

**TENDER SPECIFICATION
BHEL PSSR SCT 1377**

**FABRICATION AND ERECTION OF STRUCTURAL STEEL
WORKS IN POWER HOUSE, BUNKER, PIPIERACK AND OTHER
MISC STRUCTURES**

FOR

UNIT 1&2 OF 2 X 600MW

AT

**MALWA THERMAL POWER PROJECT,
KHANDWA, MADHYAPRADESH.**


VOLUME - II

TECHNICAL SPECIFICATION

BOOK NO



**BHARAT HEAVY ELECTRICALS LIMITED
(A GOVERNMENT OF INDIA UNDERTAKING)
POWER SECTOR – SOUTHERN REGION
690, ANNA SALAI, NANDANAM, CHENNAI – 600 035**

	TITLE PROJECT INFORMATION	SPECIFICATION NO.	
		VOLUME II	
		SECTION B	
		REV NO. 0	DATE: 20-7-2009
		SHEET 1 OF 3	

1.0 OWNER : **MADHYA PRADESH POWER GENERATING COMPANY LIMITED (MPPGCL)**

2.0 PROJECT TITLE: **2 X 500 MW MALWA THERMAL POWER PROJECT**

3.0 INTRODUCTION

The power project being proposed by Madhya Pradesh State Electricity Board /Madhya Pradesh Power Generating Company Limited., in the vicinity of Malwa Plateau of the western region is presently conceived to be a coal based power station comprising of two units of 500 MW capacity each.

4.0 Key Features of Project Site

- 4.1 Project site : Near village Purni / Dongalia of Harsaud Tahsil in Khandwa district, Madhya Pradesh
- 4.2 Latitude and Longitude : 22°06'08"
76°23'08"

Approach To Site

- 4.3 Nearest town : Khandwa, Punasa and Mundi
- 4.4 Nearest Railway Station : Talwariya Railway station (about 6 km)
- 4.5 Nearest Sea Port : Mumbai Port (about 700 km)
- 4.6 Nearest Airport : Indore (about 140 km)
- 4.7 Access Roads : Harsaud-Punasa district road
Which pass through the project area.

Meteorological Data:

- 4.8 Maximum Dry bulb temperature : 47.2°C
- 4.9 Rainfall Intensity : 60 mm per hour.
- 4.10 Seismic Zone : Zone III as per IS 1984
- 4.11 Site elevation : About 282 mtrs. above MSL
- 4.12 Mean wind velocity : 39 m/sec as per IS 875-1987



**2 X 500 MW MALWA
THERMAL POWER PROJECT**
Doc Name : Fabrication and Erection of
Structural Steel



Doc No : MALWA-SP-C-009

MP Power Gen. Co. Ltd.

For Bid

L&T – Sargent & Lundy

**TECHNICAL SPECIFICATION FOR FABRICATION AND ERECTION OF
STRUCTURAL STEEL**

END USER **MADHYA PRADESH POWER GENERATING
COMPANY LIMITED**

LTSL PROJECT No. **T 408000**

LTSL DOC. No **MALWA-SP-C-009**

REVISION CERTIFICATION

REV NO.	DATE OF ISSUE	PREPARED					REVIEWED					APPROVED
		MECHANICAL	ELECTRICAL	CIVIL	INSTRUMENTATION	PROCESS	MECHANICAL	ELECTRICAL	CIVIL	INSTRUMENTATION	PROCESS	
P0	31/7/06											
A	15/9/06											
B	30/4/07											

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**TECHNICAL SPECIFICATION FOR
FABRICATION AND ERECTION OF
STRUCTURAL STEEL**

1.1.0 INTENT

1.1.1.1 This covers fabrication, erection, alignment, welding, etc. of mild steel, medium and high strength steel at all levels, involving rolled sections (including rounds), pipes/hollow sections, built-up sections fabricated out of plates and / or rolled sections (including pipes / hollow sections), plates, chequered plates, etc., in columns, beams, gantry girders, crane girders, roof trusses, roof girders, trestles, galleries, portals, purlins, space frames, shear connectors, hangers, struts, monorail beams, stiffeners, wall beams, sheeting runners, brackets, stub columns, bracings, cleats, base plates, splice plates, chequered plate flooring, decking plates, floor plates, seal plates, diaphragms, steel frame grid over false ceiling, walkways, platforms, ladders, stairs, stringers, treads, landings, toe plates, rungs, insert plates, edge protection structures, embedments, lugs, posts, stays, gates, louvers, lacings, batten plates, stiffeners, gusset plates, washers, bunkers, silos, hoppers, all sampling and testing etc. all complete.

1.1.1.2 The provisions of IS: 800 shall be followed as general guidance along with all other relevant Indian Standards, Codes and Acts, unless otherwise specifically mentioned.

1.1.1.3 Work to be provided by the Contractor, unless otherwise specified elsewhere in the contract, shall include, but not limited to the following :-

- Preparation and checking of complete detailed fabrication drawings and erection markings required for all the structures covered under the scope of the contract based on design drawings to be furnished by the Owner.
- To submit revised design with calculations and detailed fabrication drawings in case any substitution of designed sections are to be made.
- To submit design calculations for joints and connections developed by the Contractor along with detailed fabrication drawings and getting the same approved.

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- Supply, Fabrication, Erection, Alignment, Bolting, Welding, Testing etc. complete including one shop coat of primer painting as specified elsewhere in the specification.
- Prepare and submit monthly material reconciliation statement showing effective utilization of raw materials as received from Owner's stores.
- Furnish quarterly and monthly requirement of matching steel sections for maintaining required progress of fabrication in accordance with the approved programme and take delivery of raw materials from Owners stores.
- Marking and packing for transport of fabricated materials.
- Prepare and furnish detailed Bill of Materials (BOM), Drawing Office Dispatch Lists, Bolt List and any other list of Bought Out Items required in connection with the fabrication and erection of structural steelworks.
- Dismantling, modification and re-erection of fabricated / erected steel members complete with touch-up work.
- Maintain a fully equipped workshop at site for fabrication, modification and repairs of steelworks at site as may be required to complete the works in accordance with the Contract.
- Establish stores for safe preservation of all consumable, inspection tools / gauges and all quality records regarding materials, equipment, fabrication and erection.
- Maintain a fully equipped field laboratory as required for quality assurance. No work under this specification shall be provided for by any agency other than the Contractor, unless specifically mentioned otherwise elsewhere in the contract.
- Furnish all materials, labour, tools and plant and all consumables required for fabrication and supply, all necessary rivets, bolts, nuts, washers, tie rods and welding electrodes for field connections.
- Suitably mark, bundle, and pack for transport all fabricated materials.
- The Contractor shall provide all construction and transport equipment, tools, tackle, consumables, materials, labour, and supervision required for erection of the structural steelwork.

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- Receiving, unloading, checking, and moving to storage yard at Site including prompt attendance to all insurance matters as necessary for all fabricated steel materials arriving at Site. The Contractor shall pay all demurrage and/or wharfage charges etc. on account of default on his part.
- Transportation of all fabricated structural steel materials from Site storage yard, handling, rigging, assembling, riveting, bolting, welding and satisfactory installation of all fabricated structural steel materials in proper location according to approved erection drawings and/or as directed by the Engineer. If necessary suitable temporary approach roads to be built for transportation of fabricated steel structures.
- Checking center lines, levels of "all foundation blocks including checking line, level, position and plumb of all bolts and pockets. Any defect observed in the foundation shall be rectified with Engineer's approval. The Contractor shall fully satisfy himself regarding the correctness of the foundations before installing the fabricated steel structures on the foundation blocks.
- Aligning, plumbing, leveling, riveting, bolting, welding and securely fixing the fabricated steel structures including floor gratings, chequered plates etc. in accordance with the Drawings or as directed by the Engineer.
- Painting of the erected steel structures.
- All minor modifications of the fabricated steel structures as directed by the Engineer including but not limited to the following:
 - i) Removal of bends, kinks, twists etc. for parts damaged during transport and handling.
 - ii) Cutting, chipping, filling, grinding, etc. if required for preparation and finishing of site connections.
 - iii) Reaming of holes for use of higher size rivet or bolt if required.
 - iv) Re fabrication of parts damaged beyond repair during transport and handling or re- fabrication of parts, which are incorrectly fabricated.

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- v) Fabrication of parts omitted during fabrication by error, or subsequently found necessary.
- vi) Drilling of holes that are either not drilled at all or drilled at incorrect location during fabrication.
- vii) Carry out tests in accordance with this specification.

1.1.1.4 The above including the details shown in the Bid drawings, are for the purpose of illustration. It is possible that some items indicated above may not appear in actual work and on the other hand some other items not specifically mentioned above but similar in nature will have to be executed as per the relevant drawings and instruction of Owner.

No work under this specification will be provided for by any agency other than the contractor, unless specifically mentioned otherwise elsewhere in the contract.

1.1.1.5 CONFIRMITY WITH DESIGNS

The contractor shall design all connections, supply and fabricate all steelwork and furnish all connection materials in accordance with the detailed design drawings and/or as instructed by the Engineer keeping in view the maximum Utilization of the available sizes and sections of steel materials. The methods of painting, marking, packing and delivery of all fabricated materials shall be in accordance with the provisions of the contract and/or as approved by the Engineer. Provision of all relevant Indian Standard Specifications and Codes of Practice shall be followed unless otherwise specified in the contract.

The Contractor shall erect the entire fabricated steel structure, align all the members, complete all field connections and grout the foundations all as per the provisions of this specification and the sequence and the design criteria laid down by the Engineer. All work shall conform to the provisions of this specification and /or instructions of the engineer. The testing and acceptance of the erected structures shall be in accordance with the provisions of this Specification and/or the instructions of the Engineer.

1.2.0 GENERAL REQUIREMENTS

1.2.1 General

1.2.1.1 The Contractor shall furnish all labour, plant, equipment, consumable, scaffolding, tools, tackles, materials and everything that is required for complete executions of the work on

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schedule in accordance with the drawings and as described herein and/ or as directed by the Owner.

1.2.2 Reference points and bench marks

1.2.2.1 The Contractor shall make his own arrangements for locating the coordinates and positions of all work and reduced levels (RL) at these locations based on two reference grid lines and one bench mark which shall be furnished by the Owner. The Contractor has to provide at site all the required survey instruments to the satisfaction of the Owner so that the work can be carried out accurately according to the specifications and drawings. Contractor shall be solely responsible for correctness of layout and levels.

1.2.3 Safe working

1.2.3.1 The Contractor shall strictly follow, at all stages of fabrication, transportation and erection of steel structures, the stipulations contained in IS:7205- Indian Standard Safety Code for Erection of Structural Steel work and the provisions of the safety rules as specified in the General conditions of the contract for ensuring safety of men and materials. This shall include proper approach and working platform during erection of the structures.

1.2.4 Issue of Materials

Structural Steel, pipes, chequered plate in required sections and thickness, shall be made available by the Contractor in accordance with the procedure laid down in the Special Conditions of Contract.

1.2.5 Material

All steel materials, required for the work shall be supplied by the Contractor, unless otherwise specified elsewhere in the contract. The materials shall be free from all imperfections, mill scales, slag intrusions, laminations, fittings, rusts etc. that may impair their strength, durability, and appearance. All materials shall be of tested quality only unless otherwise permitted by the Engineer and/or Consultant. If desired by the Engineer, Test Certificates in respect of each consignment shall be submitted in triplicate. Whenever the materials are required to be used from unidentified stocks, if permitted by the Engineer, a random sample shall be tested at an approved laboratory from each lot of 50 tones or less of any particular section.

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The arc welding electrodes shall be of approved reputed manufacture and conforming to the relevant Indian Standard Codes of Practice and Specifications and shall be of heavily coated type and the thickness of the coating shall be uniform and concentric. With each container of electrodes, the manufacturer shall furnish instructions giving recommended voltage and amperage (Polarity in case of D.C. supply) for which the electrodes are suitable.

All fabricated steel structures and connection materials shall be supplied by the Contractor to the site. The Contractor shall take delivery Horn railway wagons or trucks at site, and unload the materials and perform all formalities like checking of materials and attend to insurance matters as specified in the specifications.

1.2.5.1 Mild Steel

- a) Rolled sections and plates up to and including 20mm thickness shall conform to grade 'A' of IS: 2062 and shall be semi-killed. Plates beyond 20mm thickness shall conform to grade 'B' of IS: 2062.
- b) All steel upto and including 40mm thickness shall be in as rolled condition. Plates beyond 40mm thickness shall be normalized and ultrasonically tested.
- c) Rolled sections and plates conforming to IS: 808 and IS: 226 respectively can also be used as available in the stock of the Owner.
- d) Pipes shall conform to IS: 1161.
- e) Hollow (square and rectangular) steel sections shall be hot formed conforming to IS: 4923 and shall be of Grade Yst 240.
- f) Chequered plate shall conform to IS: 3502 and steel shall conform to grade A of IS: 2062.

1.2.5.2 Medium and High Tensile Steel

- a) Medium and high tensile steel shall generally conform to grade 'Fe-490B' of IS: 8500, IS: 961 or equivalent.
- b) Rolled sections and plates up to and including 20mm thickness shall be semi-killed and plates beyond 20mm thickness shall be killed.

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c) All steels upto and including 40mm thickness shall be in as rolled condition. Plates beyond 40mm thickness shall be normalized and ultrasonically tested.

1.2.5.3 All other materials (nuts, lock nuts), consumables etc. shall be as per applicable standards and codes.

1.2.5.4 In case any defect like laminations is noticed in the steel sections and plates during fabrication and erection, same shall be immediately brought to the notice of the Owner, who shall direct the usage or non-usage of the same. In case of non-usage, the Contractor shall return the same to the Owner's store at his own cost. However, in case of usage, the Contractor shall take necessary precautions such as plug welding etc. and as directed by the Owner, without any extra cost to the Owner.

1.2.6 Substitution

1.2.6.1 If it is found necessary to substitute Indian or imported alternative sections for any of the steel section specified, the written approval of the Owner to the substitution and to the detailed drawing showing the substitution shall be obtained before fabrication is taken up.

1.2.7 Storage of Materials

1.2.7.1 General

All materials shall be so stored as to prevent deterioration and to ensure their preservation of their quality and fitness for the work. Any material which has deteriorated or has been damaged shall be removed immediately from the Contractor's yard, failing which the Owner shall have the liberty to get the material removed and the cost incurred thereof shall be realized from the Contractor. The Contractor shall maintain up to date accounts of receipt, use and balance of all sizes and sections of steel and other materials. In case the fabrication is carried out in Contractors fabrication shop outside the plant site, all materials meant for use in this contract shall be stacked separately with easily identifiable marks.

1.2.7.2 Yard

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The Contractor will have to establish a suitable yard in an approved location at site for storing the fabricated steel structures and other raw steel materials such as structural sections and plates as required. The yard shall have facilities like drainage, lighting, and suitable access for large cranes, trailers, and other heavy equipments. The yard shall be fenced all around with security arrangement and shall be of sufficiently large area to permit systematic storage of the fabricated steel structures without overcrowding and with suitable access for cranes, trailers and other equipment for use in erection work in proper sequence in accordance with the approved Programme of work.

The Contractor must visit the site prior to submission of his Bid to acquaint himself with the availability of land and the development necessary by way of filling, drainage, access roads, fences, sheds etc. all of which shall be carried out by the Contractor at his own cost as directed by the Engineer.

