense. Necessary care and precautions shall be taken so as not to cause any damage to the structure during any such removal and replacement.

5.1.4 Any faulty fabrication pointed out at any stage of work by the Engineer-in- Charge, shall be made good or replaced by the Contractor at his own cost.

5.1.5 Tolerances for fabrication of steel structures shall be as per IS 7215.

5.2 Fabrication Procedure

5.2.1 Straightening & Bending

- 5.2.1.1 All materials shall be straight and, if necessary, before being worked shall be straightened and/or flattened (unless required to be of curvilinear form) and shall be free from twists.
- 5.2.1.2 Bending of rolled sections and plates shall be done by cold process to shape/s as shown on drawings.
- 5.2.1.3 After completion of bending or straightening, welds within the area of bending or straightening shall be thoroughly visually inspected. Nondestructive tests required to be carried out for such locations shall be done only after straightening or bending activity.

5.2.2 Clearances

The erection clearance for cleated ends of members shall be not greater than 2mm at each end. The erection clearance at ends of beams without web cleats and end plates shall be not more than 3mm at each end but where for practical reasons, greater clearance is necessary, suitably designed seatings approved by the Engineer-in-Charge shall be provided.

5.2.3 Cutting

- 5.2.3.1 Prior to cutting, all members shall be properly marked showing the requisite cut length/width, connection provisions e.g. location and dimensions of holes, welds, cleats etc. Marking for cutting shall be done judiciously so as to avoid wastages or unnecessary joints as far as practicable. Marking shall be done by placing the members on horizontal supports/pads in order to ensure accuracy. Marking accuracy shall be limited to + 1mm.
- 5.2.3.2 Cutting may be affected by shearing, cropping or sawing. Gas cutting by mechanically controlled torch shall be permitted for mild steel. Hand flame cutting may be permitted subject to the approval of the Engineer-in-Charge.
- 5.2.3.3 Except where the material is subsequently joined by welding, no loads shall be transmitted into metal through a gas cut surface.
- 5.2.3.4 Shearing, cropping and gas cutting shall be clean, square, free from any distortion & burrs, and should the Engineer-in-Charge find it necessary, the edges shall be ground afterwards, to make the same straight and uniform at no extra cost to the Owner.

5.2.4 Making Holes

- 5.2.4.1 Holes for bolts shall not be formed by gas cutting process.
- 5.2.4.2 Holes through more than one thickness of material of members such as compound stanchions and girder flanges shall, where possible, be drilled after the members are assembled and tightly clamped/bolted together. Punching may be permitted before assembly, provided the thickness of metal is less than 16mm and the holes are punched 3mm less in diameter than the required size and reamed, after assembly, to the full diameter. Punching shall not be adopted for dynamically loaded structures.
- 5.2.4.3 Holes may be drilled in one operation through two or more separable parts and burrs removed from each part after drilling.

- 5.2.4.4 Holes in connecting angles and plates, other than splices, also in roof members and light framing, may be punched full size through material not over 12mm thick, except where required for close tolerance bolts or barrel bolts.
- 5.2.4.5 All matching holes for black bolts shall register with each other so that a gauge of 2mm less in diameter than the diameter of hole shall pass freely through the assembled members in the direction at right angle to such members. Finished holes shall be not more than 2mm in diameter larger than the diameter of the black bolt passing through them, unless otherwise specified by the Engineer- in-Charge.
- 5.2.4.6 Holes for turned and fitted bolts shall be drilled to a diameter equal to the nominal diameter of the shank or barrel subject to H8 tolerance specified in IS 919. Parts to be connected with close tolerance or barrel bolts shall be firmly held together by tacking bolts or clamps and the holes drilled through all the thicknesses in one operation and subsequently reamed to size. Holes not drilled through all the thicknesses in one operation shall be drilled to a smaller size and reamed out after assembly. Where this is not possible, the parts shall be drilled and reamed separately.
- 5.2.4.7 To facilitate grouting, holes shall be provided in column bases or seating plates exceeding 300mm in width for the escape of air.
- 5.2.4.8 To avoid accumulation of water in gusseted column bases of laced, battened or box type stanchions, suitable reverse U-type holes shall be provided at the junction of base plate and column section in the vertical gussets for draining out of any water.
- 5.2.4.9 Slotted holes shall be punched or formed by drilling two holes and completed by cutting.

5.2.5 Assembly

The component parts shall be assembled and aligned in such a manner that they are neither twisted nor otherwise damaged, and shall be so prepared that the required camber, if any, is provided. Proper clamps, clips, jigs and other fasteners (bolts and welds) shall be placed in a balanced pattern to avoid any distortion in the members and to ensure their correct positioning (i.e. angles, axes, nodes etc.). Any force fitting, pulling/stretching of members to join them shall be avoided. Proper care shall be taken for welding shrinkage & distortion so as to attain the finished dimensions of the structure shown on the drawings.

5.2.6 Welding

5.2.6.1 General

- All joints shall be welded unless noted otherwise on the design drawings.
- Welding shall be in accordance with IS 816, IS 819, IS 1024, IS 1261, IS 1323 and IS 9595 as appropriate.
- The Contractor shall make necessary arrangement for providing sufficient number of welding sets of the required capacity, all consumables, cutting and grinding equipment with requisite accessories/ auxiliaries, equipment & materials required for carrying out various tests such as dye penetration, magnetic particle, ultrasonic etc.
- Adequate protection against rain, dust, snow & strong winds shall be provided to the welding personnel and the structural members during welding operation. In the absence of such a protection no welding shall be carried out.

- e) It shall be the responsibility of the Contractor to ensure that all welding is carried out in accordance with the terms of this specification and relevant BIS codes. The Contractor shall provide all the supervision to fulfil this requirement.

5.2.6.2 Preparation of Member for Welding

a) Edge Preparation

Edge preparation/bevelling of fusion faces for welding shall be done strictly as per the dimensions shown in the drawings. In case, the same are not indicated, edges shall be prepared (depending on the type of weld indicated in the drawing) as per the details given in IS 9595. Bevelling of fusion faces shall be got checked and approved by the Engineer- in-Charge. The tolerances on limits of gap, root face & included angle shall be as stipulated in IS 9595.

b) Cleaning

Welding edges and the adjacent areas of the members (extending upto 20mm) shall be thoroughly cleaned of all oil, grease, scale and rust and made completely dry. Gaps between the members to be welded shall be kept free from all foreign matter.

c) Preheating

Preheating of members, shall be carried out as per IS 9595 when the base metal temperature is below the requisite temperature for the welding process being used. Preheating shall be done in such a manner that the parts, on which the weld metal is being deposited, are above the specified minimum temperature for a distance of not less than 75mm on each side of the weld line. The temperature shall be measured on the face opposite to that being heated. However, when there is access to only one face, the heat source shall be removed to allow for temperature equalization (1 minute for each 25mm of plate thickness) before measuring the temperature.

d) Grinding

- i) Column splices & butt joints of struts and compression members (depending on contact for load transmission) shall be accurately ground and close-butt over the whole section with a tolerance not exceeding 0.2mm locally at any place. In column caps & bases, the ends of shafts together with the attached gussets, angles, channels etc., shall be accurately ground so that the parts connected butt over minimum 90% surface of contact. In case of connecting angles or channels, care shall be taken so that these are fixed with such accuracy that they are not reduced in thickness by grinding by more than 2mm.
- ii) Ends of all bearing stiffeners shall be ground to fit tightly at both top and bottom. Similarly bottom of the knife edge supports along with the top surface of column brackets shall be accurately ground to provide effective bearing with a tolerance not exceeding 0.2mm locally at any place.
- iii) Slab bases and caps shall be accurately ground over the bearing surfaces and shall have effective contact with the ends of stanchions. Bearing faces which are to be grouted direct to foundations need not be ground if such faces are true & parallel to the upper faces.
- iv) Tack welding shall be thoroughly removed by grinding or gouging such that subsequent welding shall be done properly.

5.2.6.3 Welding Processes

Welding of various materials under this specification shall be carried out using one or more of the following processes.

- Manual Metal Arc Welding Process (MMAW)
- Submerge Arc Welding Process (SAW)
- Gas Metal Arc Welding Process (GMAW)
- Flux Cored Arc Welding Process (FCAW)

The welding procedure adopted and consumables used shall be specifically approved by the Engineer-in-Charge. A combination of different welding processes or a combination of electrodes of different classes/makes may be employed for a particular joint only after qualifying the welding procedures to be adopted and obtaining the written approval of the Engineer-in-Charge.