1.2.7.3 Covered Store

All field connection materials, paints, cement etc. shall be stored on well designed racks and platforms off the ground in a properly covered store building to be built at the cost of the Contractor.

1.2.7.4 Steel

The steel to be used in fabrication and the resulting cut-pieces shall be stored in separate stacks off the ground, section wise and lengthwise, so that they can be easily inspected, measured and accounted for at any time. If required by the Owner, the materials may have to be stored under cover and suitably painted for protection against weather.

Any steel procured by the Owner other than that of tested quality in accordance with the requirements of Indian Standard obtained either from the main producers or from the open market, shall be marked out separately with paint at ends so that strict control can be exercised in the use of such materials by more frequent tests.

1.2.7.5 Electrodes

The electrodes for electric arc welding shall be stored in properly designed racks, separating different types of electrodes in distinctly marked compartments. The electrodes shall be kept in a dry and warm condition if necessary by resorting to heating.

1.2.7.6 Bolts, Nuts and Washers

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Bolts, nuts and washers and other fastening materials shall be stored on racks off the ground with a coating of suitable protective oil. These shall be stored in separate gunny bags or compartments according to diameter, length and quality.

1.2.7.7 Paints

Paints shall be stored under cover in airtight containers with adequate fire safety measures. Paints supplied in sealed containers shall be used up as soon as possible once the container is opened.

1.2.8 Drawings

1.2.8.1 The design (scope) drawings shall be supplied by the Owner. The development of the detailed fabrication drawings, on the basis of these design drawings, shall be done by the Contractor.

1.2.8.2 The detailed drawings (fabrication drawings) shall show complete details including connection / welding / bolting details required for fabrication and erection of structural steel works, all complete, along with their respective bill of materials and design calculation documents.

The fabrication drawings shall include but not limited to the following:

- a) Assembly drawings giving exact sizes of the sections to be used and identification marks of the various sections.
- b) Dimensional drawings of base plates, foundation bolts location etc.
- c) Comparison sheets to show that the proposed alternative section, if any, is as strong as the original sections shown on the Design Drawings.
- d) Complete Bill of Materials and detailed drawings of all sections as also their billing weights.
- e) Any other drawings or calculations that may be required for, the clarification of the works or substituted parts thereof.

"Design Calculation Documents" shall include design of all connections including weld / bolt sizes, brackets, cleats, etc.

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- 1.2.8.3** The detailed fabrication drawings shall be either prepared by the Contractor or by an experienced Specialist Consultant (i.e. an engineering consultancy agency specializing in structural joint / connection design and detailing) engaged by the Contractor for the work. The fabrication drawings shall be duly checked by the Contractor or by the Specialist Consultant before being submitted to the Owner.
- 1.2.8.4** There shall be separate consultants for preparation of fabrication drawings and their checking. The Contractor can either prepare or detail (i.e. be Detailer) or check (i.e. be Checker) the fabrication drawings, provided he has requisite dedicated experienced manpower and expertise to the satisfaction of the Owner. For the other activity, that is other than the activity the Contractor wishes to carry himself (i.e. either Detailer or Checker), he shall engage a Specialist Consultant. In case the Contractor intends to get both preparation and checking of the fabrication drawings done from the outside consultants, then he shall engage two independent Specialist consultants, one for the preparation / detailing of the fabrication drawings (i.e. Detailer) and the other for checking the fabrication drawings (i.e. Checker).
- 1.2.8.5** Depending upon the capacity / capability of the Specialist Consultant engaged by the Contractor, there can be more than one Specialist Consultant, engaged for the purpose of preparation / detailing of fabrication drawings. However, it is intended that for the purpose of checking, there shall be only one agency i.e. the Specialist Consultant (different from the Detailer) or the Contractor himself.
- 1.2.8.6** The Contractor shall engage his own courier / facilities for the collection and distribution of the scope / fabrication drawings and design calculations for the following works, as soon as possible after getting information / intimation.
- Collection of scope / design drawings from the Owner on receiving information from the Owner telephonically.
 - Distribution of the scope / design drawings to the Detailer on the same day.
 - Collection of the fabrication drawings and the design calculations from the Detailer and submission to the Checker, on receiving intimation from the Detailer, regarding readiness of the documents, at various stages.
 - Collection of the fabrication drawings and the design calculations from the Checker and submission to the Detailer, on receiving intimation from the Checker, regarding checking of the documents, at various stages.

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e) Submission of the Checker approved fabrication drawings and the design calculations to the Owner.

1.2.8.7 All fabrication drawings shall be prepared on AutoCAD latest revision, as available on the date of bid opening and submitted to the Owner in both PDF as well as AutoCAD version after checking at their end.

1.2.8.8 The fabrication drawings shall indicate complete details of fabrication and erection including all splicing details, lacing details, weld sizes and lengths, detailing of all joints, bill of materials, schedule of permanent bolts and all other customary details in accordance with standard structural engineering practice.

1.2.8.9 The design calculations shall include the design of joints (shear and moment connections), gusset plate, weld calculations viz. size and length of welds, dia. and number of bolts, erection and fabrication splices, shear cleat sizing, stiffener for built-up sections, center to center distance of stiffeners, size of gussets, brackets required for wall beams and other areas etc. in accordance with IS: 800 and other relevant standards.

1.2.8.10 The fabrication drawings shall indicate identification (erection) marks for purposes of dispatch and erection etc.

1.2.8.11 In the fabrication drawings, quantities of different sections of structural steel material required shall be indicated. Fabrication drawings shall also give the abstract of quantities for the structures to be painted with different painting systems.

1.2.8.12 The schedule for permanent bolts and nuts shall show the length, size, weight and numbers required for each fabricated member.

1.2.8.13 The abstract of quantities (Bill of Material) shall indicate the following as a minimum:

- a) Total weight of the erection mark.
- b) Weight of the erection mark that is to be blast cleaned and applied with red oxide zinc chromate primer and is to be finish painted with synthetic enamel paint of approved shade and colour
- c) Schedule of permanent bolts with their designation, length, numbers and weight.

1.2.8.14 Each fabrication drawing shall prominently carry the bill of material statement for each section covered in the drawing..

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1.2.8.15 Whole responsibility for the correctness and completeness of the details shown in the fabrication drawings and design calculations shall lie with the Contractor. In case any modification / dismantling / re-erection is required to be carried out due to incomplete details or mismatch / deficiency in the fabrication drawings and design calculations, the same shall be made good by the Contractor, at his own cost. The cost of any materials (including steel) required for such rectification / modification work shall be borne by the Contractor or else penal recovery at the rates specified under relevant clauses of special conditions of contract shall be applied and recovered. Approval of the design calculations by the Owner shall however not dilute or relieve in any manner, the Contractor of his sole responsibility, for the correctness and completeness of the design calculations and details shown in the fabrication drawings, safety of the structure, good connections, erectability etc.

1.2.8.16 The fabrication drawings along with the design calculations duly checked and approved by the Checker shall be submitted to the Owner within four (04) weeks of release of scope / design drawings, by the Owner, maintaining strictly the time duration specified here under:

- a) Fabrication drawings and design calculations shall be submitted to the Owner, only after the same has been duly checked and approved by the Checker, and the necessary corrections incorporated. These shall accompany a brief write up prepared by the Checker regarding the comments furnished by him at initial checking stage and as being incorporated by the Detailer in the revised drawings.
- b) If any clarifications are required by the Detailer on the design / scope drawings, the Contractor shall seek such clarification from the Owner, within one (01) week of the release of the design / scope drawing.
- c) Detailer shall submit fabrication drawings and the design calculations to the Checker within two (02) weeks of the release of design / scope drawing.
- d) Checker shall give his comment on the fabrication drawings and the design calculations to the Detailer within three (03) days of his receiving the fabrication drawings and the design calculations from the detailer.
- e) Detailer shall revise the fabrication drawings and the design calculations based on the comments of the Checker and resubmit the same to the Checker, within the next three (03) days of the receipt of the comments.

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- f) Checker shall recheck the fabrication drawings and the design calculations for the comment incorporation, in the next three (03) days of the receipt of the drawing and forward the same after duly approving so as to reach the Owner within next three (03) days. Thus fabrication drawings along with the design calculations duly checked and approved by the Checker are submitted to the Owner within four (04) weeks of the release of scope / design drawings by the Owner.
- g) In case, Checker is different from the Contractor himself the Contractor shall issue necessary authorization to the Checker to directly submit the checked and approved fabrication drawings and the design calculations to the Owner for information / approval.

1.2.8.17 Owner shall approve the design calculations, either under Cat I / II / III and the fabrication drawings under Cat IV / IVR.

1.2.8.18 Following shall be categories of approval accorded to the design calculations.

Cat I : Approved without comments.

Cat II : Approved with comments, resubmit.

Cat III : Not approved, to be re-submitted.

1.2.8.19 Following shall be categories of approval accorded to the fabrication drawings.

Cat IV : For information purposes only.

Cat IVR : To be re-submitted incorporating comments

1.2.8.20 Six (06) copies of fabrication drawings (with Bill of Material) after being duly checked and approved by the Checker shall be submitted by the Contractor to the Owner.

1.2.8.21 In case, approval accorded to the design calculations is placed under Cat I by the Owner, then the corresponding fabrication drawings can be considered under Cat IV, provided compatibility of the connection details as per the calculations is ensured in the fabrication drawings. The Detailer shall incorporate all comments / modifications, as noted by the Checker, in the fabrication drawings and furnish six (06) copies of the fabrication drawings (along with the revised Bill of Material), within next three (03) days of his receiving of the Checker's comments, to the Owner.

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- 1.2.8.22** In case, approval accorded to the Design calculations is placed under Cat II by the Owner, then the detailer shall incorporate all comments / modifications, as noted therein and shall revise within next three (03) days and re-submit through the Checker, four (04) copies of the revised fabrication drawings (with revised bill of material) along with the revised design calculations, within next seven (07) days of his receiving the Owner's comments, to the Owner, for his approval.
- 1.2.8.23** In case, approval accorded to the design calculations is placed under cat III by the Owner, the detailer shall incorporate all comments / modifications, as noted therein and shall revise thoroughly within next five (05) days and re-submit through the Checker, four (04) copies of the revised fabrication drawings (with revised bill of material) along with the revised design calculations, within next ten (10) days of his receiving the Owner's comments, to the Owner, for his approval.
- 1.2.8.24** In case, approval accorded to the fabrication drawings is placed under Cat IV by the Owner and to the design calculations is placed under Cat I by the Owner, then the Contractor shall submit six (06) number of fabrication drawings and three (03) number of design calculation to the Owner at site, within next three (03) days of the approval.
- 1.2.8.25** The Contractor shall also furnish to the Owner two (02) hard copies and one soft copy both for the design calculations (approved under Cat I) and the fabrication drawings with Bill of Material (approved under Cat IV) on CDs or any other electronic media, as approved by the Owner. The Contractor shall further submit to the Owner at site two hard copies and one soft copy of the as-built / as-fabricated fabrication drawing on CDs or any other electronic media, as approved by the Owner. Soft copy of as-built / as-fabricated fabrication drawings shall be made by the Contractor by scanning the as-built / as-fabricated fabrication drawings, in which all the changes made at site and the approval by the site Owner have been incorporated.
- 1.2.8.26** If it is found necessary to substitute alternative sections for any of the steel sections specified, a written approval of the Owner for the substitution, shall be obtained by the Contractor and details of all such substitution, as duly approved by the Owner shall be incorporated in the as-built fabrication drawings.
- 1.2.8.27** The scope / design drawings may require revisions either before or after the preparation and approval of fabrication drawings and design calculations. The design drawings may also be released with holds, which are to be released subsequently. Such revisions and release of holds shall be duly incorporated by the Contractor at his own cost, in the fabrication drawings and design calculations already finalised and re-submit to the Owner, after getting them duly checked by the Checker. The Contractor is expected to

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make his own assumptions regarding the quantum of such revisions involving preparation / revision / checking of design calculations / fabrication drawings.

1.2.9 Design of Connections

1.2.9.1 All connections shall generally be done through welding, unless otherwise specified in the design / scope drawings. Bolts when used for connections shall be of mild steel, high strength steel and / or friction grips, as indicated in the scope / design drawings.

1.2.9.2 Fabrication drawings and design calculations shall be prepared according to the provision of IS: 800, IS: 816, IS: 1367, IS: 3757, IS: 4000, IS: 9178 and IS: 9595.

1.2.9.3 Connection of vertical bracing with connecting members and diagonals of truss members shall be designed for full tensile capacity of the bracing, unless actual loads are indicated on the design / scope drawings.

1.2.9.4 Size of fillet weld for flange to web connection for built-up section shall be as follows: -

- a) For box section weld size shall be designed for full shear capacity or actual shear if indicated in design / scope drawings, whichever is more. Wherever fillet weld is not possible, full strength full penetration butt weld shall be provided.
- b) For built-up plated I-section, weld size shall be designed for 80% of full shear capacity or actual shear, if indicated in design / scope drawings, whichever is more. However, weld size shall not be less than 0.5 times the web thickness. Weld shall be of double fillet.
- c) All structural welds shall be continuous and the minimum size of the Fillet weld shall be 6mm.

1.2.9.5 Erection bolts shall be provided to hold the steel members in position during erection and alignment.

1.2.9.6 Shear connections shall be designed for 65% of section strength for rolled sections and 80% of section strength for built-up plated I-section or combination of rolled section with cover plates. However, if the load actually applied is more than the above-specified value, the connection shall be designed for actual applied load.

1.2.9.7 Moment connections between beam and column shall be designed for 100% of moment capacity of the beam section. This can be achieved either by direct butt welding of the

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top flange of beam with column flange or by providing top moment plate with suitable notch for additional weld length, as directed by the Owner.

- 1.2.9.8** All butt welds shall be of full strength full penetration butt welds.
- 1.2.9.9** Connection between top flange and web of crane girder shall be of full penetration butt weld. Bottom flange connection with web can be of fillet weld or butt weld, as directed by Owner.
- 1.2.9.10** Connection of base plate and associated stiffeners with the columns shall be designed considering the total load transferred through welds. However, the minimum weld size (double fillet) shall not be less than 0.6 times the thickness of stiffeners.
- 1.2.10 Splicing**
- 1.2.10.1** All splicing works shall be for full strength.
- 1.2.10.2** Field splicing shall be done with web/flange cover plates. For exceptional cases the field splicing will be designed for 50% of load carried by the cover plates and remaining 50% load through full penetration butt weld. Shop splicing of all plates shall be carried out by full strength - full penetration butt welds. Shop splicing for all rolled sections (beams, channels, angles, hollow sections, etc.) shall be carried out using web and flange cover plates. Shop splicing for solid round sections shall be done by combination of butt weld and stiffening (splice) plates.
- 1.2.10.3** Field splicing of built-up section is generally not envisaged. However it can be provided only in exceptional cases, if indicated in the scope / design drawings, with butt weld followed by splice cover plates. Splice cover plates shall be designed for the full strength.
- 1.2.10.4** In case any additional splices are needed than those indicated in the design / scope drawings by the Contractor, on account of limitation of crane (Le. by not mobilizing crane of specified capacity), then the same can be provided subject to a maximum penal recovery of steel sections used for such additional splicing, at the rates specified for reconciliation of structural steel consumption under relevant clauses of special conditions of contract.