5.2.6.4 Approval & Testing of Welders

The Contractor shall satisfy the Engineer-in-Charge that the welders are suitable for the work upon which they will be employed. For this purpose, the welders shall have satisfied the relevant requirements of IS 7318 or AWS D1.1. If the welders will be working to approved welding procedures, they shall have satisfied the relevant requirements of IS 7310 or AWS D1.1.

Adequate means of identification shall be provided to enable each weld to be traced to the welder by whom it was made. The Contractor shall intimate the Engineer-in-Charge sufficiently in advance, the commencement of tests, to enable him to be present to witness the same.

5.2.6.5 Approval & Testing of Welding Procedures

The Contractor shall carry out procedure tests in accordance with IS 7307 or AWS D1.1 to demonstrate by means of a specimen weld of adequate length on steel representative of that to be used, that he can make welds with the welding procedure to be used for the work to the complete satisfaction of the Engineer-in-Charge. The test weld shall include weld details from the actual construction and it shall be welded in a manner simulating the most unfavourable instances of fit-up, electrode condition etc., which are anticipated to occur on the particular fabrication. Where material analysis is available, the welding procedure shall be carried out on material with the highest carbon equivalent value.

After welding, but before the relevant tests given in IS 7307 or AWS D1.1 are carried out, the test weld shall be held as long as possible at room temperature, but, in any case not less than 72 hours, and shall then be examined for cracking. The examination procedure shall be sufficiently rigorous to be capable of revealing significant defects in both parent metal and weld metal.

After establishing the welding method, the Contractor shall finally submit to the Engineer-in-Charge for his approval the welding procedure specification in standard format given in IS 9595 before starting the fabrication.

5.2.6.6 Sequence of Welding

- As far as practicable, all welds shall be made in a sequence that will balance the applied heat of welding while the welding progresses.
- The direction of the general progression in welding on a member shall be from points where the parts are relatively fixed in position with respect to each other towards points where they have a greater relative freedom of movement.
- All splices in each component part of a cover-plated beam or built up member shall be made before the component part is welded to other component parts of the member.
- Joints expected to have significant shrinkage shall be welded before joints expected to have lesser shrinkage.
- Welding shall be carried continuously to completion with correct number of runs.
- The Contractor shall choose the welding sequence after carefully studying each case such as to minimize distortion and shrinkage & submit the same to the Engineer-in-Charge for comments and approval.

5.2.6.7 Welding Technique

- After the fusion faces are carefully aligned and set with proper gaps, the root pass of butt joints shall be executed properly so as to achieve full penetration with complete fusion of the root edges.
- On completion of each run, all slag and spatters shall be removed and the weld and the adjacent base metal shall be cleaned by wire brushing and light chipping. Visible defects such as cracks, cavities and other deposition faults, if any, shall be removed to sound metal before depositing subsequent run of weld.
- All full penetration butt welds shall be completed by chipping/gouging to sound metal and then depositing a sealing run of weld metal on the back of the joints. Where butt welding is practicable from one side only, suitable backing steel strip shall be used and joint shall be arranged in such a way as to ensure that complete fusion of all the parts is readily obtained.
- While welding is in progress care shall be taken to avoid any kind of movement of the components, shocks, vibrations to prevent occurrences of weld cracks.
- Any deviation desired from the recommended welding technique and electrodes shall be adopted only after obtaining written approval of the Engineer-in-Charge.

5.2.6.8 Inspection & Testing of Welds

The method of inspection shall be according to IS 822 and extent of inspection and testing shall be in accordance with the relevant applicable standard or, in the absence of such a standard, as specified by the Engineer-in-Charge. Welds shall not be painted or otherwise obscured until they have been inspected, approved and accepted.

The Engineer-in-Charge or his representative shall have access to the Contractor's work at all reasonable times and the Contractor shall provide him with all facilities necessary for

inspection during all stages of fabrication and erection with, but not limited to, the following objectives.

- i) To check the conformity with the relevant standards and suitability of various welding equipments and their performance.
- ii) To witness/approve the welding procedure qualification.
- iii) To witness/approve the welders performance qualification.
- iv) To check whether shop/field welding being executed is in conformity with the relevant specifications and codes of practice.

Inspection and testing of all fabricated structures shall be carried out by the Contractor by any, or, a combination of all the following methods as directed by the Engineer-in-Charge and no separate payment shall be made, unless otherwise mentioned, for inspection and testing of welds/fabricated structures:

A. Visual Inspection

All finished welds (i.e. 100 percent) shall be visually inspected for identification of the following types of weld defects & faults.

- a) Weld defects occurring at the surface such as blow holes, exposed porosity, unfused welds etc.
- b) Surface cracks in the weld metal or in the parent metal adjacent to it.
- c) Damages to the parent metal such as undercuts, burning, overheating etc.
- d) Profile defects such as excessive convexity or concavity, overlapping, unequal leg lengths, excessive reinforcement, incompletely filled grooves, excessive penetration beads, root grooves etc.
- e) Distortion due to welding i.e., local shrinkage, camber, bowing, twisting, rotation, wariness etc.
- f) Linear eccentric, angular and rotational misalignment of parts.
- g) Dimensional errors.

B. Mechanical Tests

The mechanical testing (such as tensile load tests, bend tests, impact tests etc.) shall be done in accordance with the relevant standards and as per the instructions of the Engineer-in-Charge.

C. Magnetic Particle/Dye Penetration/Ultrasonic Examination

The examination shall be done at random as directed by the Engineer-in-Charge. Whenever such tests are directed, the tests shall be carried out on joints chosen by him. The tests shall be carried out by employing approved testing procedure in accordance with IS 822.

D. Radiographic Examination

Radiographic examination shall be carried out only in special cases for random joints as directed by the Engineer-in-Charge. The Contractor shall be paid extra for such examination except for penalty radiographic tests for which the cost shall be borne by him. The Contractor shall make necessary arrangement at his own expense for providing the radiographic equipment, films and all other necessary materials required for carrying out the examination. The tests shall be carried in the presence of the Engineer-in-Charge by employing approved testing procedure in accordance with IS 822. The Contractor shall fulfill all the statutory safety requirements while handling X-ray and Gamma-ray equipment and provide the Engineer-in-Charge all the necessary facilities at site such as dark room, film viewer etc., to enable him to examine the radiographs.

5.2.6.9 Repair of Faulty Welds

No repair of defective welds shall be carried out without proper permission of the Engineer-in-Charge and his approval for the corrective procedure.

Welds not complying with the acceptance requirements (as specified by BIS Codes & the Engineer-in-Charge), as revealed during inspection & testing of welds or erection or in-situ condition, shall be corrected either by removing & replacing or as follows:

- | | |
|--|--|
| a) Excessive convexity | - Reduced to size by removal of excess weld metal. |
| b) Shrinkage cracks, cracks in
in parent plates and craters | - Defective portions removed down to sound metal
and re-welded. |
| c) Under cutting. | - Additional weld metal deposited. |
| d) Improperly fitted/
misaligned parts. | - Welding cut & edges suitably prepared and parts. |
| e) Members distorted
by the heat of welding | - Member straightened by mechanical means or
careful application of limited amount of heat,
temperature of such area not to exceed 650 degree
Centigrade (dull red heat). |

In removing defective parts of a weld, gouging, chipping, oxygen cutting or grinding shall not extend into the parent metal to any substantial amount beyond the depth of weld penetration, unless cracks or other defects exist in the parent metal. The weld or parent metal shall not be undercut in chipping, grinding, gouging or oxygen cutting.

Any fabricated structure or its component which, in the opinion of Engineer-in-Charge, is defective and/or beyond any corrective action shall be removed forthwith from the site as instructed by the Engineer-in-Charge without any extra claim. The owner reserves the right to recover any compensation due to any loss arising out of such rejections.

5.2.7 Bolting

5.2.7.1 All bolts shall be provided such that no part of the threaded portion of the bolts is within the thickness of the parts bolted together. Washers of suitable thickness shall be used under the nuts to avoid any threaded portion of the bolt being within the thickness of parts bolted together.