1.3.0 CODES AND STANDARDS

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- 1.3.1** All applicable Standards, Specifications, Acts and Codes of Practice referred to herein shall be the latest editions including all applicable official amendments and revisions. A complete set of all such documents, shall generally be available at site, with the Contractor.
- 1.3.2** In case of conflict between this Specification and those (IS Standards, Codes etc.) referred to herein in the subsequent article, the former shall prevail.
- 1.3.3** Some of the relevant applicable Indian Codes, Standards and Acts are referred to herein below:

a) Materials

1. IS: 226 Structural steel (Standard Quality)
2. IS: 808 Dimensions for Rolled Steel Beam, Column, Channel and Angle Sections.
3. IS: 814 Covered Electrodes for Manual Metal Arc Welding of Carbon and Carbon Manganese Steel.
4. IS: 815 Classification and coding of covered electrodes for metal arc welding of structural steels
5. IS: 961 Structural Steel (High Tensile)
6. IS: 1148 Rivet bars for structural purposes
7. IS: 1149 High tensile rivet bars for structural purposes
8. IS: 1161 Steel Tubes for structural purposes.
9. IS: 1239 Mild Steel Tubes
10. IS: 1363 Hexagon Head Bolts, Screws and Nuts of Product Grade C.
11. IS: 1364 Hexagon Head Bolts, Screws and Nuts of Product Grades A and B.
12. IS: 1367 (Part I,II) Technical supply conditions for Threaded Steel Fasteners
13. IS: 1367 (Part – 3) Mechanical Properties and Test Methods For Bolts, Screws and Studs With full loadability
14. IS: 1367 (Part – 6) Mechanical Properties and Test Methods For Nuts with Specified Proof Load.
15. IS: 1367 (Part – 9) Surface discontinuities on Bolts. (Sections 1 and 2)
16. IS: 1367 (Part – 13) Hot Dip Galvanized Coating on Threaded Fasteners.

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17. IS: 1442 Covered electrodes for the metal arc welding of high tensile structural steel
18. IS: 1852 Specification for Rolling and Cutting Tolerances for Hot Rolled Steel Products.
19. IS: 1977 Structural steel (ordinary quality) St-42-0
20. IS: 2016 Specification for Plain Washers.
21. IS: 2062 Steel for General Structural Purposes.
22. IS: 2074 Ready mixed paint, red oxide Zinc chromate priming
23. IS: 3063 Specification of Single Coil Rectangular Section Spring Lock Washers for Bolts, Nuts and Screws.
24. IS: 3502 Specifications for Steel Chequered Plates.
25. IS: 3757 Specification for High Strength Structural Bolts.
26. IS: 4218 Specification for ISO Metric Screw Threads.
27. IS: 4923 Specification for Hollow Steel Sections for Structural use.
28. IS: 5369 General requirements for Plain Washers and Lock Washers.
29. IS: 5624 Specification for Foundation Bolts.
30. IS: 6623 Specification for High Strength Structural Nuts.
31. IS: 6639 Specification for Hexagon Bolts for Steel Structures.
32. IS: 6649 Specification for Hardened and Tempered Washer for High Strength Structural Bolts and Nuts.
33. IS: 6911 Specification for Stainless Steel Plate, Sheet and Strip.
34. IS: 7280 Bare wire electrodes for submerged arc welding of structural steels.
35. IS: 8500 Specification for Structural Steel Micro-Alloyed (Medium and high Strength qualities).
36. IS: 13238 Specification for Epoxy Based Zinc Silicate Primer (Two Pack).
37. IS: 13239 Epoxy Surfacer (Two Pack).
38. IS: 13467 Chlorinated Rubber for Paints.
39. IS: 14209 Epoxy Enamel Two Component Glossy.

b) Codes of Practice

1. IS: 800 Code of Practice for General Construction in Steel.
2. IS: 806 Rolled steel beams, channels, and angle sections
3. IS: 813 Scheme of symbols for welding.
4. IS: 816 Code of Practice for Use of Metal Arc Welding for

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- General Construction in Mild Steel.
5. IS: 817 Code of Practice for Training and Testing of Metal Arc Welders.
 6. IS: 818 Code of practice for safety and health requirements in electric and gas welding and cutting operations
 7. IS: 822 Code of practice for inspection of welds
 8. IS: 919 Recommendations for limits and fits for Engineering
 9. IS: 1024 Code of Practice for Use of welding in Bridges and structures subject to Dynamic Loading.
 10. IS: 1477 Code of Practice for Finishing of Ferrous Metals in Buildings - Painting and Allied Finishes.
 11. IS: 1730 Dimensions for steel plate, sheet, and strip for structural and general engineering purposes
 12. IS: 1731 Dimensions for steel flats for structural and general engineering purposes
 13. IS: 2629 Recommended Practices for Hot Dip Galvanising of Iron and Steel.
 14. IS: 2811 Recommendations for Manual Tungsten Inert Gas Arc Welding of Austenitic Stainless Steel.
 15. IS: 3696 Safety Code of Scaffolds and Ladders.
 16. IS: 4000 Code of Practice for High Strength Bolts in Steel Structure.
 17. IS: 4353 Recommendations for Submerged Arc welding of Mild Steel and Low Alloy Steels
 18. IS: 4759 Hot Dip Zinc Coatings on Structural Steel and Other Allied Products.
 19. IS: 5206 Covered Electrodes for Manual Metal Arc Welding of Stainless Steel and other similar High Alloy Steels.
 20. IS: 7205 Safety Code for Erection of Structural Steelwork.
 21. IS: 7215 Tolerances for Fabrication of Steel Structures.
 22. IS: 7293 Safety Code for working with Construction Machinery.
 23. IS: 7318 Fusion Welding of Steel-Approval Test for Welders.
 24. IS: 9178 Criteria for Design of Steel Bins for Storage of Bulk Materials.
 25. IS: 9595 Recommendations for Metal Arc Welding of Carbon and Carbon-Manganese Steels.
 26. IS: 12843 Tolerances for Erection of Steel Structures.
 27. SP : 6 ISI Hand Book for Structural Engineers.
- Parts 1 - 7

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28. ISO: 898/2 Mechanical Properties of Nuts.
29. ISO: 3269 Fasteners - Acceptance Inspection.

c) Standards for Testing

1. IS: 228 Methods of Chemical Analysis of Steels.
2. IS: 1181 Qualifying Tests for Metal Arc Welders (Engaged in welding structures other than Pipes).
3. IS: 1182 Recommended Practice for Radiographic Examination of Fusion Welded Butt Joints in Steel Plates.
4. IS: 1200 Method of measurement of steelwork and ironwork (Part 8)
5. IS: 1599 Method of Bend Test.
6. IS: 1608 Mechanical Testing of Metals - Tensile Testing.
7. IS: 1852 Specifications for Rolling and Cutting Tolerances for Hot-rolled Steel Products
8. IS: 2595 Code of Practice for Radiographic Testing.
9. IS: 2614 Methods for Sampling of Fasteners.
10. IS: 2633 Method for testing uniformity of coating on Zinc Coated Articles
11. IS: 3613 Acceptance Tests for Wire Flux Combination for Submerged Arc Welding.
12. IS: 3658 Code of Practice for Liquid Penetrant Flaw Detection.
13. IS: 3664 Code of Practice for Ultrasonic Pulse Echo Testings by Contact and immersion methods.
14. IS: 5334 Code of Practice for Magnetic Particle Flaw Detection of Welds.
15. IS: 6821 Methods for Sampling of Non Threaded Fasteners.
16. IS: 7307 Approval Test for welding Procedures.
Part - 1: Fusion welding of Steel.
17. IS: 7310 Approval Test for Welders working to approved welding
Part - 1: Procedure: Fusion welding of Steel.

1.4.0 TECHNICAL REQUIREMENTS – INSTALLATION

1.4.1 Fabrication

1.4.1.1 Site Fabrication

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The fabrication of works shall be carried out generally in accordance with IS: 800 as well as with the stipulations contained in these specifications. IS: 9178 (Parts I and II) shall be followed as general guidance for fabrication and erection of bins / silos. All structures shall be completely site fabricated, in the fabrication / pre-assembly yard developed by the Contractor, at his own cost, within the project site.

1.4.1.2 Identification of Material

Fabricated components shall be traceable to material test certificates and shall be capable of positive identification at different stages of fabrication. During fabrication, upto the point of assembling members, each piece of high strength steel shall carry fabricators identification mark.

1.4.1.3 Collection of Steel

The Owner shall issue steel to the Contractor from their project stores. Contractor shall make all arrangements, whatsoever required for the collection, loading, weighing, transportation, protection against damage in transit, unloading and storage of steel, reconciliation and return of surplus / waste steel to the Owner's stores, etc. all complete.

1.4.1.4 Straightening

Rolled materials before being laid off or worked, must be clean, free from sharp kinks, bends or twists and straight within the tolerances allowed by the Indian Standard Specification on IS: 1552 - Specification for rolling and cutting tolerance for hot-rolled steel products. If straightening is necessary, it may be done by mechanical means or by the application of a limited amount of localized heat. The temperature of heated areas, as measured by approved methods, shall not exceed 600° C.

1.4.1.5 Cutting

The Contractor shall prepare necessary cutting plans for all fabrication work taking into consideration the availability of materials and cut pieces generated during the work with the object of minimizing wastage. Care shall be taken by the Contractor to ensure maximum utilization of cut pieces and if required by providing additional butt weld, at his own cost.

Shearing, cropping, or sawing shall affect cutting. Use of a mechanically controlled gas-cutting torch may be permitted for mild steel only. Gas cutting of high tensile steel may

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also be permitted provided special care is taken to leave sufficient metal to be removed by machining, so that all metal that has been hardened by flame is removed. Gas cutting without a mechanically controlled torch may be permitted if special care is taken and done under expert hand, subject to the approval of the Engineer.

To determine the effective size of members cut by gas, 3 mm shall be deducted from each cut edge. Gas cut edges, which will be subjected to substantial stress or which are to have weld metal deposited on them, shall be reasonably free from gouges, occasional notches or gouges not more than 4 mm deep will be permitted. Gouges greater than 4 mm that remain from cutting shall be removed by grinding. All re-entrant corners shall be shaped notch free to a radius of at least 12 mm. Shearing, cropping and gas cutting shall be clean, reasonably square and free from any distortion.

1.4.1.6 Planning of Edges

Planning or finishing of sheared or cropped edges of plates or shapes or of edges gas-cut with a mechanically controlled torch shall not be required, unless specifically required by design and called for on the drawings, included in a stipulation for edge preparation for welding or as may be required after the inspection of the cut surface. Surface cut with hand-flame shall generally be ground, unless specifically instructed otherwise by the Engineer.

1.4.1.7 Bending and Rolling

Bending of plates and rolled sections to the specially required shapes for fabrication shall be done on plate bending machine or by cold bending process without resorting to heating, hammering, angle smithy and black smithy process.

1.4.1.8 Grinding

- All the edges cut by flame shall be ground before they are welded.
- Ends of all bearing stiffeners shall be machined or ground to fit tightly at both top and bottom. The maximum permissible gap between the bearing stiffeners and the flanges shall not be more than 0.2 mm locally.
- In case of crane / gantry girder, the bottom of the knife-edge support shall be accurately ground to provide effective bearing on the column bracket with a clearance not exceeding 0.2 mm locally at any place. The top surface of the column bracket shall also be ground similarly. The column splices and butt joints of struts and compression members shall be accurately ground and closely butted over the

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whole section with tolerance not exceeding 0.2 mm locally at any place. Notwithstanding the above, full load shall be transferred through the welds.

- d) The ends of column shafts together with attached gussets, stiffeners, angles, channels, etc. after welding together shall be accurately ground, so that the parts connected butt over the entire surface of contact.
- e) The column base slabs shall be similarly ground over the bearing surface and shall have effective contact with the end of the shaft. The bearing face that is to be grouted direct to a foundation need not be ground.

1.4.1.9 Clearances

The erection clearance for cleat ends of members connecting steel to steel shall not be greater than 2mm at each end, unless approved by the Owner.

The erection clearance for cleated 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 web shall be not more than 3 mm at each end, but where for practical reasons greater clearance is necessary, suitably designed cleatings shall be provided.

1.4.1.10 Riveted and Bolted Construction

a) Holes

Holes through more than one thickness of material for members, such as compound stanchions and girder flanges, shall be drilled after the members are assembled and tightly clamped or bolted together. Punching may be permitted before assembly, if the thickness of the material is not greater than the nominal diameter of rivet or bolt plus 3 mm subject to a maximum thickness of 16 mm provided that the holes are punched 3 mm less in diameter than the required size and reamed after assembly to the full diameter.

Holes for rivets or black bolts shall be not more than 1.5 mm or 2.0 mm (depending on whether the diameter of the rivet or bolt is less or more than or equal to 25 mm) larger in diameter than the nominal diameter of the rivet or black bolt passing through them.

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Holes for turned and fitted bolts shall be drilled to a diameter equal to the nominal diameter of the shank or barrel subject to a tolerance grade of BS as specified in IS: 919. Parts to be connected shall be firmly held together by tacking welds or clamps and the holes drilled through all the thickness in one operation and subsequently reamed to size. Holes not drilled through all thickness in one operation shall be drilled to a smaller size and reamed out after assembly.

Holes for rivets or bolts shall not be formed by gas cutting process.

b) Assembly

All parts of riveted members shall be well pinned or bolted and rigidly held together while riveting. Drifting to enlarge un matching holes shall not generally be permitted. In case drifting is permitted to a slight extent- during assembly, it shall not distort the metal or enlarge the holes. Holes that must be enlarged to admit the rivets or bolts shall be reamed. Poor matching of holes shall be cause for rejection .The component parts shall be so assembled that they are neither twisted not otherwise damaged, and shall be so prepared that the specified cambers, if any, are maintained.

Rivets shall ordinarily be hot driven, in which case their finished heads shall be approximately hemispherical in shape and shall be of uniform size throughout the work for rivets of the same size full, neatly finished and concentric with the holes. Rivets shall be heated uniformly to a temperature not exceeding 1125° C they shall not be driven after their temperature has fallen below 540° C.

Rivets shall be driven by power riveters, of either compression or manually operated type, employing pneumatic, hydraulic or electric power. Hand driven rivets shall not be allowed unless in exceptional cases specifically approved by the Engineer. After driving, rivets shall be tight, shall completely fill the holes and their heads shall be in full contact with the surface. In case of countersunk rivets, the countersinking shall be fully filled by the rivet, any roughness of the countersunk head being dressed off flush, if required.

Riveted members shall have all parts firmly drawn and held together before and during riveting and special care shall be taken in this respect for all single riveted connections. For multiple riveted connections, a service bolt shall be provided in every third or fourth hole.

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All loose, burnt, or otherwise defective rivets shall be cut out and replaced and special care shall be taken to inspect all single riveted connections. Special care shall also be taken in heating and driving long rivets. The Contractor shall prove the quality of riveting by cutting some rivets chosen at random by the Engineer. No extra payment will be made to the Contractor for such cutting and replacing. Riveting Work, for any particular section or group, will be considered satisfactory when at least 90% of the corresponding cut rivets is found to be sound. If the ratio is below 75%, all the rivets in the particular section or group shall be cut, removed and replaced and tested again at the Contractor's expense. For cases between 75% and 90% the engineer shall have the option to instruct cutting and replacing any number of further rivets at the Contractor's cost as he deems necessary.

Bolted construction shall be permitted only in case of field connections if called for on the Drawings and is subjected to the limitation of particular connections as may be specified. In special cases, however, shop bolt connections may be allowed if shown on drawing or directed by the Engineer.

Washers shall be tapered or otherwise suitably shaped, where necessary, to give the heads and nuts of bolts a satisfactory bearing. The threaded portion of each bolt shall project through the nut at least one thread. In all cases the bolt shall be provided with a washer of sufficient thickness under the nut to avoid any threaded portion of the bolt being within the thickness of the parts bolted together. In addition to the normal washer one spring washer or lock nut shall be provided for each bolt for connections subjected to vibrating forces or otherwise as may be specified on the Drawings.

The component parts shall be assembled in such a manner that they are neither twisted nor otherwise damaged and shall be so prepared that the specified camber, if any is provided. If the individual components are to be bolted, parallel and tapered drifts shall be used to align the parts so that the bolts can be accurately positioned.

Items like roof trusses, galleries, bunkers / hoppers, etc. shall be trial assembled keeping in view the actual site conditions, prior to dispatch to site for erection so that they can be conveniently pre-assembled before erection or conveniently pre-assembled during erection. Necessary match marks shall be made on these components before disassembly in the shop and dispatching.

For columns which are fabricated in two or more parts, controlled / trial assembly shall be carried out in the pre assembly / fabrication yard before dispatch to the erection Site.

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c) Bolting

- a) Bolting will involve the provision of bolts in clearance holes and / or high strength friction grip fasteners.
- b) The diameter of the bolt hole shall be taken as the nominal diameter of the bolt plus 1.5mm, unless noted otherwise.
- c) Every bolt shall be provided with a washer under the nut so that no part of the threaded portion of the bolt is within the thickness of the parts bolted together.
- d) Flat washers shall be circular of a diameter 2.5 times that of bolt and of suitable thickness. Where bolt heads / nuts bear upon the beveled surfaces they shall be provided with the square tapered washers of suitable thickness to afford a seating square with the axis of the bolt as per satisfaction of Owner.
- e) All bolts and nuts shall be of steel, with well-formed hexagonal heads. The nuts shall be good fit on the bolts and minimum two clear threads shall show through the nut when it has been finally tightened up.
- f) Notwithstanding anything to the contrary contained in IS: 1363, IS: 1364, and IS: 1367, the unthreaded length of the bolt shall be equal to total thickness of metal being bolted together plus 2mm. The threaded length shall be equal to at least the diameter of bolt plus 6mm.
- g) IS: 4000 shall be followed for high strength friction grip fasteners.

1.4.1.11 Notches

The ends of all joints, beams and girders shall be cut truly square unless required otherwise and joist flanges shall be neatly cut away or notched where necessary, the notches being kept as small as possible.

1.4.1.12 Machining of Butts, Caps and Bases

- a) Column splices and butt joints of struts and compression members depending on contact for stress transmission shall be accurately machined and close-butted over the whole section with a clearance not exceeding 0.1 mm locally at any place if the welds are not designed to transmit the entire loading. In column caps and bases, the ends of shafts together with the attached gussets, angles, channels, etc., after

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welding together should be accurately machined so that the parts connected butt over the entire surfaces of contact. Care should be taken that these gussets, connecting angles or channels are fixed with such accuracy that they are not reduced in thickness by machining by more than 1.0mm. Where sufficient gussets or welds are provided and specifically designed to transmit the entire loading and are indicated in the drawing, the column ends need not be machined.

- b) Slab Bases and Caps - Slab bases and slab caps, except when cut from material with true surfaces, shall be accurately machined over the bearing surfaces and shall be in effective contact with the end of the column. A bearing face which is to be grouted direct to a foundation need not be machined if such face is true and parallel to the upper face.
- c) To facilitate grouting, holes shall be provided where necessary in column bases for the escape of air.

1.4.1.13 Lacing Bars

The ends of lacing bars shall be neat and free from burns.

1.4.1.14 Separators

Rolled section or built-up steel separators or diaphragms shall be required for all double beams except where encased in concrete, in which case, pipe separators shall be used.

1.4.1.15 Bearing Plates

Provision shall be made for all necessary steel bearing plates to take up reaction of beams and columns and the required stiffeners and gussets whether or not specified in Drawings.

1.4.2 Welding

1.4.2.1 The works shall be done as per approved fabrication drawing which would clearly indicate various details of joints to be welded, type of weld, length and size of weld, whether shop or site weld.

1.4.2.2 Welding of structural steel shall be done by an electric arc process, submerged arc welding / MIG welding / manual metal arc welding. Welding shall conform generally to relevant acceptable standards viz. IS: 816, IS: 9595, IS: 814, IS: 1024, IS: 4354 and Indian Standard hand book for metal arc welding, and other standards, codes of practice

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internationally accepted. For welding of any particular type of joint, Contractor shall give evidence acceptable to the Owner of having satisfactorily completed appropriate tests as described in any of the Indian Standards - IS: 817, IS: 7307 and international standard as relevant.

- 1.4.2.3** Welding process employing semi-automatic welding machine and / or MIG welding and / or fully automatic welding machine shall be used for welding longitudinal fillet welds (connecting flange with web) and butt joints for fabrication of columns, framing beams and crane/gantry girders, unless manual arc welding is specifically approved by the Owner. Necessary jigs and fixtures and rotation of structural shall be so arranged that vertically down-hand position of welding becomes possible. 'open-arc-welding' process employing coated electrodes shall be employed for fabrication of other welded connections and field welding.
- 1.4.2.4** Wherever welding is done for assembling the components of structural, the job shall be so positioned that down-hand welding is possible.
- 1.4.2.5** Any structural joint shall be welded only by those welders who are qualified for all welding procedures and positions required in such a joint.
- 1.4.2.6** The Contractor shall maintain records of all the welders identification marks, the joints welded by each welder, the welding procedure adopted, welding machine employed, pre and post heating done and any non-destructive test done and stress relieving / heat treatment performed on such joints. All such records for entire welding operation shall be accessible to the Owner at all times for scrutiny.
- 1.4.2.7** In fabrication of plated columns / beams and built-up members all shop splices in each component part shall be made before such component part is welded to other parts of the member. Wherever weld reinforcement interferes with proper fitting between components to be assembled for welding, these welds shall be ground flush prior to assembly.
- 1.4.2.8** The members to be joined by fillet welding shall be brought and held as close together as possible and in no event shall be separated by more than 4mm. If the separation is 1.5mm or greater, the fillet weld size shall be increased by the amount of separation.
- 1.4.2.9** The bins / silos shall be made of mild steel plates joined together with full strength butt weld and provided with stiffeners at regular intervals. Stiffeners shall be welded on the external face.

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1.4.3 Electrodes

1.4.3.1 The electrodes used for welding shall be of suitable type and size depending upon specifications of the parent material, the method of welding, the position of welding and quality of welds desired. Only low hydrogen electrodes shall be used for welding of medium / high tensile steel and for mild steel plate thickness above 20 mm.

1.4.3.2 All low hydrogen electrodes shall be baked and stored before use as per manufacturer's recommendation. The electrodes shall be re-baked at 250°C - 300°C for one hour and later on cooled in the same oven to 100° C. It shall be transferred to a holding oven maintained at 60°C - 70°C. The electrodes shall be drawn from this oven for use.

1.4.3.3 Where coated electrodes are used they shall meet the requirements of IS: 814 and relevant ASME-Sec II. Covering shall be heavy to withstand normal conditions of handling and storage.

1.4.3.4 Only those electrodes that give radiographic quality welds shall be used for welds, which are subjected to radiographic testing.

1.4.3.5 Where bare electrodes are used these shall correspond to specification of the parent material. The type of flux-wire combination for submerged arc welding shall conform to the requirements of IS: 3613 and F-60 class of AWSA-5-17-69. The electrodes shall be stored properly and the flux shall be baked before use in an oven in accordance with the manufacturer's requirements as stipulated.

1.4.3.6 The Contractor shall take specific approval of the weld for the various electrodes proposed to be used on the works before any welding is started.

1.4.4 Edge Preparation for Welding

1.4.4.1 Suitable edge as per weld joint detail shall be prepared either by machines or by automatic gas cutting. All edges cut by flame shall be ground before they are welded.

1.4.5 Pre Heating and Post Heating

1.4.5.1 Mild steel and medium / high tensile steel plates thicker than 20mm, will require Pre-Heating of the parent plate prior to welding as mentioned in Table - 1 for mild steel and Table - 2 for medium / high tensile steel, however, higher pre heat temperature may be required as per approved welding procedure and it shall be followed. In welding materials of unequal thickness, the thicker part shall be taken for this purpose.

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1.4.5.2 Base metal shall be preheated, notwithstanding provisions of IS: 9595 to the temperature given in Table - 1 for mild steel and Table - 2 for medium / high tensile steel, prior to welding or tack welding. When base metal not otherwise required to be pre heated, is at a temperature below 0°C, it shall be pre heated to at least 20°C., prior to tack welding or welding. Pre heating shall bring the surface of the base metal to the specified pre heat temperature and this temperature shall be maintained as minimum inter-pass temperature while welding is in progress.

**TABLE – 1
MINIMUM PREHEAT AND INTER-PASS TEMPERATURE FOR WELDING
MILD STEEL**

Thickness of thicker part at Point of welding	Welding Using	
	Low hydrogen electrode or submerged arc welding	Other than low hydrogen electrode
Upto and including 20mm	None	None
Over 20mm and upto and including 40mm	20°C	Not allowed
Over 40mm and upto and including 63mm	66°C	Not allowed
Over 63mm	110°C	Not allowed

Note: Type of electrode and the preheating requirements for welding shall be as per approved welding procedure.

**TABLE – 2
MINIMUM PREHEAT AND INTER-PASS TEMPERATURE FOR WELDING
MEDIUM / HIGH TENSILE STEEL**

Thickness of thicker part at Point of welding	Welding Using	
	Low hydrogen electrode or submerged arc welding	Other than low hydrogen electrode
Upto and including 20mm	None	Not allowed
Over 20mm	120°-140°C	Not allowed



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Note: Type of electrode and the preheating requirements for welding of medium and high tensile steel shall be as per approved welding procedure.

- 1.4.5.3** Pre heating may be applied by external flame which is non-carbonizing like LPG, by electric resistance or electric induction process such that uniform heating of the surface extending up to a distance of four times the thickness of the plate on either side of the welded joint is obtained.
- 1.4.5.4** Thermo-chalk, thermo-couple or other approved methods shall be used for measuring the plate temperature.
- 1.4.5.5** All butt welds with plates thicker than 50mm and all site butt welds of main framing beam supporting the bunker shall require post weld heat treatment as per procedure given in AWS D-1.1. Post heating shall be done up to 600°C and rate of application shall be 200°C per hour.
- 1.4.5.6** The post heat temperature shall be maintained for 60 minutes per 2.5cm thickness. For maintaining slow and uniform cooling, asbestos pads shall be used for covering the heated areas.
- 1.4.6 Welding Sequence**
- 1.4.6.1** The sequence of welding shall be carefully chosen to ensure that the components assembled by welding are free from distortion and large residual stresses are not developed. The distortion should be effectively controlled either by a counter effect or by a counter distortion.
- 1.4.6.2** The direction of welding should be away from the point of restraint and towards the point of maximum freedom.
- 1.4.6.3** Each case shall be carefully studied before finally following a particular sequence of welding.
- 1.4.6.4** Butt weld in flange plates and / or web plates shall be completed before the flanges and webs are welded together.
- 1.4.6.5** The beam and column stiffeners shall preferably be welded to the webs before the web and flanges are assembled unless the web and flanges of the beam or column are assembled by automatic welding process.

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- 1.4.6.6** All welds shall be finished full and made with correct number of runs, the welds being kept free from slag and other inclusions, all adhering slag being removed from exposed faces immediately after such run.
- 1.4.6.7** Current shall be appropriate for the type of electrode used. To ensure complete fusion, the weaving procedure should go proper and rate of arc advancement should not be so rapid as to leave the edges unmelted.
- 1.4.6.8** Puddling shall be sufficient to enable the gases to escape from the molten metal before it solidifies.
- 1.4.6.9** Non-uniform heating and cooling should be avoided to ensure that excessive stresses are not locked up resulting ultimately in cracks.
- 1.4.6.10** The ends of butt welds shall have full throat thickness. This shall be obtained on all main butt welds by the use of run off and run on pieces adequately secured on either side of main plates. The width of these pieces shall not be less than the thickness of the thicker part joined. Additional metal remaining after the removal of extension pieces shall be removed by grinding or by other approved means and the ends and surface of the welds shall be smoothly finished. Where the abutting parts are thinner than 20mm the extension pieces may be omitted but the end of the butt welds shall then be chipped or gouged out to sound metal and side welded to fill up the ends to the required reinforcement.
- 1.4.6.11** The fusion faces shall be carefully aligned. Presetting shall control Angle shrinkage. Correct gap and alignment shall be maintained during the welding operation.
- 1.4.6.12** All main butt welds shall have complete penetration and back surface of the weld being gouged out clean before first run of the weld is given from the back. However, partial penetration butt weld shall be permitted, when specifically shown in the fabrication drawings.
- 1.4.6.13** Intermittent welds shall be permitted only when specifically approved in the fabrication drawings.
- 1.4.6.14** The welding shrinkage shall be minimised by adopting the correct welding procedure and method. In long and slender member, extra length should be provided at the time of fabrication to account for shrinkage.

1.4.7 Testing and Qualification of Welders

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1.4.7.1 On the basis of the welding procedure, the Contractor shall conduct qualification test. All the welders to be employed for the job shall have to qualify the appropriate tests laid down in IS: 817 and IS: 1181 and ASME IX / AWS D1.1.

1.4.7.2 All necessary arrangements required for the testing and qualification of welders are to be provided by the Contractor.

1.4.8 Inspection of welds

1.4.8.1 Visual Inspection

100 % of the welds shall be inspected visually for external defects. Dimensions of welds shall be checked. The lengths and size of weld shall be as per approved fabrication drawings. It may be slightly oversized but should not be undersized. The profile of weld is affected by the position of the joint but it should be uniform. The welds should have regular height and width of beads. The joints in the weld run shall as far as possible be smooth and should not show any humps or craters in the weld surface. Welds shall be free from unfilled craters on the surface, under-cuts, slags on the surface and visible cracks. Such inspection shall be done after cleaning the weld surface with steel wire brushes and chisels to remove the spatter metal, scales, slag etc. If external defects mentioned above are noticed, there is every possibility of internal defects and further radiographic/ultrasonic examination shall be undertaken as per Indian Standards. Weld gauges shall be used to measure the size of the welds.

1.4.8.2 Mechanical testing

Test plates shall be incorporated on either side of at least one main butt weld of each flange plate and web plate of every main frame column. The weld shall be continuous over the test plate. The test plate shall be cut from extensions of the main plates and shall be fixed so that metal lies in the same direction as that of the main plate. Test plates shall be prepared and tested in accordance with the accepted Standards, in the presence of the Owner or his authorised representative. All testing equipment and facilities for carrying out these tests shall be provided by the Contractor. If any of these tests fail, further radiographic examination of the welds in question on the main members, shall be undertaken by the Contractor. These tests for the test plates and radiographic examination are additional to those contemplated under routine inspection and testing. The Contractor shall carry out these additional radiographic tests as per normal testing procedure.