5.2.7.2 The threaded portion of each bolt shall project through the nut at least one thread.

- 5.2.7.3 Flat washers shall be circular and of suitable thickness. However, where bolt heads/nuts bear upon the bevelled surfaces, they shall be provided with square tapered washers of suitable thickness to afford a seating square with the axis of the bolt.
- 5.2.7.4 Different bolt grades of the same diameter shall not be used in the same structure, except if agreed otherwise by the Engineer-in-Charge.
- 5.2.7.5 Bearing type bolts shall be used (unless noted otherwise) and tightened firmly by available means.
- 5.2.8 **Splicing**
- 5.2.8.1 Splicing of built up/compound/latticed sections shall be done in such a fashion that each component of the section is joined in a staggered manner.
- 5.2.8.2 Where no butt weld is used for splicing, the meeting ends of two pieces of joist/channel/built up section shall be ground flush for bearing on each other and suitable flange and web splice plates shall be designed and provided for the full strength of the flange/ web of the section and welds designed accordingly.
- 5.2.8.3 Where full strength butt weld is used for splicing (after proper edge preparation of the web and flange plates) of members fabricated out of joist/ channel/ angles/ built up section, additional flange and web plates shall be provided, over and above the full strength butt welds, to have 40% strength of the flange and web.
- 5.2.8.4 Where a cover plate is used over a joist/channel section the splicing of the cover plate and channel/joist sections shall be staggered by minimum 500mm. Extra splice plate shall be used for the cover plate and joist/channel section as per clause 5.2.8.2 or 5.2.8.3.
- 5.2.8.5 Prior approval shall be obtained by the Contractor for locations of splices where not shown on design drawings. For members upto a length of 7m, generally no splice shall be allowed but in exceptional cases one splice shall be allowed at approved location. Maximum two numbers of splices shall be allowed for members exceeding this length.
- 5.2.9 **Machining & Grinding**
- 5.2.9.1 All slab bases and slab caps shall be accurately machined over the bearing surfaces and shall be in effective contact with the ends of column sections (shafts).
- 5.2.9.2 For slab bases and slab caps, ends of column shafts shall be accurately machined. However, for gusseted bases and caps, the column shafts shall be ground flush for effective contact with parts connected together.
- 5.2.9.3 Gusseted bases and caps shall be ground flush for effective contact with ends of column sections.
- 5.2.9.4 End of all bearing stiffeners shall be machined or ground to fit tightly at top and bottom without any air gap.
- 5.2.9.5 While machining or grinding care shall be taken so that the length or thickness of any part does not get reduced by more than 2.0mm.
- 5.2.9.6 For all machining or grinding works for gusseted base and cap plates, the clearance between the parts joined shall not exceed 0.2mm at any location.

6.0 MARKING FOR IDENTIFICATION

- 6.1 Each component shall be distinctly marked (with paint) before delivery in accordance with the marking diagrams and shall bear such other marks as will facilitate erection. Components which are identical in all respects may have the same erection mark.
- 6.2 For small members which are delivered in bundles or crates, the required marking shall be done on small metal tags securely tied to the bundle.

7.0 SHOP ERECTION

The steel work shall be temporarily shop erected complete or as directed by the Engineer-in-Charge, so that the accuracy of fit may be checked before despatch.

8.0 INSPECTION & TESTING OF STRUCTURES

- 8.1 The Engineer-in-Charge (or his authorised representative) shall have free access at all times to those parts of the Contractor's works which are concerned with the fabrication of the steel work and shall be provided with all reasonable facilities for satisfying himself that the fabrication is being undertaken in accordance with the provisions of these specifications & other relevant BIS Codes.
- 8.2 Should any structure or part of a structure be found not to comply with any of the provisions of this specification (or relevant BIS Codes as referred to), it shall be liable to rejection. No structure or part of the structure, once rejected shall be resubmitted for inspection, exception cases where the Engineer-in-Charge or his authorised representative considers the defect as rectifiable.
- 8.3 Defects which may appear during/after fabrication/ erection shall be made good only with the consent of the Engineer-in-Charge and procedure laid down by him.
- 8.4 All necessary gauges and templates shall be supplied free to the Engineer-in-Charge by the Contractor whenever asked for during inspection. The Engineer-in-Charge, may at his discretion, check the test results obtained at the Contractor's works by independent tests at a test house, and the cost of such tests shall be borne by the Contractor.

9.0 SHOP PAINTING

- 9.1 All components and members of steel work shall be given one shop coat of primer, as specified in the tender, immediately after the surfaces have been properly prepared (i.e. degreased, derusted, descaled & cleaned) in accordance with the job specification or 6-79-0020, as applicable.

The primer coat shall be applied over completely dry surfaces (using brushes of good quality) in a manner so as to ensure a continuous and uniform film without "holidaying". Special care shall be taken to cover all the crevices, corners, edges etc. However, in areas which are difficult to reach by brushing, daubers/mops shall be used by dipping the same in paint and then pulling/ pushing them through the narrow spaces. The primer coat shall be air dried and shall have the thickness as per EIL Specification no. 6-79-0020 or the relevant job specification.

- 9.2 Surfaces which are inaccessible after shop assembly, shall receive the full specified protective treatment before assembly (this shall not apply to the interior of sealed hollow sections).
- 9.3 Steel surfaces shall not be painted within a suitable distance of any edges to be welded if the paint specified would be harmful to welders or impair the quality of the welds.
- 9.4 Welds and adjacent parent metal shall not be painted prior to deslagging, inspection and approval by the Engineer-in-Charge.
- 9.5 Parts to be encased in concrete shall have only one coat of primer and shall not be painted after erection.

10.0 PACKING

- 10.1 All items shall be suitably packed in case these are to be despatched from the fabrication shop to the actual site of erection so as to protect them from any damage/distortion or falling during transit. Where necessary, slender projecting parts shall be temporarily braced to avoid warping during transportation.
- 10.2 Small parts such as gussets, cleats etc., shall be securely wired on to their respective main members.
- 10.3 Bolts, nuts washers etc. shall be packed in crates.

11.0 TRANSPORTATION

Loading and transportation shall be done in compliance with transportation rules. In case, certain parts can not be transported in the lengths stipulated on the drawings, the position details of such additional splice joints shall be got approved by the Engineer-in-Charge.

12.0 SITE (FIELD) ERECTION

12.1 Plant & Equipment

The suitability and capacity of all plant and equipment used shall be to the complete satisfaction of the Engineer-in-Charge.

12.2 Storing & Handling

All steel work shall be so stored and handled at site so that the members are not subjected to surface abrasion, excessive stresses and any damage.

12.3 Setting Out

Prior to setting out of the steel work, the Contractor shall get himself satisfied about the correctness of levels, alignment, location of existing concrete pedestals/columns/brackets and holding down bolts/pockets provided therein. Any minor modification in the same including chipping, cutting and making good, adjusting the anchor bolts etc., if necessary, shall be carried out by the Contractor at his own expense. The positioning and levelling of all steel work including plumbing of columns and placing of every part of the structure with

accuracy shall be in accordance with the drawings and to the complete satisfaction of the Engineer-in-Charge.

12.4 Tolerances

Tolerances for erection of steel structures shall be as per Annexure 'A'

13.0 SAFETY & SECURITY DURING ERECTION

13.1 The contractor shall comply with IS 7205 for necessary safety and adhere to safe erection practices and guard against hazardous as well as unsafe working conditions during all stages of erection.

13.2 During erection, the steel work shall be securely bolted or otherwise fastened and when necessary, temporarily braced/guyed to provide for all loads to be carried by the structure during erection till the completion, including those due to the wind, erection equipment & its operation etc. at no extra cost to the owner. For the purpose of guying, the Contractor shall not use other structure in the vicinity without prior written permission of the Engineer-in-Charge.

13.3 No permanent bolting or welding shall be done until proper alignment has been achieved.

13.4 Proper access, platform and safety arrangement shall be provided for working and inspection, (at no extra cost to the owner) whenever required.

14.0 FIELD CONNECTIONS

14.1 Field Bolting

Field bolting shall be carried out with the same care as required for shop bolting.

14.2 Field Welding

All field assembly and welding shall be executed in accordance with the requirements for shop assembly and welding. Holes for all erection bolts - where removed after final erection shall be plugged by welding. Alternatively, erection bolts may be left and secured.