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1.4.8.3 Non-destructive and special testing

In addition to the normal supervision and testing procedure, radiographic / ultrasonic or other non-destructive examination shall be carried out as stipulated on butt or fillet welded joints and/ or on test specimens, as per applicable standards. All test of welds shall be carried out by the Contractor at his own cost as per applicable standards. However, for checking the quality of weld, the Owner shall carry out additional tests at his own cost. The Contractor shall provide necessary supporting facilities free of cost, as may be required by the Owner, including cordoning of radiation zone while Radiography testing is in progress. Prepared etched section of the welds may be required for examination. The Contractor shall, provide these prepared sections, at his own cost.

In case of failure of any of the tests, rectification of such components shall also be carried out by the Contractor at his own cost. Retesting of the rectified joint, shall also be carried out by the Contractor at his own cost.

1.4.9 Rectification And Correction

1.4.9.1 Wherever defects like improper penetration, extensive presence of blow holes, undercuts, cracking, slag inclusion, etc. are noticed by visual Inspection / other tests, the welds, in such location shall be removed by gouging process. The joints shall be prepared again by cleaning the burrs and residual matters with wire brushes and grinding, if necessary, and re-welded. The gouging shall as far as possible be done using gouging electrodes.

1.4.10 Correction of Defective welds

1.4.10.1 Correction of defective welds shall be carried out as directed by Owner without damaging the parent metal. When a crack in the weld is removed, Magnetic Particle Inspection (MPI) or any other equally positive means shall be used to ensure that the whole of the crack and the material up to 25mm beyond each end of the crack has been removed. Cost of all such tests and operation incidental to correction shall be to Contractor's account.

1.4.11 Acceptance of Welded Structures

1.4.11.1 The acceptance of the welded work shall depend upon correct dimensions and alignment, absence of distortion in the structure, satisfactory results from the inspection and testing of the joints and the test specimens and upon general workmanship being good meeting the tolerance requirements given elsewhere in the specification.

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1.4.12 Primer Painting

1.4.12.1 Red oxide zinc chromate shall be used as primer. The requirements shall be as per IS: 2074 or the applicable industry standards.

1.4.12.2 Unless specified otherwise in the schedule of items or elsewhere in this specification, surface preparation shall be done in accordance with IS: 1477 (Part - I). The surface shall be cleaned and degreased in accordance with one or more of the methods given in IS: 1477 (Part - I). The surface shall be de-rusted and de-scaled either mechanically or chemically by one or more of the methods given in IS: 1477. However flame cleaning and blast cleaning shall be resorted to wherever specifically mentioned in the schedule of items. While cleaning with power wire-brush, care shall be taken not to do it excessively, since mill scale easily gets burnished to a smooth even surface to which paints does not adhere, and this will be detrimental to the performance of paint. Power tools shall remove all accessible weld flux and splatter.

1.4.12.3 Primer paint shall be applied by spray. Dry film thickness (DFT) of the two coats of red oxide zinc chromate shall be minimum 50 microns.

1.4.12.4 Packing

All projecting plates or bars and all ends of members at joints shall be stiffened, all straight bars and plates shall be bundled, all screwed ends and machined surfaces shall be suitably packed and all bolts, nuts, washers and small loose parts shall be packed separately in cases so as to prevent damage or distortion during transit.

1.4.13 Stairs, Hand Railing and Ladders

1.4.13.1 General

- Fabrication and erection of the stairs, railing and ladders shall be done as per the approved fabrication drawings.
- Preparation, submission checking and approval of the drawing shall be done in the same manner as specified for fabrication drawings elsewhere in this specification.

1.4.13.2 All stairs and intermediate landings shall be constructed to size, dimensions and design, as indicated in the detailed drawings. Such stairway shall be fabricated as a complete

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unit which shall include struts, hangers, posts, cross bracing, cleats and accessories, as required for connection to structural steel framing and concrete.

1.4.13.3 Stair treads shall be finished complete with punched and slotted carrier plates attached ready to bolt to stair stringers. Treads shall be provided with anti-skid nosing using Chequered plates and set flush with the stair treads.

1.4.13.4 Pipe hand rails, as specified in detailed drawings, shall be assembled with flush type fittings and welded joints, ground and polished smooth. Railings shall be provided with all necessary fittings, posts, brackets, bolts, plates and similar accessories as shown on the detailed design drawings and as required for proper installation.

1.4.13.5 Hand rails shall be of mild steel pipes of flush welded construction, ground smooth using 32mm nominal bore medium class pipes with top rail and middle rail, about 1.0 metre above platform / framing level and pipe posts spread not more than 1.5 metres apart.

1.4.13.6 Smooth uniform curves and bends are to be provided at stair returns and also wherever specified / required. The open ends of all pipe posts shall be plugged and welded. A minimum radius of 3 times the pipe diameter shall be provided at all points of direction changes in the hand rails.

1.4.13.7 Vertical ladders shall be as called for on the detailed design drawings. The ladders shall be provided with support arms formed with bent steel plate or clip angles. The ladders shall have loose neck supports, designed to form hand grabs and end brackets for fastening to abutting construction. Maximum deviation in the linear dimensions of railings, stairs and ladders, from the approved dimensions, shall not exceed 12 mm.

1.4.13.8 Fabrication and Erection

c) Railings shall be provided with all necessary fittings and accessories as required for proper installation.

1.4.13.9 Acceptance Criteria

Sampling, testing and quality assurance requirements are as given elsewhere in the document.

1.4.14 Chequered Plate

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1.4.14.1 Minimum thickness of Chequered plate floorings, covers etc. shall be 6mm o/p. Chequered plates shall be fixed to supporting members by welding as shown / specified in relevant drawings or as directed by the Owner. The edges shall be made smooth and no burrs or jagged ends shall be left. While splicing, care should be taken so that there is continuity in pattern between the two portions. Care should also be taken to avoid distortion of the plate while welding of stiffening angle / vertical stiffening ribs. Surfaces shall be provided with primer paint.

1.4.15 Electro-forged Steel Gratings

1.4.15.1 General Requirements

- a) This covers the provision of gratings in but not limited to floorings, platforms, drain covers, trench covers, walkways, passages, structural treads with edge binding strips and anti skid nosing, etc.

1.4.15.2 Material

- a) Steel used in electro-forged gratings unit shall conform to grade 'A' of IS: 2062.

1.4.15.3 Fabrication drawings

- a) For gratings the Owner shall release the design drawing indicating the openings required and load intensity on the grating. Based on these drawing, the Contractor shall submit the grating design drawing for different spans and load intensities, along with the fabrication drawings. Thickness of gratings shall be kept as required by the design but shall be 40mm, unless specified otherwise.
- b) Preparation, submission, checking and approval of the drawing shall be done in the same manner as specified for fabrication drawings elsewhere in this document.

1.4.15.4 Fabrication

- a) All gratings shall be fabricated in a factory outside the project area.
- b) All grating units shall be rectangular in pattern and electro-forged. The size and the spacing of the bearing bars and cross bars shall be as detailed in fabrication drawings. The Contractor shall submit the grating design for different spans and loading intensities, along with fabrication drawings.

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- c) The grating unit shall be accurately fabricated and finished, free from warps, twists or any defects that would impair their strength, serviceability and appearance.
- d) The gratings shall be of reputed make and manufacturer, as approved by the Owner. Contractor shall provide all facilities and access to the Owner or his representative to carry out Inspection during all stages of manufacturing of gratings.
- e) Grating units shall be provided with all necessary clips, bolts, self drilling and tapping screws, nuts and lock washers required for proper assembly and rigid installation and fastening to abutting units / supporting structural steel framing members. Wherever required edge binding strip and anti-skid nosing shall be provided.

1.4.15.5 Erection, Alignment and Installation of Gratings

- a) Grating work shall include making cut outs and clear openings for all columns, pipes, ducts, conduits or any other installation penetrating through the grating work. Such cut outs and clearances shall be treated as specified in subsequent clauses.
- b) The gratings shall be notched, trimmed and neatly finished around flanges and webs of the columns, moment connections, cap plates and such other components of the steel structural encountered during the placement of the gratings. In all such cases, the trimming shall be done to follow the profile of the components encountered. After trimming the binding strip shall be provided on the grating to suit the profile so obtained.
- c) Opening in gratings for pipes or ducts that are 150mm (in size or diameter) or larger shall be provided with steel bar toe plates of not less than 5mm thickness and appropriate width, set flush with the bottom of the bearing bars.
- d) Penetrations in gratings that are more than 50mm but less than 150mm in size or diameter shall be welded with plates of size shown in the detailed drawing set flush with the bottom of the grating panel.
- e) Unless otherwise indicated on the drawing, grating units at all penetrations shall be made up in split section, accurately fitted and neatly finished to provide for proper assembly and erection at the job site.
- f) Grating shall preferably be installed in position by self drilling and tapping screws.

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1.4.15.6 Painting

All fabricated grating section and accessories shall be blast cleaned to near white metal surface (Sa 2 ½) followed by either of the following two:

- a) Two coats of red lead primer and two coats of black enamel finish paint.

All the provisions as mentioned for painting system with regard to preparation of surface, application of paint and acceptance criteria shall also be applicable.

- b) Hot dipped galvanization.

1.4.15.7 Galvanization of Gratings

- a) Wherever specified in the drawings, gratings shall be provided with galvanization. The weight of the zinc coating shall be at least 610 g. / Sq.m., unless noted otherwise.
- b) Purity of zinc to be used for galvanising shall be 99.5% as per IS: 209.
- c) After the shop work is complete, the structural material shall be punched with erection mark and be hot double dip galvanised. Before galvanising the steel section shall be thoroughly blast cleaned to near white metal surface (Sa 2 ½) or chemically cleaned.
- d) The galvanised surface shall consist of a continuous and uniformly thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be cleaned and smooth and shall be free from defects like discoloured patches, Bare spots, unevenness of coating, spelter which is loosely attached to the steel, blistered surface, flaking or peeling off etc. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable to rejection.
- e) There shall be no flaking or loosening when structural squarely with a chisel faced hammer. The galvanised steel member shall withstand minimum four (4) numbers one minute dips in copper sulphate solution as per IS: 2633.
- f) When the steel section is removed from the galvanizing kettle, excess spelter shall be removed by “Bumping”. The processes known as “wiping” or “scrapping” shall not be used for this purpose.

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- g) Defects in certain members indicating presence of impurities in the galvanising bath in quantities larger than that permitted by the specifications or lack of quality control in any manner in the galvanising plant, shall render the entire production in the relevant shift liable to rejection.
- h) All gratings shall be treated with sodium dichromate or an approved equivalent solution after galvanising, so as to prevent white storage stains.
- i) If the galvanising of any member is damaged, the Owner shall be shown of the extent of damage, if so directed the galvanising may have to be redone in the similar manner as stated above at no extra cost to the Owner.

1.4.16 Erection and alignment

1.4.16.1 Erection marks

Erection marks in accordance with approved fabrication drawing shall be clearly painted on the fabricated steelwork. Each piece shall be marked in at least two places. Each piece shall also have its weight marked thereon.

1.4.16.2 The center lines of all columns, elevations and beam bearings shall be marked on the sections to ensure proper alignment and assembly of the pieces at site.

1.4.16.3 Erection Scheme

- a) The Contractor shall submit for review of the work his erection scheme for the erection of all types of structural.
- b) The Contractor before commencement of fabrication work, to avoid any future modification shall check the erectability of the structural. The erection scheme shall indicate the approximate weight of the structural members, position of lifting hook, crane boom length, crane capacity at different boom length and at different boom inclination etc.
- c) The erection scheme shall also give details of the method of handling, transport, hoisting, including false work / staging, temporary bracing, guying, temporary strengthening etc. It will also give the complete details of the number and capacity of the various erection equipment that will be used such as cranes, winches, etc. along with disposition at the time of erection of column, trusses etc.

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- d) The Contractor shall examine the site conditions and transportation clearances before deciding whether columns, trusses, beams are to be transported in one piece or in more than one piece. All those steel members which are to be required to be erected in single piece but are transported in more than one piece shall be assembled, aligned bolted, welded, tested etc. on the proper assembly bed before erection at site.
- e) The erection of columns, trusses, trestles, portals, beams etc. shall be carried out in one single piece as far as practicable unless specified otherwise in the design drawing. Conveyor galleries and Pipe/Cable bridges shall generally be erected as box pieces i.e. the bottom chord and bracing, top chord and bracing, side vertical posts and bracing, end portals and roof-trusses shall be completely welded prior to erection and if required temporary strengthening during erection shall be made.
- f) The sheeting runners and roof sheeting purlins may be erected individually. When erection joints are provided in columns, their location shall generally be just above a floor level.
- g) The structural steel shall be erected frame-wise. Thereafter, the frames shall be progressively aligned and all erection welding completed. The secondary beams shall thereafter be erected, aligned and welded bay wise / floor-wise.

1.4.16.4 Embedding in Concrete / Brickwork

All embedments shall be placed true to level and location. It shall be ensured by the Contractor by provision of the temporary members and if required by welding of embedment lugs with nearby reinforcement. The embedments shall not be disturbed during concreting.

1.4.16.5 Protection Against Damage In Transit

- a) All steelwork shall be efficiently and sufficiently protected against damage in transit from fabrication yard to erection site from any cause whatsoever. All projecting plates and all ends of members at joints shall be stiffened.
- b) If the steel has been unduly bent in transit or during handling by the Contractor which cannot be rectified in the opinion of the weld, such steel shall be counted as

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wastage and the cost recovered from the Contractor at the time of reconciliation of the steel as per the provisions of the contract.

1.4.16.6 Stability of Structural Work

The Contractor shall be responsible for the stability of the structural at all stages of its erection at site and shall take all necessary measures by the additions of temporary bracings and guying to ensure adequate resistance to wind and also to loads due to erection equipment and their operations. Guying and bracing shall be done in such a way that it does not interfere with the movement or working of other agencies working in the area. For the purpose of guying the Contractor shall not use other structural in the vicinity which are likely to be damaged by the guy.

1.4.16.7 Temporary Structural Work

The stipulations contained in the Indian standard safety code for erection of structural steel work, IS: 7205 shall be followed for ensuring safety of men and material. This shall include provision of temporary structural by the Contractor at his own cost for proper approach and working platforms during the erection of structural to the satisfaction of the Owner. The Contractor at his own cost shall provide any temporary strengthening needed. Temporary structural shall include access ladders, working platforms, railings, framework etc. All temporary structural shall be subsequently dismantled and removed.

1.4.16.8 Setting Out

Positioning and levelling of all steelwork, plumbing of stanchions and placing of every part of the structure with accuracy shall be in accordance with the detailed design drawings and to the satisfaction of the Engineer. For heavy columns, etc. the Contractor shall set proper screed bars to maintain proper level. No extra -payment shall be made for this.

No permanent field connections by riveting, bolting or shall be carried out until proper alignment and plumbing has been attained.

Column bases shall be set so that the column load is uniformly transmitted to the foundation. The Contractor shall carefully check the location and layout of anchor bolts embedded in foundations to ensure that the structural can be properly erected as per requirement. In some cases the bolts may be provided in the pipe sleeves / pockets in foundations for subsequent adjustment in final alignment of the foundation bolt. Before erection of columns on their foundations, the top surface of base concrete shall be

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thoroughly cleaned with wire brushes and by chipping to remove all laitance and loose material. The Contractor shall be responsible to provide all packing and shim plates whatsoever required for erection of the structural at his own cost.