15.0 GROUTING

15.1 Prior to positioning of structural columns/girders/ trusses over the concrete pedestals/columns/brackets, all laitance & loose material shall be removed by wire brushing & chipping. The bearing concrete surfaces shall be sufficiently levelled, hacked with flat chisels to make them rough, cleaned (using compressed air) and made thoroughly wet. All pockets for anchor bolts shall also be similarly cleaned and any excess water removed. Thereafter, the structural member shall be erected, aligned & plumbed maintaining the base plates/shoe plates at the levels shown in the drawings, with necessary shims/pack plates/wedges.

15.2 After final alignment and plumbing of the structure, the forms shall be constructed around and joints made tight to prevent leakage. Grouting (under the base plates/shoe plates including grouting of sleeves & pockets) shall be done with non-shrink grout having compressive strength (28 days) not less than 40N/sq.mm. Non shrink grout shall be of free

flow premix type and of approved quality and make. It shall be mixed with water in proportion as specified by the manufacturer. Ordinary 1:2 cement/sand mortar grout shall be used only for small, isolated structures e.g. operating platforms not supporting any equipment, pipe supports, crossovers, stairs & ladders. The thickness of grout shall be as shown on the drawings. In case, not mentioned grout thickness shall not be less than 25mm nor more than 50mm in any case.

15.3 The grout mixture shall be poured continuously (without any interruption till completion) by grouting pumps from one side of the base plate and spread uniformly with flexible steel strips and rammed with rods, till the space is filled solidly and the grout mixture carried to the other side of the base plate.

15.4 The grout mixture shall be allowed to harden for a period as decided by the Engineer-in-Charge. At the end of this period, the shims/wedges/pack plates may be removed and anchor bolts tightened uniformly. The alignment of the structure shall now be rechecked and if found correct, the voids left by the removal of shims/wedges/pack plates (if removed) must be filled up with a similar mixture of grout. In case after checking, serious misalignment is indicated, the grout shall be removed completely and fresh grouting done after making appropriate correction of alignment.

16.0 SCHEME AND SEQUENCE OF ERECTION

The Contractor shall furnish the detailed scheme and sequence of erection to match with the project schedule and get the same approved by the Engineer-in-Charge. All necessary co-ordination and synchronization shall be done with the Civil contractor where Civil works are not included in the scope of structural contractor at no extra cost so as to match with the project schedule.

17.0 PAYMENT

This clause shall apply to Item Rate tender only.

17.1 Payment for structural steel works shall be made on the basis of admissible weight in metric tons (determined as described in clause 17.2 and 17.3) of the structure accepted by the Engineer-in-Charge. The rate shall include supplying (as per supply conditions given in the Tender) fabricating, erecting in position (at all levels & locations), testing/examining (excluding radiography only) of bolted and/or welded structural steel works of all types (including all built up/compound sections made out of rolled sections and/or plates) including all handling, transporting, storing, straightening if required, cutting, edge preparation, preheating, bolting and welding of joints (including sealing the joints of box sections with continuous welding), finishing edges by grinding/machining as shown, fixing in line & level with temporary staging & bracing and removal of the same after erection, grouting with non-shrink/ordinary grout as specified, preparation of fabrication & erection drawings, & erection schedule and getting them reviewed, preparation and submission of as built drawings, preparing the surfaces for painting, and applying the primer as specified after fabrication, return of surplus materials to owner's stores and material reconciliation in the case of materials supplied by the owner as per relevant contract conditions etc. all complete for all the operations mentioned in the foregoing clauses.

17.2 The weight for payment shall be determined from the fabrication drawings and respective bill of materials prepared by the Contractor. The bill of materials shall be checked and approved by the Engineer-in-Charge before making the payment. The Contractor shall prepare full scale template in order to supplement/verify the actual cutting dimensions

where so directed by the Engineer-in-Charge. The weight shall be calculated on the basis of BIS Hand Book wherever applicable. In case sections used are different from BIS sections, then Manufacturers' Hand Book shall be adopted. No allowance in weight shall be made for rolling tolerances.

17.3 Welds, bolts, nuts, washers, shims, pack plates, wedges, grout and shop painting shall not be separately measured. The quoted rate shall be deemed to include the same.

17.4 The rate shall include all expenses related to safety & security arrangements during erection and all plants & tools required for fabrication, transportation & erection.

18.0 PAINTING AFTER ERECTION

18.1 General

18.1.1 The scope of painting after erection shall be at the sole discretion of the Engineer-in-Charge and the Contractor shall obtain written instruction in this regard sufficiently prior to taking up any procurement of paint and execution of painting work after erection of steel structures.

18.1.2 The Contractor shall carry out the painting work in all respects with the best quality of approved materials (conforming to relevant EIL Specification no. 6-79-0020 or the job specification, as applicable) and workmanship in accordance with the best engineering practice. The Contractor shall furnish characteristics of paints (to be used) indicating the suitability for the required service conditions. The paint manufacturer's instructions supplemented by Engineer-in-Charge's direction, if any, shall be followed at all times. Particular attention shall be paid to the following:

- Proper storage to avoid exposure & extremes of temperature.
- surface preparation prior to painting.
- Mixing & thinning.
- Application of paint and the recommended limit on time intervals between consecutive coats.

18.1.3 Painting shall not be done in frost or foggy weather, or when humidity is such as to cause condensation on the surfaces to be painted.

18.1.4 Surface which shall be inaccessible after site assembly shall receive the full specified protective treatment before assembly.

18.1.5 Primers & finish coat paints shall be from the same manufacturer in order to ensure compatibility. Painting colour code shall be as per Annexure-'B' or the job specification.

18.2 Rub Down & Primer Application

The shop coated surfaces shall be rubbed down thoroughly with emery/abrasive paper to remove dust, rust, other foreign matters and degreased, if required, in accordance with EIL specification no. 6-79-0020 or the job specification, as applicable, cleaned with warm fresh water and air dried. The portions, from where the shop coat has peeled off, shall be touched up and allowed to dry.

Primer coat as per EIL specification no. 6-79-0029 or the job specification, as applicable, shall be applied by brushing/ spraying over the shop coat in a manner so as to ensure a continuous and uniform film throughout. Special care shall be taken to cover all the crevices, corners, edges etc. The final primer coat shall be air dried and shall have a

minimum film thickness as per EIL Specification no. 6-79-0020 or job specification after drying, as applicable.

In case different cleaning procedure & primer specifications are specified in the drawing/Tender, the same shall be adopted.

18.3 Final Paint Application

After the primer is hard dry, the surfaces shall be dusted off and the paint as per EIL specification no. 6-79-0020 or the job specification, as specified, shall be applied by brushing/spraying so that a film free from "holidaying" is obtained. The colour & shade of first coat of paint shall be slightly lighter than the second coat in order to identify the application of each coat. The second coat of paint shall be applied after the first coat is hard dry. The minimum thickness of each film shall be 20 microns ($\pm 10\%$ tolerance) after drying.

In case a different type of paint & painting procedure are specified in the drawing/tender, the same shall be adopted.

18.4 Inspection & Testing of Painting Works

18.4.1 All painting materials including primers & thinners brought to site by the Contractor for application shall be procured directly from reputed and approved manufacturers and shall be accompanied by manufacturer's test certificates. Paint formulations without certificates shall not be accepted.

18.4.2 The Engineer-in-Charge at his discretion may call for additional tests for paint formulations. The Contractor shall arrange to have such tests performance including batch wise test of wet paints for physical & chemical analysis. All costs shall be borne by the Contractor.

18.4.3 The painting work shall be subject to inspection by the Engineer-in-Charge at all times. In particular, the stage inspection will be performed and Contractor shall offer the work for inspection and approval at every stage before proceeding with the next stage. The record of inspection shall be maintained. Stages of inspection are as follows:

- (a) Surface preparation
- (b) Primer application
- (c) Each coat of paint

18.4.4 Any defect noticed during the various stages of inspection shall be rectified by the Contractor to the entire satisfaction of the Engineer-in-Charge before proceeding further. Irrespective of the inspection, repair and approval at intermediate stages of work the Contractor shall be responsible for making good any defects found during final inspection/guarantee period/defect liability period, as defined in General Conditions of Contract. Dry film thickness (DFT) shall be checked and recorded after application of each coat. The thickness shall be measured at as many locations as decided by the Engineer-in-Charge. The Contractor shall provide standard thickness measuring instrument such as elcometer (with appropriate range for measuring dry film thickness of each coat) free of cost to the Engineer-in-Charge whenever asked for.