1.4.16.9 Alignment

The Contractor shall be responsible for the correct alignment and leveling of all steelwork on site to ensure that the columns are in plumb and all the structural are erected conforming to the specified permissible erection tolerances. Welding works shall be done only after the approval of alignment of erected structural, by the weld.

1.4.16.10 New Erection Marks

Additional structures involving new erection marks may be required to be added at any stage of work.

All such new erection marks shall be detailed and included in marking schemes and fabrication carded out thereafter.

All such new erection marks shall be considered under item of original fabrication work. As a result of additional structures becoming necessary if the work is delayed beyond the time schedule stipulated, the Engineer shall give suitable extension of time provided he is satisfied about the reasonableness of the delay involved. However, no claim for extra payments or revision of rates due to delay shall be entertained.

1.4.17 Painting System

1.4.17.1 Materials

- a) Primer shall be Red Oxide Zinc Chromate primer (minimum 50 micron Dry Film Thickness - DFT) as per IS: 2074. (Minimum two (2) coats)
- b) Intermediate (Under) coat (minimum 50 micron DFT) shall be of synthetic enamel paint of approved shade and colour as per accepted standards
- c) Top / Finish coat (minimum 50 micron DFT) shall be of synthetic enamel paint of approved shade and colour with glossy finish as per accepted standards.
- d) However, areas/surfaces subjected to chemical attacks will be painted with epoxy paint/epoxy lining.

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- e) All paints including primer shall be of reputed brand / manufacturer and as approved by the Owner.

1.4.17.2 Preparation of Surface

- a) The surfaces shall be blast cleaned to near white metal surface (Sa 2 ½) i.e. 2nd quality (requiring at least 95% of the surface completely cleaned) as given in BS: 4232. For blast cleaning, dry method as approved shall be used.
- b) Approved type of abrasives shall only be used for blast cleaning of steel surfaces. To avoid contamination of the adjoining areas with abrasive, suitable enclosure shall be provided to carry out the blast cleaning operation. If required prior approval from the factory inspector / pollution control board etc. shall be obtained regarding the method of blast cleaning and abrasives used therein.
- c) Steel may be blast cleaned either before or after fabrication. Immediately after blast cleaning of the steel surfaces, primer coat shall be applied onto the surfaces.

1.4.17.3 Application of paint

- a) The Contractor shall submit the total painting scheme and works shall be started after the approval of the scheme, from the Owner.
- b) Painting works shall be carried out on structural as per the approved scheme. The total painting scheme to be submitted to the Owner shall include the following:
- i) Method of blast cleaning giving the details and sizing of various equipment required, abrasive used, enclosure provided to avoid contamination of the adjoining area, expected productivity on an eight (08) hour shift working etc.
- ii) Arrangement of airless spray with the equipment rating.
- iii) Drying time to be allowed before the application of subsequent coat.
- iv) Recommended paint for primer, intermediate (under) coat and finish / top coat with their brand name and designation, considering the requirements of applicable accepted standards.

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- v) Number of coat and the thickness of each coat to be applied to achieve the specified thickness of each coat i.e. primer, intermediate (under), and top / finish coats.
- vi) Environmental conditions i.e. ambient temperature and humidity at the time of application of the paint.
- vii) Quality control setup for painting i.e. checking of surface preparation, thickness of each coat, quality of applied paints vis-a-vis the approved sample etc.
- viii) Method of touch up painting for surfaces damaged during handling, transit, erection, welding, subsequent to painting, removal of the temporary supports etc.
- ix) Reference of relevant Indian / International standards for the testing and acceptance.
- c) Before application of Red Oxide Zinc Chromate primer, the steel surfaces shall be blast cleaned to near white metal surface (Sa 2 ½).
- d) Primer paint and intermediate (Under) coat shall be done by airless spray. However finish coat and final finish coat can be applied either by spray and or brush.
- e) All subsequent coats shall be applied only after acceptance of the previous applied coat. Inaccessible surfaces shall be primer painted before shop assembly.
- f) For final touch up painting of surfaces, which are damaged during handling, transit, erection, etc. surfaces shall be well prepared, by rubbing the entire damaged area using wire brush, emery paper etc. and shall be provided with same painting system as described elsewhere in this document. Touch up painting of areas welded subsequent to painting and areas exposed after removal of temporary supports shall also be carried out in same way.
- g) Rectification of the damaged painted surfaces on account of welding / handling etc. of each coat shall be done by touch up painting, before the application of next coat, using the same painting system as specified elsewhere in the document.

1.4.17.4 Acceptance Criteria

- a) All painted surfaces shall be uniform and pleasing in appearance.

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- b) Dry film thickness of each coat shall be checked and measured by using echo-meter. The thickness as measured shall not be less than the minimum thickness specified for the coat of paint under relevant clauses of the technical specification.
- c) Colour, texture shall match exactly with the approved sample.
- d) Sampling, testing and quality assurance requirements are given elsewhere in this technical specification.

1.4.18 Foundation Bolts

1.4.18.1 General

- a) Foundation bolt shall comprise of foundation bolts, nuts, lock nuts, anchor plates, stiffener plates, protective tape etc.
- b) All foundation bolts other than nut and lock nuts shall be site-fabricated.
- c) Every bolt shall be provided with nut and lock nuts. The nut and lock nuts shall be of reputed make and manufacture as approved by the Owner.

1.4.18.2 Material

- a) Foundation bolts shall generally conform to IS: 5624.
- b) Mild steel bars used for the fabrication of bolt assembly shall conform to grade '1' of IS: 432 and / or grade 'A' of IS: 2062.
- c) Hexagonal nuts and lock nuts shall conform to IS: 1363 and IS: 1364 upto M36 diameter and IS: 5624 for M42 to M150 diameter.

1.4.18.3 Fabrication

- a) The fabrication of bolt assemblies shall include threading, cutting, grinding, drilling, welding, etc. all complete.
- b) All bolts, bolt assemblies, etc. shall be fabricated to the correct dimensions and shapes as per requirement. The bolts shall have coarse pitch screw thread in the diameter range 8 to 64 mm and 6 mm pitch screw thread for diameter greater than 64 mm, as per IS: 4218.

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- c) For fabrication of any particular size of bolt, the diameter of the threaded portion of the bolt shall be considered as the diameter of the bolt.
- d) All nuts shall be of steel with well formed hexagonal heads, unless specified otherwise, forged from solid metal and shall be dipped in hot boiled linseed oil as soon as these are made. The nuts shall fit well on the bolts.
- e) Splicing in the foundation bolt can be done with full strength butt weld, which shall be further strengthened by provision of stiffening ribs for the full strength of the bolt. While splicing the foundation bolts, it shall be ensured that not more than 25% of the foundation bolts of each pedestal are spliced.

1.4.18.4 Erection

- a) During erection, necessary temporary members like template, bracing, supports, etc. to ensure proper positioning of the assemblies and alignment of the bolts and holding them firmly during concreting shall be provided by the Contractor at his own cost.
- b) All materials shall be erected in plumb and in level (unless otherwise specified) and at true locations as per requirement.
- c) Fabrication and erection shall be carried out as per IS: 800. Welding shall conform to IS: 816 and IS: 9595.

1.4.19 Permanent bolts, Nuts and Washers

1.4.19.1 General Requirements

- a) Permanent bolts shall be used for field connections only for those joints where so specified in the design document and fabrication drawings.
- b) All bolts, nuts, washers shall be of reputed make as approved by the Owner.

1.4.19.2 Material

- a) Permanent Mild Steel Bolts : The permanent mild steel bolts shall be of carbon steel of product Grade 'C' as per IS: 1363 (part - 2). The technical supply condition shall be as per IS: 1367 (part - I). The threads shall be of class 8g as per metric screw

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threads of IS: 4218 (part - 6). The bolts shall be of diameter up to 39mm and shall conform to mechanical properties class 4.6 as per IS 1367 (part - 3).

- b) Permanent Mild Steel Nuts : The permanent mild steel nuts shall be of carbon steel of product grade C meeting the requirements of IS: 1363 (part - 2). The technical supply condition shall be as per IS: 1367 (part - 1). The Threads shall be of tolerance class 7H as per metric screw threads as per IS: 4218 (part - 6). The nuts up to diameter 16mm shall be of property class 5 and for diameters beyond 16mm and up to 39mm shall conform to property class either 4 or 5 as per the provisions of IS: 1367 (part - 6) or ISO 898 / 2.
- c) Permanent Mild Steel Washers : The permanent mild steel washers shall be of ordinary grade conforming to the requirements of IS: 5369 and IS: 2016. The washers shall be supplied in natural finish.
- d) Permanent High Strength Structural Bolts : The permanent high strength structural bolts shall be either of carbon steel with additives (e.g. Boron or Mn or Cr) quenched and tempered or carbon steel quenched and tempered of product grade C meeting the provisions of IS: 3757. The technical supply condition shall be as per IS: 1367 (part - 1). The threads shall conform to tolerance class 6g of IS: 4218 (part - 6). The bolts shall conform to mechanical properties class 8.8 as per is: 1367 (part - 3).
- e) High Strength Structural Nuts : High strength structural nuts shall be of product grade B meeting the requirements of IS: 6623. The technical supply condition shall be as per IS: 1367. The threads shall conform to tolerance class 6H as per metric screws threads of IS: 4218 (part - 6). The nuts shall conform to property class 8 of IS: 1367 (part - 6) / ISO 898 / 2 and all nuts shall be hardened and then tempered at temperature of at least 425°C.
- f) Washers for High Strength Structural Bolts and Nuts : The various types of washers for use with high strength structural bolts and nuts shall be of ordinary grade as per IS: 5369 and shall meet all the requirements of IS: 6649. The washer shall be made according to IS: 1570 (part - 2). The washer shall be thorough hardened and tempered. Washer shall be supplied in dull back heat-treated condition with residual coating of light oil.

1.4.19.3 Installation

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- a) Installation of the high strength bolts / high strength friction grip bolts shall be as per the requirements specified in IS: 4000.
- b) Mild steel bolts shall be installed and placed in position as per IS: 1363/ IS: 1367.
- c) Field Riveting

All rivets shall be heated and driven with pneumatic tools. Hand passing or "throwing" of rivets are desirable. Any other method of conveying hot rivets from the furnace to the driving point must be approved by the engineer. No cold rivets shall be driven. All other requirements of riveting including quality and acceptance criteria shall be in accordance with the relevant portions of the Specification for Fabrication of Structural Steelwork of the Project.

- d) Field Bolting

All relevant Portions in respect of bolted construction of the Specification for Fabrication of Structural Steelwork applicable to the Project shall also be applicable for field bolting in addition to the following:

Bolts shall be inserted in such a way so that they may remain in position under gravity even before fixing the nut. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible materials. When assembled, all joint surfaces, including those adjacent to the washers shall be free of scales except tight mill scales. They shall be free of dirt, loose scales, burns, and other, defects that would prevent solid seating of the parts. Contact surfaces within friction type joints shall be free of oil, paint, lacquer, or galvanizing.

All high tensile bolts shall be tightened to provide, when all fasteners in the joint are tight, the required minimum bolt tension by any of the following methods.

i) Turn-of-nut Method

When the turn-of-nut method is used to provide the bolt tension, there shall first be enough bolts brought to a "snug tight" condition to ensure that the parts of the Joint are brought into good contact with each other. 'Snug tight' is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Following this initial operation, bolts shall be placed in any remaining holes in the connection and brought to snug tightness. All bolts in the joint shall then be tightened additionally by the applicable amount of

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nut rotation specified in Table-3 with tightening progressing systematically from the most rigid part of the joint to its free edges. During this operation there shall be no rotation of the part not turned by the wrench.

TABLE-3

Bolts length not exceeding 8 times dia or 200 mm	Bolt length exceeding 8 times dia or 200 mm	Remarks
1/2 turn	2/3 turn	Nut rotation is relative to bolt regardless of the element (nut or bolt) being turned. Tolerance on rotation-30 over or under.

Bolts may be installed without hardened washers when tightening is done by the turn -of-nut -method. However, normal washers shall be used.

Bolts tightened by the turn-of-nut method may have the outer face of the match-marked with the protruding bolt point before final tightening, thus affording the inspector visual means of noting the actual nut rotation. Such marks can be made by the wrench operator by suitable means after the bolts have been brought up snug tight.

ii) Torque Wrench Tightening

When torque wrenches are used to provide the bolt tensions, the bolts shall be tightened to the torques specified in TABLE - 4 (See Note below the Table). Nuts shall be in tightening motion when torque is measured. When using torque wrenches to install several bolts in a single joint, the wrench shall be returned to touch up bolts previously tightened, which may have been loosened by the tightening of subsequent bolts, until all are tightened to the required tension.

TABLE - 4

Nominal Bolt Diameter (mm) (Kg.M) of IS: 1367	Torque to be applied for bolt class 8.8
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20	59.94
22	81.63
24	103.73

Note: The above torque values are approximate for providing tensions of 14.7 T for 20 mm dia. and 21.2 T for 24 mm dia. bolts under moderately lubricated condition. The torque wrench shall be calibrated at least once daily to find out the actual torque required to produce the above required tension in the bolt by placing it in a tension indicating device. These torques shall be applied for tightening the bolts on that day with the particular wrench.

In either of the above two methods, if required, for bolt entering and wrench operation clearances, tightening may be done by turning the bolt while the nut is prevented from rotating.

Impact wrenches if used shall be of adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately ten seconds. Holes for turned bolts to be inserted in the field shall be reamed in the field. All drilling and reaming for turned bolts shall be done only after the parts to be connected are assembled. Tolerances applicable in the fit of the bolts shall be in accordance with relevant Indian Standard Specifications. All other requirements regarding assembly and bolt tightening shall be in accordance with this sub clause.

1.4.20 Stainless Steel Hoppers

1.4.20.1 General Requirements

- a) Stainless steel hopper can be of any shape like conical, hyperbolic, pyramid etc. and shall be used only when indicated in the design (scope) drawings of the Owner.

1.4.20.2 Material

- a) Stainless steel hopper shall conform to grade SS 415M of approved manufacturer.
- b) SS 415M shall have the following chemical composition.

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Material	%	Remarks
Carbon	0.03%	Max.
Silicon	1.60%	Max.
Manganese	0.80% to 1.50%	
Phosphorous	0.03%	Max.
Sulphur	0.03%	Max.
Chromium	10.80% to 12.50%	
Nickel	1.50%	Max.
Titanium	0.75%	Max.
Nitrogen	0.03%	Max.

The mechanical properties shall be as follows:

Description	Value	Remarks
Hardness rock well B scale	90	Max.
Tensile strength	450 Mpa	Min.
Yield strength	300 Mpa	Min.
Elongation	25%	Min.

- c) Contractor shall return to the Owner's store all unutilized (surplus) stainless steel plates and all waste and cut pieces generated. Non return of any part of the surplus / waste stainless steel pieces to the Owner's store will call for the penal recovery. The penal recovery for stainless steel shall be worked out in the same manner as mentioned in the special conditions of contract for maximum penal recovery for tile structural steel.