18.5 Payment

Payment for painting of structural steel works shall be made on the basis of admissible weight in metric tons of the painted structures accepted by the Engineer-in-Charge.

The rate shall include supplying & applying the paint, specified in the tender, of approved quality and shade over the primer, specified in the tender, over the shop primer already applied to structural steel works of all types/shapes at all levels, locations & positions including storage, surface preparation, degreasing, cleaning, drying, touching up of shop primer coat, providing temporary staging, testing etc. all complete to the entire satisfaction of the Engineer-in-Charge.

ANNEXURE-'A'
(Clause 12.4)

Maximum Permissible Erection Tolerances

A. Columns

1. Deviation of column axes at foundation top level with respect to true axes.
 - i) In longitudinal direction $\pm 5 \text{ mm}$
 - ii) In lateral direction $\pm 5 \text{ mm}$
2. Deviation in the level of bearing surface of columns at foundation top with respect to true level $\pm 5 \text{ mm}$
3. Out of plumb (Verticality) of column axis from true vertical axis, as measured at top:
 - i) Upto and including 30m height whichever is less. $\pm H/1000 \text{ or } \pm 25 \text{ mm}$
 - ii) Over 30m height $\pm H/1200 \text{ or } \pm 35 \text{ mm}$ whichever is less.
4. Deviation in straightness in longitudinal & transverse planes of column at any point along the height. $\pm H/1000 \text{ or } \pm 10 \text{ mm}$ whichever is less.
5. Difference in the erected positions of adjacent pairs of columns along length or across width of building prior to connecting trusses/beams with respect to true distance. $\pm 5 \text{ mm}$
6. Deviation in any bearing or seating level with respect to true level. $\pm 5 \text{ mm}$
7. Deviation in difference in bearing levels of a member on adjacent pair of columns both across & along the building. $+ 5 \text{ mm}$

Note: 1. Tolerance specified under 3 should be read in conjunction with 4 & 5.

Note: 2. 'H' is the column height in mm.

B. Trusses

1. Shift at the centre of span of top chord member with respect to the vertical plane passing through the centre of bottom chord. $\pm 1/250 \text{ of height of truss in mm at centre of span or } \pm 15 \text{ mm}$ whichever is less.
2. Lateral shift of top chord of truss at the centre of span from the vertical plane passing through the centre of supports of the truss. $\pm 1/1500 \text{ of span of truss in mm or } \pm 10 \text{ mm}$ Whichever is less.
3. Lateral shift in location of truss from its true position. $\pm 10 \text{ mm}$

4. Lateral shift in location of purlin from true position. $\pm 5\text{mm}$
5. Deviation in difference of bearing levels of truss from the true level. $\pm 1/1200$ of span of truss in mm or 20mm whichever is less.

C. Gantry Girders & Rails

1. Shift in the centre line of crane rail with respect to centre line of web of gantry girder. $\pm \left[\frac{\{\text{web thickness (mm)}\}}{2} + 2 \text{ mm} \right]$
2. Shift of alignment of crane rail (in plan) with respect to true axis of crane rail at any point. $\pm 5 \text{ mm}$
3. Deviation in crane track gauge with respect to true gauge.
 - i) For track gauge upto and including 15 m. $\pm 5 \text{ mm}.$
 - ii) For track gauge more than 15m. $\pm [5 + 0.25 (S-15)]$
Subject to maximum $\pm 10\text{mm}$, where S in metres is true gauge.
4. Deviation in the crane rail level at any point from true level. $\pm 10 \text{ mm}.$
5. Difference in level between crane track rails (across the bay) at
 - i) Supports of gantry girders 15 mm.
 - ii) Mid span of gantry girders 20 mm.
6. Relative shift of crane rail surfaces (at a joining) in plan and elevation. 2 mm.

ANNEXURE-'B'
(Clause 18.1)

PAINTING COLOUR CODE FOR STRUCTURAL STEEL

1.	GANTRY GIRDER & MONORAIL	DARK GREEN
2.	GANTRY GIRDER & MONORAIL STOPPER SIGNAL	RED
3.	BUILDING STRUCTURAL STEEL COLUMNS, BRACKETS, BEAMS, BRACINGS, ROOF TRUSS, PURLINS, SIDEGIRTS, LOUVERS, STRINGERS	DARK ADMIRALITY GREY
4.	PIPE RACK STRUCTURE & TRESTLE	DARK ADMIRALITY GREY
5.	CHEQUERED PLATE (BOTH FACES)	BLACK
6.	GRATING	BLACK
7.	LADDER RUNGS	BLACK VERTICALS & CAGE RED
8.	HAND RAILING	
-	HANDRAIL, MIDDLE RAIL, TOE PLATE	SIGNAL RED
-	VERTICAL POST	BLACK

मानक विनिर्देशन सिविल एवं संरचनात्मक कार्य

STANDARD SPECIFICATION CIVIL & STRUCTURAL WORKS

विभिन्न इस्पात कार्य

MISCELLANEOUS STEEL WORKS

9	11.12.25	REVISED & REISSUED	CK	AJS	AS	MN
8	18.04.25	REVISED & REISSUED	TK	AJS	AS	MN
7	27.08.18	REVISED & REISSUED	AS	AS	RS	RKT
6	24.01.14	REVISED & REISSUED	AJS	RS	PKM	SC
5	10.06.08	REVISED & REISSUED	PKB	PKM	VK	VC
Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
Approved by						

Abbreviations:

AFC	:	Approved for Construction
BIS	:	Bureau of Indian Standards
DIN	:	Deutsches Institut für Normung (German Institute for Standardization)
EN	:	European Standards
IS	:	Indian Standard
ISO	:	International Organization for Standardization
MS	:	Mild Steel
PCC	:	Plain Cement Concrete
RCC	:	Reinforced Cement Concrete

Structural Standards Committee

Convenor: Mr. Anurag Sinha

Members: Mr. Virender Goel
Mr. Deepak Agrawal
Ms. Alpana Srivastava
Dr. Sudip Paul
Ms. Papia Mandal
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1.0 GENERAL

- 1.1 All materials supplied by the Contractor shall conform to specifications given in EIL Standard Specification No. 6-68-0002.
- 1.2 The Contractor shall furnish test certificates for all materials prior to their use in the works. Structural steel materials not supported by mill test certificates may be used after confirming their quality by carrying out appropriate tests in accordance with the method specified in IS 1608.
- 1.3 Other requirements not covered under this specification shall be in accordance with EIL Standard Specification No. 6-68-0006.

2.0 REFERENCES

As mentioned in the respective clauses.

3.0 MATERIAL

As mentioned in the respective clauses.

4.0 ANCHOR BOLTS

4.1 Material

Materials for anchor bolts, nuts, locknuts, washers, pipe sleeves and anchor plates shall conform to their respective clauses given in EIL Standard Specification No. 6-68-0002.

4.2 Fabrication

Fabrication of anchor bolts and their complete assemblies shall be strictly in compliance with the specifications and drawings/standards.

4.3 Placement

Anchor bolt assemblies shall be placed in position strictly as per drawings and securely held during pouring and vibrating of concrete with necessary templates and other dummy structures to prevent their dislocation.

4.4 Tolerances

Tolerances allowed for anchor bolts positioning shall be as below:

- a) For sleeved bolts, one tenth of the bolt nominal diameter.
- b) For bolts without sleeves, one twentieth of the bolt nominal diameter.

4.5 Protection

The exposed surfaces of bolts shall be properly covered (after greasing of bolts and packing of sleeves) with jute cloth so as to protect them from damage till final erection of structure/equipment is over.

4.6 Payment

- 4.6.1 Payment shall be made on the basis of actual weight in metric tons of the anchor bolt/anchor bolt assembly. The rate shall include supply (as per scope of supply conditions given in the

tender) of all materials, handling, transporting, fabrication, turning from available size to required diameter, threading, welding, fixing in position at all levels and locations, providing necessary templates, greasing, packing of sleeves, covering with jute cloth and other protective measures etc. all complete.