1.4.20.3 Fabrication drawings of Hopper

- a) The Contractor on the basis of the design / scope drawing furnished by Owner shall prepare the fabrication drawings. Fabrication drawings for the hopper shall include the cutting plan for each hopper plate. Cutting plans shall be based on the size of the stainless steel plates available at store.
- b) Most optimal solution for reducing the wastage of stainless steel plate shall be adopted. In order to reduce the wastage and ensure the maximum utilization of stainless steel plate, the cutting plan shall take into consideration the reverse curvature and place the various elements of hopper plate in opposite fashion to reduce the end wastage. Similarly the hopper plate element having different radii shall be placed one inside the other, to optimize the stainless steel plate use such

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optimization may also require adjustment in the size of the each element of hopper plate and also additional weld joints.

- c) The bill of material of hopper plate shall indicate the inner surface area of the hopper, weight of the hopper based on the inner surface area, weight of each of the cut plate for hopper fabrication, weight of cut and scrap pieces generated.
- d) In case the Contractor does the cutting of the stainless steel plates without approved cutting plan then all the wastage (i.e. the difference between the weight of stainless steel plate cuts and the actual finished weight considered for the measurement for payment) shall be subjected to the maximum penal recovery at the rate specified under relevant clause of the special conditions of contract. This clause will be applicable only when the material is free supply item to the Contractor by Owner.
- e) Preparation, submission, checking and approval of the drawing shall be done in the same manner as specified for fabrication drawings elsewhere in this document.

1.4.20.4 Fabrication

- a) Site Fabrication : The Fabrication, erection, alignment and welding shall be carried out as per the accepted practice and in accordance with relevant IS and international specification as well as stipulations contained herein. The Fabrication and erection works shall be done as per the approved fabrication drawings.
- b) Cutting : Cutting may be effected by shearing, or by using plasma. The cut edges of all plates shall be perfectly straight and uniform through out. Cutting shall be done as per the cutting plan shown in the fabrication drawing. All the edges shall be ground smooth before they are welded.
- c) Bending : The stainless steel plates shall be subjected to cold forming and bending in order to get the desired shape and profile.

1.4.20.5 Welding

- a) Welding shall be used for jointing of stainless steel plates.
- b) All weld joints (along the inclined plane) shall be staggered.

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- c) Stainless steel can be welded by any common welding process viz. MIG, metal arc or plasma using the covered compatible electrodes as per IS: 5206 or by inert gas arc welding as per IS: 2811.
- d) Shielding gas shall be Argon + Hydrogen mixture or Argon + Oxygen mixture. However, Argon + Oxygen mixture shall be preferred. Carbon dioxide mixture shall be avoided.

1.4.20.6 Electrodes

- a) 308L and 315L electrodes / fillers shall be used for the welding of stainless steel to stainless steel and stainless steel to mild steel respectively.
- b) The welding process and the type of the electrodes to be used for welding shall be as per welding procedure, as approved by the Owner.

1.4.20.7 Welding sequence

- a) The type of electrodes, welding sequence, preheat and Inter-pass temperature and post weld heat treatment shall be as approved by the Owner.

1.4.20.8 Welder's Qualification

- a) On the basis of the welding procedure, the Contractor shall conduct qualification test. All the welders to be employed for the job shall have to qualify the appropriate tests laid down in IS: 817 and IS: 1181 and ASME IX I AWS D1.1. All the necessary arrangements required for the testing and qualification of welders are to be provided by the Contractor.

1.4.20.9 Acceptance criteria

- a) Acceptance of the fabricated structural work shall depend upon the correct dimensions and alignment, absence of distortion in the structural, satisfactory results from the inspection and testing of the welded structural joints and the test specimens general workmanship being good and meeting the tolerance requirements as given IS: 7215.
- b) Sampling, testing and quality assurance requirements are given elsewhere in the specification

1.4.21 Dismantling

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1.4.21.1 Dismantling of Steel Work

- a) In case it is found that certain erection marks already erected at any elevation are to be dismantled for any reason whatsoever, this shall be done only on the written orders / permission of the Owner.
- b) Such dismantling shall be done carefully without damaging other structural and lowered to ground. Thereafter, it shall be carried to the field fabrication shop, if modifications are to be carried out or return to the project stores if the dismantled member is not to be re-erected at all. This operation may involve temporary dismantling, cutting, re-welding, supporting and restoring to correct position all temporarily dismantled members realigning of all other adjacent connected members, to their correct positions as well.

1.4.22 Additions To, Alterations in and / or Modification

1.4.22.1 Modification of Erection Marks

- a) In case, it is found that certain erection marks as already detailed and approved in fabrication drawings, require additions, alterations and modifications; this shall be done on the written orders of the Owner. Wherever a modification is ordered, the Contractor shall request the Owner in writing to examine the stage of completion of the erection mark. The weight of the erection mark (i.e. the calculated weight as per approved bill of materials) shall be recorded and termed as the unmodified weight of the erection mark.

1.4.22.2 Additions To, Alterations In

- a) If additions to, alterations in and / or modifications are intimated before completion and acceptance of fabrication of erection marks as per originally approved fabrication drawings, such changes shall not be classified as additions to, alterations in and / or modifications of erection marks and no payment shall be due to the Contractor for such additions, alterations and modification. If additions to, alterations in and / or modifications is ordered after completion and acceptance of fabrication and / or erection, payment shall be due to the Contractor for additions to, alterations in and/ or modifications.
- b) Normally the work of additions to, alterations in and / or modifications of erected erection marks shall be carried out in the erected position. Only in exceptional

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cases, where the Owner specifically approves that modification cannot be carried out in the erected position, the erection mark shall be dismantled.

- c) The work of additions to, alterations in and / or modifications may involve cutting of certain portions and parts, gouging of welds, cuttings, grinding, fabrication, welding, drilling holes specifically required for the work, straightening, raising to the required level, removal of bends, painting and touch up painting, transporting the cut and removed parts / items, pieces re-utilised out of cut and removed parts / items and new steel to be added. Wherever modification is involved it shall be done carefully without damaging other structural. In case of cutting from an erected member, the cut portion shall be safely lowered to the ground. Thereafter pieces not utilised out of such cut and removed parts shall be returned to the project stores if the Owner feels that these cannot be used elsewhere. Further the member from where the piece / item has been cut shall be ground smooth at the cut joint location. Modification may involve temporary dismantling, cutting, re-welding, supporting and restoring to the correct position of all temporarily dismantled members realigning of other adjacent connected members as well. Modifications to erection marks at erection site shall involve transporting the fabricated part / items (pieces re-utilized out of cut and removed parts / items and or new steel added) to erection site, raising to required level and welding in position. Modifications to erection marks in fabrication yard shall involve turning and handling of structural.
- d) Additions to, alterations in and / or modifications may be ordered either before erection or after erection and may have to be carried out either in erected position at erection site on the ground or in the fabrication shop. The scheme of dismantling and modification wherever required shall be got approved by the Owner before the work is taken up.

1.4.23 Re-Erection Of Erection Marks After Additions, Alterations And Modifications

- a) The items, where additions to, alterations in and / or modifications or change of erection mark have been ordered and such operations have necessarily to be carried out after dismantling, shall require re-erection.
- b) The work of re-erection includes carriage of modified erection marks from the field fabrication shop to erection site, lifting of same to the required position, aligning, and erecting in position, inclusive of erection bolts, tack welding and final welding and touch up painting etc., all complete to the satisfaction of the Owner. The work shall also involve the re-erection of members which had to be temporarily dismantled including temporary dismantling, cutting, re-welding, supporting and

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restoring to the correct position of all temporarily dismantled members, realignment of other adjacent connected members including gouging of welds, realigning, re-welding, etc. of such members.

1.4.24 PTFE (Poly Tetra Fluoro Ethylene) Slide Bearings

1.4.24.1 General Requirements

- a) The bearings shall consist of upper and lower units. The upper unit shall include a sole plate with mirror finish stainless steel facing bonded to the bottom surface of the sole plate. The lower unit shall consist of a relevant laminated elastomer pad surfaced with PTFE. A rigid confining medium substructure bonds the PTFE to the pad. When the upper and lower units are mated the stainless steel slides on the PTFE surface with an extremely low coefficient of friction. These bearings shall be designed by the manufacturer / Supplier of PTFE with the loads specified in the drawings as per the performance requirements. The bearing shall be of reputed make and manufacturer as approved by Owner, for required vertical loads, as per the construction drawing and for a maximum displacement of (\pm) 50 mm.

1.4.24.2 Material

- a) PTFE bearing shall be sliding against highly polished stainless steel and the coefficient of friction between them shall be less than 0.06 at 55 kg / cm². In order to prevent cold flow in the PTFE surface it shall be rigidly bonded by a special high temperature resistant adhesive to the stainless steel sub-strata. The stainless steel surface that slides against the PTFE is mirror polished. The stainless steel shall be bonded to the top plate by special high strength adhesive. The thickness of the stainless steel shall be between 1.0 to 1.5mm.
- b) The resilient bearing pad shall consist of multiple layers of lightweight fabric impregnated with a high quality elastomer compound vulcanised into slabs of uniform standard thickness as per the requirements. This shall withstand vertical (compressive) load not less than 500 Kg / sq. cm and shear loads up to 40 Kg / sq. cm.

1.4.24.3 Installation

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- a) The seating area for PTFE bearing shall be prepared accurately level and furnished with a thin layer of epoxy resin mortar. The bearing will be placed on this layer while it is still workable and the bearing is leveled. The bearing should not be displaced as the beam is lowered into position. When the mortar and adhesive are fully set and the beam is slightly above the top of the bearing, the upper surface of the bearing shall then be coated with sufficient thickness of epoxy resin mortar so that when the beam is lowered on to the temporary supports it comes into full contact with the mortar and some is squeezed out. The surplus mortar shall be trowelled off and after the mortar is fully set the temporary supports removed.

1.4.25 Flexible Open Ended Bellow Strap

1.4.25.1 General Requirements

- a) Pre-formed flexible open ended bellow strap of neoprene is to be provided between top of bunker and bottom of tripper floor or any other such place as directed by Owner, to avoid coal dust nuisance.

1.4.25.2 Material

- a) The pre-formed flexible open ended bellow strap shall be of reputed make and manufacturer, as approved by the Owner and shall consist of neoprene impregnated lightly woven tightly twisted light weight cotton canvas with aluminum striped edges.
- b) The life of the strap shall be guaranteed by the Contractor.
- c) The below strap shall be of minimum 200mm wide under un-stretched condition and shall be of minimum 2mm thick.

1.4.25.3 Installation

- a) The flexible open-ended strap shall be fixed in position with permanent bolts and it shall be ensured that sealing is total without any leakage.

1.4.26 Coal Bin

Shape of bins shall be circular, polygonal, square or rectangular in plan. Bottom hopper portion may have be conical-cum-hyperbolic or any other profile shape as shown in the

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drawing. Bin shall be termed as bunkers or silos according to their shape and plane of rupture of coal.

For general requirements, fabrication and construction details IS: 9178 (Part I, II) shall be followed as general guidance. The bins shall be fabricated and erected in segments.

The Coal bins shall be made of mild steel plates joined together with full strength butt weld and provided with stiffeners at regular interval. Stiffeners shall be provided on the external face and it may be welded with external face.

Bending of plates and rolled sections to the required shape for fabrication shall be done by plate bending machine or cold bending process Without resorting to heating, hammering, angle smithy and black smithy process

Poking hole (manual or pneumatic) and striking plate shall be provided to facilitate coal flow. Poking holes shall have circular MS pipe and cover cap as per requirement.

Trial assembly of coal bin/bunker including hopper shall be made at least for one bunker before commencing regular fabrication of the bunkers.

1.5.0 SAMPLING, TESTING, QUALITY ASSURANCE AND DELIVERY OF MATERIALS

1.5.1.1 General

- a) The Contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and/or International Standards and shall conduct such tests as called for by the Owner. Where no specific testing procedure is mentioned, the tests shall be carried out as per the prevalent / accepted engineering practice to the directions of the Owner. Tests shall be done in the field and at a laboratory approved by the Owner and the Contractor shall submit to the Owner, the test results in triplicate within three days after completion of a test. The Owner may at his discretion, waive off some of the stipulations given for small and unimportant operations.
- b) Non Destructive Test (NDT) requirements for columns, crane girder frame, beam, truss, coal bins/bunkers etc., physical and chemical properties of material shall be as per relevant codes. Review of correlated Mill Test Certificates (MTC) or check testing in absence of MTC. Ultrasonic Test (UT) on plates above 40mm shall be as

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per ASTM A435. Welding Procedure & Welders Qualification Test shall be as per ASME Section IX / AWS D1.1

- c) The inspector shall have free access at all reasonable times to those parts of fabricators works which are concerned with the fabrication of the steel work and shall be afforded all reasonable facilities for satisfying himself that the fabrication is being undertaken as per provisions of this specification.
- d) The inspection shall be made at the place of fabrication prior to dispatch and shall be conducted so as not to interfere unnecessary with the operation of the work.
- e) Should any structure or part of a structure be found not to comply with any of the provisions of this standard , it shall be liable to rejection. Defects which may appear during fabrication shall be made good with the consent of and according to the procedure laid down by the Inspector / Owner
- f) All gauges, templates and instruments necessary to satisfy the Inspector shall be supplied by the fabricator. The Inspector, may, at his discretion check the test results obtained at the fabricators works by independent tests at the Government Test House or elsewhere and should the material so tested be found to be unsatisfactory, the costs of such tests shall be borne by the manufacturer.
- g) Material/work found unsuitable for acceptance, shall be removed and replaced by the Contractor. The work shall be redone as per specification requirements and to the satisfaction of the Owner.
- h) Radiography and ultrasonic testing of welds shall be carried out by Specialist agency only. In case, the Contractor does not have the required expertise, he shall engage Specialist agency for this purpose, after getting approval from the Owner.
- j) All steel supplied by, the Contractor shall conform, to the relevant Indian Standards. Except otherwise mentioned in the contract, only tested quality steel having mill test reports shall be used. In case unidentified steel materials are permitted to be used by the Engineer, random samples of materials will be taken from each unidentified lot of 50 M.T or less of any particular section for tests to conform to relevant Indian Standards. Cost of all tests shall be born by the contractor. All material shall be free from all imperfections, mill scales, slag intrusions, laminations, fittings, rusts etc. that may impair their strength, durability, and appearance.

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- k) The weld surface shall be cleaned with steel wire brush to remove spatter metal, slag etc. and 100% of welds shall be inspected visually for- size, length of weld and external defects. Weld gauges shall be used for checking weld sizes. The surface shall be clean with regular beads and free from slags, cracks, blowholes etc.

Non-destructive examination shall be carried out to determine soundness of weldments as follows:

- i) 10% at random on fillet-joints.
ii) 100% on all butt-joints.

Should the ND tests indicate defects like improper root penetration, extensive blowholes, slag intrusion etc., such welds shall be back gauged, joints prepared again and re-welded. All defects shall be rectified by the Contractor at no extra cost to owner.

All electrodes shall be procured from approved reputed manufacturers with test certificates. The correct grade and size of electrode, which has not deteriorated in storage, shall be used. The inspection and testing of welding shall be performed in accordance with the provisions of the relevant Indian Standards or other equivalents. For every 50 tones of welded fabrication, the Engineer may ask for I (one) test-destructive or non-destructive including X -ray, ultrasonic test or similar, the cost of which shall be borne by the Contractor.