4.6.2 The rate shall cover bolt of any diameter and nomenclature.

4.6.3 Payment for fixing anchor bolt assembly (already fabricated and supplied by the Owner as free issue) in position shall be made on the basis of actual weight of anchor bolts/bolt assemblies in metric tons. The rate shall include handling, transporting, fixing in position at all levels and locations, welding if required, providing necessary templates, greasing, packing of sleeves, covering with jute cloth and other protective measures etc. all complete.

4.6.4 No separate payment shall be made for templates, dummy structures, supports etc. and the rate quoted shall be inclusive of all cost related to such provision required for correct and accurate installation of anchor bolts/anchor bolt assembly.

5.0 METAL INSERTS

5.1 Material

Materials required for fabricating metal inserts shall conform to their respective specification given in EIL Standard Specification No. 6-68-0002.

5.2 Fabrication

Fabrication of inserts shall be done strictly as per drawings/standards and in compliance with the requirements given in EIL Standard Specification No. 6-68-0006.

5.3 Placement

Metal inserts shall be correctly embedded (in plain concrete/ reinforced concrete) as per their location shown on the drawings. Care shall be taken that these are securely held in position and do not get disturbed during concreting. Where necessary, these may be welded to the reinforcement bars. Suitable templates, spacers, dummy structures and temporary staging shall be provided. Necessary cutting in the formwork and adjustment of reinforcement bars shall be done for the placement of metal inserts where required.

5.4 Painting

The exposed surfaces of metal inserts shall be cleaned and given one coat of primer as per EIL Standard Specification No. 6-79-0020 or job specification (wherever applicable), as specified, after fabrication.

5.5 Payment

Payment shall be made on the basis of actual weight in metric tons of the metal inserts. The rate shall include supply (as per supply conditions given in the tender) of all materials, handling, transporting, fabrication, welding, fixing in position at all levels and locations, providing necessary templates, spacers, dummy structures, adjusting the formwork and reinforcement, staging, preparation of surface for painting, applying one coat of primer as per EIL Standard Specification No. 6-79-0020 or job specification (wherever applicable), as specified, etc. all complete.

6.0 CHEQUERED PLATES

6.1 Material

Material required for chequered plates shall conform to the specifications given in EIL Standard Specification No. 6-68-0002. Chequering shall be closed or open-ended or of any other pattern as shown on drawings.

6.2 Fabrication Drawings

As per the requirements given in EIL Standard Specification No. 6-68-0006.

6.3 Fabrication

Chequered plates shall be fabricated as per the "Approved for Construction" fabrication drawings (prepared by the Contractor based on design drawings). These shall be perfectly flat and without any dents/deformations and shall be cut to the required size and shape. Holes/ notches/ openings of the required size, if any, shown on drawings shall be made. Nosing for staircase treads shall be made by cold bending of chequered plates. All edges shall be made smooth and even. All chequered plate units shall be given distinct erection marks in accordance with the marking drawings. Stiffeners of any description shall be welded with the chequered plates where shown on drawings.

6.4 Erection/Fixing

Chequered plates shall be fixed to the bearing members by welding/ bolting/ screwing as shown on drawings. All bolts/ screws shall be of counter-sunk type so that the heads remain flush with the top of plate. Where welding is used for fixing, stitch welds of minimum 50mm length with a pitch of 150 mm shall be used. Continuous sealing run of weld shall be provided along the junction of two consecutive chequered plates parallel to the span. For removable flooring, details as shown on drawings shall be followed.

6.5 Painting

Chequered plates shall be cleaned (both the surfaces) and given one coat of primer/ galvanization as per EIL Standard Specification No. 6-79-0020 or job specification, as specified, on both surfaces.

6.6 Payment

6.6.1 Payment shall be made on the basis of actual weight in metric tons of the chequered plate. If any stiffening sections are provided below the chequered plates for strengthening, the same shall be separately measured & paid under Structural Steel item (Refer EIL Standard Specification No. 6-68-0006).

6.6.2 The rate shall include supplying (as per supply conditions given in the tender), fabricating, erecting M.S. chequered plates including transporting, handling, straightening if required, cutting to required size and shape, making holes/ notches/ opening of required size and nosing, smoothening the edges, fixing by welding/bolting/screwing, at all levels and locations, preparing detailed fabrication drawings, surface cleaning, removal of rust, scale, grease and applying one coat of primer/ galvanization as per EIL Standard Specification No. 6-79-0020 or job specification (wherever applicable), as specified, etc. all complete.

6.6.3 Welds, bolts, nuts, screws, washers, clips shall not be measured. The quoted rate shall be deemed to include the same.

7.0 GRATINGS

7.1 Categories

Electroforged Carbon Steel/ Stainless Steel gratings shall be either Type-I or Type-II as per EIL Standard No. 7-68-0697 and shall be procured from approved manufacturers as per Departmental List of Approved Manufacturers.

7.2 Material

Materials for fabrication and fixing of Gratings shall conform to EIL Standard No. 7-68-0697 and EIL Specification No. 6-68-0002.

7.3 Fabrication Drawings

As per the requirements given in EIL Standard Specification No. 6-68-0006.

7.4 Fabrication

The gratings shall be manufactured by electroforging process strictly as per the "Approved for Construction" fabrication drawings prepared by the Contractor based on EIL standard. All units shall be given distinct erection marks in accordance with the marking drawing. The Contractor shall submit sample gratings for inspection and approval by the Engineer-in-Charge whenever asked for.

7.5 Erection/Fixing

Gratings shall be fixed to the bearing members by welding, clamping/ disc and bolting/ studs as indicated in the Standard.

7.6 Galvanisation

Carbon steel gratings and the fixing clamps, bolts, nuts shall be cleaned as per EIL Standard Specification No 6-79-0020 or job specification (wherever applicable), as specified and galvanisation shall be done as specified in accordance with IS 2629 and tested as per IS 2633 & IS 6745. Carbon Steel Disc & Stud shall either be hot dip galvanized or shall have a coating that can withstand neutral salt spray test of 2000H as per DIN EN ISO 9227.

7.7 Payment

7.7.1 Payment shall be made on the basis of actual weight in metric tons of the gratings manufactured in accordance with EIL Standard and accepted by the Engineer-in-Charge.

The weight for payment shall also include the weight of galvanization and welding.

7.7.2 The rate shall include supplying, fabricating, erecting electroforged Carbon steel/ Stainless steel gratings (of the specified category) including transporting, handling, cutting to required size and shape, making holes/ notches/ openings, smoothening the edges, fabricating clamps/discs, fixing by welding/ clamping/ bolting/ disc & stud, at all levels and locations, preparing detailed fabrication drawings, surface cleaning, removal of rust, scale, grease and carrying out galvanization on Carbon steel gratings, clamps, nuts & bolts and/or a coating on Carbon steel discs & studs that can withstand neutral salt spray test of 2000H as per DIN EN ISO 9227, repairing the damaged area of galvanized coating using cold galvanizing spray process for Carbon steel grating, chemical treatment of Stainless steel grating, etc. all complete.

- 7.7.3 Bolts, clamps/ discs, nuts/ studs and washers for both Carbon steel and Stainless steel gratings shall not be measured. The quoted rate shall be deemed to include the same.

8.0 TUBULAR HAND RAILING

8.1 Material

Materials for fabrication and fixing of Tubular Hand Railing shall confirm to specification given in EIL Standard Specification No. 6-68-0002.

8.2 Fabrication Drawings

As per the requirements given in EIL Standard Specification No. 6-68-0006.

8.3 Fabrication

- 8.3.1 Hand railing shall be fabricated strictly as per the "Approved for Construction" fabrication drawings prepared by the Contractor based on design drawings and standards. All tubes shall be straight and without any dents/ deformations. Tubes shall be cut and ends shall be prepared to a neat and workman-like finish. All elements shall be directly welded. All welded joints shall be cleaned and filed or ground smooth, if required, to have a smooth surface and aesthetically pleasant appearance. Splicing of top rail shall not be allowed. Tubes shall be cold bent to shape and curvature in case of discontinuous ends of handrails. Ripples, kinks and/ or dents at bends shall not be accepted.

- 8.3.2 Lower ends of vertical posts shall be cut and splayed (for grouting in pockets in the concrete members). For removable type of hand railing, suitable base plates (with provision for bolting) shall be welded to the lower end of vertical posts. All units shall be given distinct erection marks in accordance with the marking drawing.