- l) Rivets, bolts, nuts and washers

All rivets, bolts, nuts, and washers shall be of approved make and shall confirm to the relevant Indian Standards. If desired by the Engineer, representative samples of these materials may have to be tested in an approved laboratory and in accordance with the procedures described in relevant Indian Standards. Cost of all such testing shall have to be borne by the Contractor. In addition to testing the rivets by hammer, 2% (two per cent) of the rivets done shall have to be cut off by chisels to ascertain the fit, quality of material and workmanship. The removal of the cut rivets and re-installing new rivets shall be done by the Contractor at his own cost.

- m) Shop painting

All paints and primers shall be of standard quality and procured from approved manufacturers and shall conform to the provisions of the relevant Indian Standards.

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n) Galvanizing

All galvanizing shall be uniform and of standard quality when tested in accordance with IS: 2633 - Method for testing uniformity of coating on Zinc Coated Articles and 15: 4759 - specification for Hot-Dip Zinc Coatings on Structural Steel & other allied products.

1.5.2 Testing

1.5.2.1 General

Loading tests shall be carried out on erected structures, if required by the Engineer, to check adequacy of fabrication and/or erection. Any structure or a part thereof found to be unsuitable for acceptance as a result of the test shall have to be dismantled and replaced with suitable member as per the Contract and no payment towards the cost of the dismantled portion and any connected work shall be made to the contractor. In course of dismantling, if any damage is done to any other parts of the structure or to any fixtures, the same shall be made good free of cost by the Contractor, to the satisfaction of the Engineer. The Cost of the tests specified hereinafter shall be borne by the Owner; but if the structure fails to pass the tests, the cost of the tests shall be recovered from the Contractor. Any extra claim due to loss of time, idle labour, etc. arising out of these testing operations shall not be entertained, however, only reasonable and appropriate time extensions will be allowed.

The structure or structural member under consideration shall be loaded with its actual dead load for as long a time as possible before testing and the tests shall be conducted as indicated in the following clauses. The method of testing and application of loading shall be as approved by the Engineer.

1.5.2.2 Stiffness Test

In this test, the structure or member shall be subjected, addition to its actual dead load, to a test load equal to 1.5 times the specified superimposed load, and this loading shall be maintained for 24 hours. The maximum deflection attained during the test shall be within the permissible limit. If, after removal of the test load, the member or structure does not show a recovery of at least 80 per cent of the maximum strain or deflection shown during 24 hours under load, the test shall be repeated. The structure or member shall be considered to have sufficient stiffness, provided that the recovery after this

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second test is not less than 90 per cent of the maximum increase in strain or deflection recorded during the second test.

1.5.2.3 Strength Test

The structure or structural member under consideration shall be subjected, in addition to its actual dead load, to a test load equal to the sum of the dead load and twice the specified superimposed load, and this load shall be maintained for 24 hours.

In the case of wind load, a load corresponding to twice the specified wind load shall be applied and maintained for 24 hours, either with or without the vertical test load for more severe condition in the member under consideration or the structure as a whole. Complete tests under both conditions may be necessary to verify the strength of the structure. The structure shall be deemed to have adequate strength if, during the test, no part fails and if on the removal of the test load, the structure shows a recovery of at least 20 per cent of the maximum deflection or strain recorded during the 24 hours under load.

1.5.2.4 Structure of same design

Where several structures are built to the same design and it is considered unnecessary to test all of them, one structure, as a prototype, shall be fully tested, as described in previous Sub-clauses, but in addition, during the first application of the test load, particular note shall be taken of the strain or deflection when the test load 1.5 times the specified superimposed load has been maintained for 24 hours. This information is required as a basis of comparison in any check test carried out on samples of the structure.

When a structure of the same type is selected for a check test, it shall be subjected, in addition to its actual dead load, to a superimposed test load, equal to 1.5 time the specified live load, in a manner and to an extent prescribed by the Engineer. This load shall be maintained for 24 hours, during which time, the maximum deflection shall be recorded. The check test shall be considered satisfactory, provided that the maximum strain or deflection recorded in the check test does not exceed by more than 20% of the maximum strain or deflection recorded at similar load in the test on the prototype.

1.5.2.5 Repair for subsequent test and use after strength tests

An actual structure, which has passed the “Strength Test” and is subsequently to be erected for use, shall be considered satisfactory for use after it has been strengthened by replacing any distorted members and has subsequently satisfied the “Stiffness Test”.

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1.5.2.6 Fillet Welds

- a) Check for size and visual examination.
- b) Macrotech examination on production test coupons for main fillet welds with minimum one joint per built up beams, columns and crane girder etc.
- c) 25% weld length of tension member of crane girder shall be subjected to Dye Penetration Test (DPT)
- d) On all other fillet welds, DPT on 5% of weld length with minimum 300mm at each location shall be carried out.

1.5.2.7 Butt Welds

- a) 100% visual examination
- b) DPT on all butt welds after back gouging
- c) Mechanical testing of production test coupons with minimum one joint per built up beam, column and crane/gantry girder.
- d) 100% radiography test on butt welds of tension flange (bottom flange) of crane/gantry girder. All other butt welds shall be subjected to Radiography Test (RT) on 10% weld length of each welder. Wherever RT is not feasible, UT shall be carried out.
- e) Minimum 300mm length will be spot radio-graphed. When radiograph is not possible ultrasonic test will be carried out after grinding the surface with prior approval of Engineer.
- f) Full penetration welds (other than butt welds) shall be subjected to Ultrasonic Testing in following quantum:
 - i) 100% UT on web to flange joint of crane/gantry girder.
 - ii) 10% UT on other full penetration joints.

1.5.2.8 Coal Bunker/Bins

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- a) 10% DPT after back gouging.
- b) 5% spot radiography test on butt welds where access not available. UT shall be carried out with prior approval of Owner.
- c) In case of failure of any welds in SPOT RT/UT, the %age for retesting shall be doubled at that particular location. Acceptance criteria of Non Destructive Tests (NOT) on welds shall be as per AWS D1.1.

1.5.3 Tolerances

1.5.3.1 General

All structure components/members shall be checked for dimensional tolerances during fabrication and erection as given below.

a) Fabrication tolerances

- i) Maximum permissible gap in built up members
- ii) Maximum permissible deviation in depth and/or width of girder at the joints
- iii) Maximum permissible out-of-square of flanges in built-up girders
- iv) Tolerances on length of beams and girders and their components
- v) Permissible deviation in column heights

All tolerances for above shall be as per IS: 7215

Tolerance on dimensions of individual rolled steel components shall be as specified in IS: 1852.

b) Erection tolerances

All tolerances shall be as per IS: 12843

- i) Permissible tolerances in erected steel columns

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- ii) Permissible tolerances in erected steel trusses
 - iii) Permissible tolerances in crane/gantry girder and rails
 - iv) Permissible tolerance limit for building with cranes shall be as listed below in the table.

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Permissible Tolerance limits For Buildings Containing Cranes:

Component	Description	Variation Allowed
I.	2.	3.
Main columns	<p>a) shifting of column axis at foundation level with respect to building line</p> <p>i) In longitudinal direction ii) In lateral direction mm</p> <p>b) Deviation of both major column axis from vertical between foundation and other member connection levels</p> <p>i) For a column up to and including 10M height ii) For a column greater than 10M but less than 40M height</p> <p>c) For adjacent pairs of columns across the width of the building prior to placing of truss</p> <p>d) For any individual column deviation of any bearing or resting level from levels shown on drawings.</p> <p>e) For adjacent pairs of columns either across the width of building or longitudinally level difference allowed between bearing or seating</p>	<p>i) ± 3.0 mm ii) ± 3.0</p> <p>i) ± 3.5mm from true vertical ii) ± 3.5 mm from true vertical for any 10M length -measured between connection levels, but not more than 1 ± 7 mm per 30m length.</p> <p>± 9.0 mm on true span.</p> <p>± 3.0 mm</p> <p>3.0mm</p>



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Component	Description	Variation Allowed
I.	2.	3.
Trusses	a) Deviation at centre of span of upper chord member from vertical plane running through centre of bottom chord b) Lateral displacement of top chord at center of span from vertical plane running through center of supports	1/1500 of the span or not greater than 10mm whichever is the least., 1/250 of depth of truss or 20 mm which ever is the least.
Crane Girders	a) Difference in levels of crane rail measured between adjacent columns. b) Deviation to crane rail gauge c) Relative shifting of ends of adjacent crane rail in plan and elevation after thermite welding. d) Deviation of crane rail axis from centre line of web.	2.0mm ±3.0mm 1mm ±3.5 mm
Setting of Expansion gaps	At the time of setting of the expansion gaps, due regard shall be taken of the ambient temperature above or below 30° C. The coefficient of expansion or contraction shall be taken as 0.000012 per° C per unit length.	

c) Requirement of pre-heating

Thickness of thickest part at the point of welding electrodes	Welding using other than low hydrogen welding electrodes IS : 2062	Welding using low hydrogen welding electrodes or submerged arc welding IS:2062
Upto 20 mm	None	None

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(including)

Over 20 mm to 40 mm 66°C 20°C
(including)

Over 20 mm to 63 mm Not allowed 00°C
(including)

Over 63 mm Not allowed 110°C

The tolerances for Embedded part in concrete shall be as specified in technical specification for concrete works.

1.5.4 Quality Assurance Program

The Contractor shall submit and finalise a detailed Field Quality Assurance Programme within 30 days from the date of award, before commencement of the work, according to the requirements of the specification. This shall include setting up of a testing laboratory, arrangement of testing apparatus/ equipment, deployment of qualified/ experienced manpower, preparation of format for record, field quality plan, etc. On finalised field quality plan, the Owner shall identify, customer hold points beyond which work shall not proceed without written approval from the Owner.

The contractor shall establish and maintain quality control procedures for different items of work and materials as may be directed by the Engineer to assure compliance with the provisions of the Contract and shall submit the records of the same to the Engineer. The quality control operation shall include but not be limited to the following items of work:

- i) Erection: Lines, levels, grades, plumbs, joint characteristics including tightness of bolts.
- ii) Grouting: Cleaning and roughness of foundation, quality of materials used for grouting, admixtures, consistency, and strength of grout.
- iii) Painting: Preparation of surface for painting, quality of primers and paints, thinners, application and uniformity of coats.

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

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- a) The quality control procedure shall cover but not be limited to the following items of work: -
- i) Steel : Quality, manufacturer's test certificates, test reports of representative samples of materials from unidentified stocks if permitted to be used.
 - ii) Bolts, Nuts & Washers : Manufacture's certificate, dimension checks, material testing.
 - iii) Electrodes : Manufacturer's certificate, thickness and quality of flux coating.
 - iv) Welders : Qualifying Tests
 - v) Welding Sets : Performance Tests
 - vi) Welds : Inspection, X-ray, Ultrasonic tests
 - vii) Paints : Manufacturer's Test certificate, physical inspection reports
 - viii) PTFE bearings, Neoprene Bellow Strap : Manufacturer's Test certificate, physical inspection reports
- b) The dimensions, forms, weights and tolerances of all rolled shapes , bolts, nuts, studs, washers etc. and other members used in the fabrication of any structure shall, wherever applicable, conform to the requirements of the latest relevant Indian Standards, wherever they exist or in the absence of Indian Standards to other equivalent standards.

1.5.5 Acceptance Criteria

Should any structure or part of a structure be found not to comply with any of the provisions of this specification, the same shall be liable to rejection. No Structure or part of the structure once rejected, shall be offered again for test, except in cases where the Engineer considers the defects rectifiable. The Engineer may, at his discretion, check some of the tests at an appropriate laboratory at the contractor's cost.

When all tests to be performed in the Contractor's shop under the terms of this contract have been successfully carried out, the steelwork will be accepted forthwith and the

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Engineer will issue acceptance certificate, upon receipt of which, the items will be shop painted, packed and dispatched. No item to be delivered unless an acceptance certificate for the same has been issued. The satisfactory completion of these tests or the issue of the certificates shall not bind the Owner to accept the work, should it, on further tests before or after erection, be found not in compliance with the Contract.

Structures and members have passed the tests and conform to all requirements specified in the foregoing clauses and other applicable provisions of this specification and are within the limits of tolerances specified in relevant clauses and/or otherwise approved by the Owner shall be treated as approved and accepted for the purpose of fulfillment of the provisions of this contract.

1.5.6 Delivery of Materials

1.5.6.1 General

The Contractor will deliver the fabricated structural steel materials to site with all necessary field connection materials in such sequence as will permit the most efficient and economical performance of the erection work. The Owner may prescribe or control the sequence of delivery of materials, at his own discretion.

The Contractor shall take delivery of fabricated structural steel and necessary connection materials from railhead/trucks as may be necessary and as directed by the Engineer. He shall check, unload; transport the materials to his stores for proper storing at his own cost. The Contractor shall submit claims to insurance or other authorities and pursue the same in case of loss or damage during transit and handling and all loss thereof shall be borne by him.

The Contractor shall also take all precautions against damage of the materials in his custody after taking delivery and till the same are erected in place and accepted. The Contractor shall salvage, collect, and deliver all the packing materials to the Owner free of charge.

1.5.6.2 Marking

Each separate piece of fabricated steelwork shall be distinctly marked on all surfaces before delivery in accordance with the markings shown on approved erection drawings and shall bear such other marks as- will further facilitate identification and erection.

1.5.6.3 Shipping

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Shipping shall be strictly in accordance with the sequence stipulated in the agreed Programme. Contractor shall dispatch the materials to the work site securely protecting and packing the materials to avoid loss or damage during transport by rail, road or water. All parts shall be adequately braced to prevent damage in transit.

Each bundle, bale or package delivered under this contract shall be marked on as many sides as possible and such distinct marking (all previous irrelevant markings being carefully obliterated) shall show the following:

- Name and address of the consignee
- Name and address of the consignor
- Gross weight of the package in tonnes and its dimensions
- Identification marks and/or number of the package
- Custom registration number, if required

All markings shall be carried out with such materials as would ensure quick drying and indelibility.

Each component or part or piece of material when shipped, shall be indelibly marked and/or tagged with reference to assembly drawings and corresponding piece numbers.

Each packing case shall contain in duplicate in English a packing list pasted on to the inside of the cover in a water-proof envelope, quoting especially

- Name of the Contractor
- Number and date of the Contract
- Name of the office placing the contract
- Nomenclature of stores
- A schedule of parts or pieces, giving the parts or piece number with reference to assembly drawings and the quantity of each.

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The shipping dimensions of each packing shall not exceed the maximum dimensions permissible for transport over the Indian Railways/Roads.

After delivery of the materials at site, all packing materials shall automatically become the property of the Owner.

Notwithstanding anything stated herein before, any loss or damage resulting from inadequate packing shall be made good by the Contractor at no additional cost to the Owner. When facilities exist, all shipments shall be covered by approved Insurance Policy for transit at the cost of the Contractor.

The contractor shall ship the complete materials or part on board a vessel belonging to an agency approved by the owner or on rail and/or road transport as directed. The Contractor- shall take all reasonable steps to ensure correct appraisal of freight rates, weights and volumes and in no case will the Owner be liable to pay any warehouse, wharf age, demurrage and other charges.

If, however, the Owner has to make payment of any of the above-mentioned charges, the amount paid will be deducted from the bills of the Contractor.

Necessary advice regarding the shipment with relevant details shall reach the Engineer at least a week in advance.

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