8.4 Erection/ Fixing

Hand railing shall be fixed to the bearing members by welding/ bolting/ grouting as indicated on the drawings. Local notching shall be made in the floor plate/ grating to accommodate vertical posts/ their base plates which shall always be welded to the main supporting member. When the posts are to be fixed in concrete members, suitable pockets shall be made in concrete for grouting as shown on drawings/standards.

8.5 Painting

All hand railing components shall be cleaned and given one coat of primer/ galvanization as per EIL Standard Specification No. 6-79-0020 or job specification (wherever applicable), as specified, after fabrication.

8.6 Payment

- 8.6.1 Payment shall be made on the basis of measured length in meters (m) of top rail only (Horizontal and/or inclined lengths). The rate shall include preparation of fabrication drawings, supply of all materials, handling, transporting, straightening if required, cutting to required size, bending, welding, bolting, fixing in position at all levels and locations, grouting with 1:2 (cement: sand) mortar, surface cleaning, removal of rust, scale, grease and applying one coat of primer/ galvanization as per EIL Standard Specification no. 6-79-0020 or job specification (wherever applicable), as specified, after fabrication etc. all complete.
- 8.6.2 The rate shall include making suitable notches in floor plates/ gratings and pockets in concrete structures for fixing the vertical posts.

9.0 MILD STEEL RUNGS

9.1 Material

All materials shall conform to specifications given in EIL Standard Specification No. 6-68-0002.

9.2 Fabrication

Rungs shall be fabricated as per EIL standards/ drawings. Mild steel bars shall be straightened if required, cut, bent to shape and given one coat of primer and two coat of finish paints per EIL Standard Specification No. 6-79-0020 or job specification (wherever applicable) as specified, on exposed portions after fabrication.

9.3 Fixing

Rungs shall be fixed in position as per detailed drawing and firmly tied/welded with reinforcement to prevent their displacement during vibration of concrete.

9.4 Payment

Payment shall be made on the basis of actual weight in kilogram (Kg) of the M.S. rungs. The rate shall include supply of all materials, handling, transporting, straightening if required, cutting to required size, bending to shape, tying/welding with reinforcement bars, fixing at all levels and locations, adjustment of formwork, applying one coat of primer and two coats of finish paint as per EIL Standard Specification No. 6-79-0020 or job specification (wherever applicable), as specified, on the exposed portion of rungs etc. all complete.

10.0 LIGHT GAUGE STEEL STRUCTURAL SECTIONS

10.1 Material

All materials required for fabrication and fixing in position of Light Gauge Steel Structural Sections shall conform to EIL Standard Specification No. 6-68-0002.

10.2 Fabrication Drawings

As per the requirements given in EIL Standard Specification No. 6-68-0006.

10.3 Fabrication

10.3.1 Fabrication of members shall be done strictly as per the "Approved for Construction" fabrication drawings prepared by the Contractor based on the latest design drawings and in accordance with IS 800, IS 801 and other relevant BIS Codes.

10.3.2 All members shall be straight and free from any dents/deformations/ twists. Members shall be cut to the required sizes and ends prepared to a neat and workman like finish. Holes (for sag rods and cleat bolts) of appropriate size shall be drilled and all members/ components shall be given distinct erection marks in accordance with the marking drawings. Holes shall not be formed by gas cutting process.

10.4 Erection

Structural members shall be erected in proper sequence and aligned properly without causing any twist. Permanent bolting/ welding shall be done only after proper alignment has

been achieved. Proper access, working platforms and safety arrangements shall be provided by the Contractor for working and inspection.

10.5 Painting

All structural components shall be cleaned and given one coat of primer as per EIL Standard Specification No. 6-79-0020 or job specification (wherever applicable), as specified, after fabrication.

10.6 Payment

- 10.6.1 Payment shall be made on the basis of admissible weight in metric tons of the structure accepted by the Engineer-in-Charge. The weight for payment shall include all structural members, cleats, splices, gussets and sag rods and shall be determined from the fabrication drawings along with respective bill of materials prepared by the Contractor. The bill of materials shall be checked and approved by the Engineer-in-Charge before making the payment. The weight shall be calculated as per IS 808/ IS 1161. BIS Handbook/ Manufacturer's catalogues/ charts shall be adopted in case relevant weights of sections used are not covered in IS 808/ IS 1161. No allowance in weight shall be made for rolling tolerances. In case of any doubt, actual weight of the section shall be measured at site.

The rate shall include supplying, fabricating, erecting, at all levels and locations, testing of bolted and/ or welded Light Gauge structural steel works including cleats, crook bolts, splices/ sleeves, all other fixtures and accessories, straightening if required, cutting, edge preparation, welding and bolting of joints, fixing in line and level with temporary staging and removal of the same after final alignment, handling, transporting, storage, preparation of detailed fabrication drawings and getting them reviewed by the Engineer-in-Charge, surface cleaning, removal of scale, rust, oil or grease and applying one coat of primer as per EIL Standard Specification No. 6-79-0020 or job specification (wherever applicable), etc., all complete.

- 10.6.2 All welds, bolts, nuts, washers, fixtures and accessories shall not be measured. The quoted rate shall be deemed to include the same.

11.0 MECHANICAL ANCHOR FASTENERS

Design and testing of Mechanical Anchor Fasteners shall conform to IS 1946 Part-2 and Part-4 respectively or they shall be approved by European Organization for Technical Approval (EOTA) / Deutsches Institut für Bautechnik (DIBt)/ Factory Mutual Laboratories (FM)/ International Code Council- Evaluation Services (ICC-ES formerly ICBO-ES) for use in Cracked Concrete.

Design of post-installed Mechanical anchor fasteners shall be provided/ verified by the approved manufacturer with installation instructions and execution shall be done by an applicator trained by the approved manufacturer (preferably in the presence of manufacturer for critical applications/ structures).

11.1 Material

Mechanical Anchor Fasteners shall be of minimum grade 5.8 galvanised to at least 5 microns or Stainless Steel (SS304 or SS316) and shall be approved for use in cracked concrete.

Stainless steel Mechanical anchor fasteners shall be preferred for sites located in coastal areas or in high rainfall zone.

11.2 Classification

11.2.1 Mechanical anchor fasteners shall be of following types:

a) Wedge/ Expansion anchor fasteners

They are most commonly used anchor fasteners and shall be utilized in safety related installations, fixing of insert or base plate for beams & columns, jacking of column, staircase railing, handrails, racks, walkways, pipe supports, ladders, jacketing, platform supports, strengthening of structure, knee supports, fire sprinklers, concrete formwork, telecommunication equipments, etc.

b) Screw anchor fasteners

They shall be used for installation of door & window frames, fences, facade panels, cable trays, electrical fixtures, hangers, sill plates, Signages, temporary fabrications, formwork props, Tilt ups & Prefab connectors, etc.

c) Undercut anchor fasteners

They shall be used only for critical applications with prior design assistance from the manufacturer, like for fixing pumps, turbines, industrial exhaust fans, heavy pipes, crane rails, crash & safety barriers, industrial machines, heavy platform supports, knee brackets with heavy loads, supports subjected to cyclic/dynamic loadings (shock, seismic & fatigue), etc.

11.2.2 Mechanical anchor fasteners shall be designated as medium and heavy duty depending on their usage. The broad classification is given below for general guidance.

11.2.2.1 Medium Duty for:

- a) Ladders, balconies and stairs support.
- b) Cables and cable trays support.
- c) Electrical panels and fixtures.
- d) Hangers for pipes and cable trays
- e) Secondary & tertiary Pipe supports.
- f) Equipment Skids
- g) Formwork props, tilt ups and prefab connectors.
- h) Small Industrial equipments.

11.2.2.2 Heavy Duty for:

- a) Platform supports (beam and columns)
- b) Knee brackets for pipes/ multi tiers cable trays/ walkways etc.
- c) Foundation anchors for heavy equipment like boiler, silos, etc.
- d) Primary connection for erection of Beams & Columns for missing insert/ base plates
- e) Primary pipe supports, Industrial machines
- f) Safety barriers, Crash barriers, Crane rails, dorm structures
- g) Elevator tracks, Car hoists, roof & slab supports

11.2.3 Necessary support shall be taken from the Manufacturer while deciding the Mechanical anchor fasteners for following applications:

- a) Members supporting equipment and pipes subjected to vibrations.
- b) Cantilever connections designed to cater for effective cantilever spans greater than 1m and concentrated load of more than 10KN at the free end.

11.3 Selection

The Contractor shall procure the Mechanical anchor fasteners from the approved manufacturers as per Departmental List of Approved Manufacturers.

11.4 Testing

If so desired by the Engineer-in-Charge, the Contractor shall carry out all the requisite tests (pullout test, torque test etc.) of specimen Mechanical anchor fasteners (representative of those to be used) from approved laboratory/ test house and submit the report to him for approval. The decision of the Engineer-in-Charge regarding the adequacy of strength and load carrying capacity of Mechanical anchor fasteners shall be final and binding to all. The cost of all such tests shall be borne by the Contractor.

11.5 Installation

The Contractor shall install Mechanical anchor fasteners at their correct location (to suit the requirement of fixtures as shown in drawings) as per the procedure laid down by the manufacturer. Location of all holes shall be pre-marked on the concrete surfaces. Scanning before drilling shall be done with appropriate ferro scanner tool to avoid rebar hits and structural damage. The holes shall then be drilled carefully with an electric drill to the correct recommended size and depth. Holes shall be exactly round and true perpendicular to the concrete surface. Edge distance and pitch of fasteners shall be as recommended by the manufacturer. The contractor shall suitably shift the hole with the approval of the Engineer-in-Charge in case any reinforcement bar is encountered while scanning/ drilling the hole in RCC structure. Anchors shall preferably be driven with the help of setting tool, fixed at right embedment depth, by applying torque using calibrated impact wrench as per manufacturer's instructions. Necessary staging shall be provided for working and the Contractor shall take requisite safety precautions so as not to cause any damage to the existing structure/ equipment. Any damage done while executing the job shall be made good by the Contractor at his own cost.

11.6 Protection

The exposed surfaces of Mechanical anchor fasteners shall be properly greased & covered with jute cloth so as to protect them from damage.

11.7 Payment

Payment for installing rust proof Mechanical anchor fasteners shall be made on number basis (each). The rate shall include supply of complete assembly, handling, transporting, providing necessary temporary staging, installing (as per manufacturer's specifications) in PCC/ RCC structures, at all levels and locations, testing, scanning, drilling, cleaning, covering with jute cloth, relocating and re-drilling in case of any obstruction, making good any damage done to the structure, grouting the abandoned holes and any gap left between the contact surfaces of PCC/ RCC and fixtures to be added, design assistance from the Manufacturer (wherever required), etc. all complete.

12.0 CHEMICAL ANCHOR FASTENERS AND DOWELS (REBARS)

Design and testing of Chemical anchor fasteners including Adhesive (Chemical) shall conform to IS 1946 Part-2 & Part-3 respectively or they shall be approved by European Organization for Technical Approval (EOTA)/Centre Scientifique et Technique du Bâtiment (CSTB)/ Code Officials and Laboratory Accreditation (COLA)/ International Code Council-Evaluation Services (ICC-ES formerly ICBO-ES) for use in Cracked Concrete. They shall

have Seismic (Zone III & above equivalent), Fatigue, Shock and Fire approvals from European Technical Assessment (ETA) agency.

The adhesive (Chemical) shall have an ETA approval for 100 years of age testing and shall comply with EOTA Technical Report (TR 029)/ EN 1992-4 while using with Chemical anchor fasteners and EOTA Technical Report (TR 069) & European Assessment Document (EAD 332402-00-0601) while using with Dowels (Rebars).

Design of post-installed Chemical anchor fasteners and Dowels (Rebars) shall be provided/ verified by the approved manufacturer with installation instructions and execution shall be done by an applicator trained by the approved manufacturer (preferably in the presence of manufacturer for critical applications/ structures).

12.1 Material

Chemical anchor fasteners shall be of high tensile steel rods of minimum grade 5.8 galvanised to at least 5 microns or Stainless Steel (SS304 or SS316) and shall be approved for use in cracked concrete.

Stainless steel Chemical anchor fasteners shall be preferred for sites located in coastal areas or in high rainfall zone.

Rebars used as dowels shall be of grade as per General Notes of the project.

12.2 Selection

The Contractor shall select the chemical anchor fasteners based on the parameters such as Loads and rebars for dowels as specified in the AFC drawings/ documents. The chemical anchor fasteners shall be procured from the approved manufacturers as per Departmental List of Approved Manufacturers.

12.3 Testing

The Contractor shall carry out, at the work place, the requisite tests like pull out test, shear test, etc. for chemical anchor fasteners and pull out test for dowels (rebars). The chemical anchor fasteners shall withstand the load specified in the drawing/ documents and the Dowels (rebars) shall be tested for full tensile capacity of the rebars. The decision of the Engineer-in-Charge regarding the adequacy of strength and load carrying capacity of the anchor fasteners/ dowels (rebars) shall be final and binding to all. The cost of all such tests shall be borne by the Contractor.

12.4 Installation

The Contractor shall install the chemical anchor fasteners/ dowels (rebars) at their correct location (to suit the requirement of fixtures as shown in drawings) as per the procedure laid down by the manufacturer. Location of all holes shall be pre-marked on the concrete surfaces. Scanning before drilling shall be done with appropriate ferro scanner tool to avoid rebar hits and structural damage. The holes shall then be drilled carefully with an electric drill to the correct recommended size and depth. Holes shall be exactly round and true perpendicular to the concrete surface. Edge distance and pitch of fasteners shall be as recommended by the manufacturer. The contractor shall suitably shift the hole with the approval of the Engineer-in-Charge in case any reinforcement bar is encountered while scanning/ drilling the hole in RCC structure. The adhesive (chemical) shall preferably be dispensed with the help of battery operated dispenser gun & mixer nozzle to avoid over/ under dosing & void creation. Piston plugs and extension pipe shall be used for embedment depths beyond 300 mm. Anchors shall preferably be driven with the help of setting tool,

fixed at right embedment depth, by applying torque using calibrated impact wrench as per manufacturer's instructions. Necessary staging shall be provided for working and the Contractor shall take requisite safety precautions so as not to cause any damage to the existing structure/ equipment. Any damage done while executing the job shall be made good by the Contractor at his cost.

12.5 Payment

Payment for installing chemical anchor fasteners shall be made on number basis (each). The rate shall include supply of complete assembly i.e. chemical anchor fasteners along with adhesive (chemical) foils as per manufacturer specifications.

Payment for installing chemical dowels (rebars) shall be made on number basis (each). The rate shall include fixing of dowels (rebars) by drilling/ cleaning hole and injecting odourless adhesive (chemical) as per manufacturer specifications. Rebars used as dowels shall be paid separately under relevant SOR item.

For chemical anchor fasteners/ dowels (rebars), the rate shall be inclusive of handling, transporting, providing necessary temporary staging, installing (as per manufacturer's specifications) in PCC/ RCC structures to a required depth with a specified hole diameter, at all levels and locations, testing, scanning, drilling holes, cleaning, covering with jute cloth, relocating and re-drilling in case of any obstruction, making good any damage done to the structure, grouting the abandoned holes and any gap left between the contact surfaces of PCC/ RCC and fixtures to be added, design assistance from the Manufacturer (wherever required), etc. all complete.

मानक विनिर्देशन
सिविल एवं संरचनात्मक कार्य
STANDARD SPECIFICATION
CIVIL & STRUCTURAL WORKS
गिराने एवं तोड़ने सम्बंधी कार्य
DEMOLITION AND DISMANTLING

6	03.04.25	REAFFIRMED & REISSUED	AD	MM	AS	MN
5	13.05.19	REAFFIRMED & REISSUED	TK	AS	RS	RKT
4	18.11.13	REVISED & ISSUED AS STANDARD SPECIFICATION	AJS	RS	PKM	SC
3	10.06.08	REAFFIRMED & REISSUED	PKB	PKM	VK	VC
2	25.04.01	REVISED & ISSUED AS STANDARD SPECIFICATION	SKP	RS	SCJ	MI
1	16.03.98	REVISED & ISSUED AS STANDARD SPECIFICATION	SARITA	SKP	SCJ	AS
0	AUG'89	ISSUED AS STANDARD SPECIFICATION		AKV	GPL	RCPC
Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
Approved by						