D.8.1 **SCOPE**

D.8.1.1 This specification covers the general requirements for supply where specified, fabrication and delivery at site of structural steel. Section C covers the specific requirements for the project. The two parts are complementary and are to be read together for a correct interpretation of the provisions of this specification. Where requirements of the two parts conflict, those of Section C shall govern.

D.8.1.2 This specification also covers design of all connections and substituted members, preparation of all shop fabrication drawings, inspection and shop painting of structures.

D.8.2 **APPLICABLE CODES & SPECIFICATIONS:**

The following specifications, standards and codes are made a part of specification. All standards, specifications and codes of practices referred to herein shall be the latest editions including all applicable official amendments and revisions.

In case of discrepancy between this specification and other documents referred to herein, this specification shall govern.

**a) Materials**

i) IS : 808 Dimensions for Hot Rolled Steel sections

ii) IS: 814 Covered Electrodes for Manual Metal Arc Welding of Carbon and Carbon Manganese Steel

iii) IS: 1161 Steel Tubes for structural purposes

iv) IS : 1239 Mild steel tubes, tubulars and other Wrought steel fittings
    Part 1 - Mild steel tubes
    Part 2 - Mild steel Tubulars and other wrought steel pipe fittings

v) IS : 1363 Hexagon Head Bolts, Screws and Nuts of product (Parts I to 3) Grade C (Size range M5 to M64)

vi) IS: 1367 Technical Supply Conditions for Threaded Fasteners (All Parts)

vii) IS: 1852 Rolling and Cutting Tolerances for Hot Rolled Steel Products.

viii) IS : 1977 Structural Steel (Ordinary Quality)

xi) IS : 2062 Steel for General Structural Purposes
x) IS : 2074  Ready Mixed Paint, Air drying, Red Oxide Zinc Chrome and Priming

xi) IS : 3502  Steel Chequered Plate

xii) IS : 3757  High Strength Structural Bolts

xiii) IS : 5369  General Requirements for Plain Washers and Lock Washers.

xiv) IS : 5372  Taper Washers for Channels

xv) IS : 5374  Taper Washers for Channels

xvi) IS : 6610  Heavy Washers for Steel Structures

xvii) IS : 8500  Structural Steel-microalloyed (medium and high strength qualities)

b) Codes of Practice

i) IS : 800  Code of Practice for General Construction in Steel


iii) IS : 803  Code of practice of design, fabrication and erection of vertical mild steel cylindrical welded storage tanks.

iv) IS : 806  Code of practice for use of steel tubes in general building construction

v) IS : 816  Code of practice for use for Metal Arc Welding for General construction in Mild Steel

vi) IS : 822  Code of procedure for Inspection of Welds


viii) IS : 1200  Method of Measurement in Building Civil Engineering Works.

ix) IS : 1477  Code of practice for painting of (parts 1 & 2) Ferrous Metals in Buildings

x) IS : 2595  Code of practice for Radiographic Testing

xi) IS : 3658  Code of practice for Liquid Penetrant Flaw Detection
xii) IS : 4000 High strength bolts in Steel Structures – Code of practice

xiii) IS : 5334 Tolerance for Fabrication of Steel Structures

xv) IS : 9595 Recommendations for Metal Arc Welding of Carbon and Carbon manganese Steel

D.8.3 STEEL MATERIALS

Steel materials shall comply with the specifications laid down under clause 2.0 and/or as called for on the design drawings.

All materials used shall be new, unused and free from defects.

Steel conforming to IS : 1977 shall be used only for the following:

Fe310 (St 32-0) : for general purposes such as door / window frames, grills, steel gates, handrails, fence posts, tee bars and other non-structural use.

Fe310 (St 32-0) : for structures not subjected to dynamic loading other than wind loads such as:
Platform roofs, foot over bridges, building, factory sheds etc.

Fe410-0 (St 42-0): grade steel shall not be used

a) if welding is to be employed for fabrication.

b) if site is in severe earthquake zone.

c) if plastic theory of design is used.

D.8.4 USE OF STEEL SUPPLIED BY THE PURCHASER

The VENDOR/CONTRACTOR shall use steel supplied by the PURCHASER judiciously and to the best advantage so as to minimise splicing and wastage. All steel materials remaining after completion of the report, whether in the form of balance pieces or unutilised prime steel, shall be returned to the PURCHASER’S stores by the VENDOR/CONTRACTOR at his own cost. An unaccountable wastage up to a maximum of 1% of the fabricated steel will be allowed. This wastage does not include the balance cut lengths/pieces of steel returned to the PURCHASER.
D.8.5 DRAWINGS PREPARED BY THE OWNER

D.8.5.1 Design drawings will be furnished to the VENDOR/CONTRACTOR and all drawings so furnished shall form a part of this specification. These design drawings prepared by the ENGINEER will show all the, levels, forces on members where shall necessary, size and orientation of each member, location/size of openings, to enable the VENDOR/CONTRACTOR to prepare drawings for fabrication and erection. It shall be clearly understood that these drawings are not intended to show connection details, thickness of members, cuts, notches, bends and such other details.

D.8.5.2 The ENGINEER reserves the right to make changes. Revisions to drawings, even after release for preparation of shop drawings, are very likely to be made to reflect additional data/details received and updated requirements. Revisions to drawing and any new drawings made to include additional work by the VENDOR/CONTRACTOR shall be considered a part of this specification and contract. The PURCHASER shall not entertain any extra claims on this account.

D.8.5.3 Where the fabrication drawings are to be furnished by the ENGINEER, he will issue to the VENDOR/CONTRACTOR the required copies of such drawings in the sequence required for the fabrication of the components in the order they will be required to be erected at site. Such drawings will be issued in such numbers as required for the VENDOR/ CONTRACTOR to adhere to the project schedule.

D.8.5.4 Should the VENDOR/CONTRACTOR during the execution of his work. Find discrepancies in the information furnished by the ENGINEER, he shall refer such discrepancies to the ENGINEER before proceeding with such work.

D.8.6 DRAWINGS PREPARED BY THE VENDOR/CONTRACTOR

D.8.6.1 The VENDOR/CONTRACTOR shall prepare all fabrication and erection drawings for the entire work. All the drawings for the entire work shall be prepared in metric units. The drawings shall preferably be of one standard size and the details shown there in shall be clear and legible.

D.8.6.2 The VENDOR/CONTRACTOR shall not commence detailing unless ENGINEER’S design drawings are officially released for preparation of shop drawings. The VENDOR/CONTRACTOR shall be responsible for the correctness of all fabrication drawings. Fabrication drawings shall be revised by the VENDOR/CONTRACTOR to reflect all revisions in design drawings as and when such revisions are made by the ENGINEER.

D.8.6.3 All fabrication drawings shall be submitted to the ENGINEER for approval.

D.8.6.4 No fabrication drawings will be accepted for ENGINEER’S approval unless checked and approved by the VENDOR/CONTRACTOR’S qualified structural engineer and accompanied by an erection plan showing the location of all pieces detailed. The VENDOR/CONTRACTOR shall ensure that connections are detailed to obtain ease in erection of structures and in making field connections.
D.8.6.5 Fabrication shall be started by the VENDOR/CONTRACTOR only after ENGINEER’S approval of fabrication drawings. Approval by the ENGINEER of any of the drawings shall not relieve the VENDOR/CONTRACTOR from the responsibility for correctness of engineering & design of connections, workmanship, fit of parts, details, material, errors or omissions of any and all work shown thereon. The ENGINEER’S approval shall constitute approval of the size of members, dimensions and general arrangement but shall not constitute approval of the connections between members and other details.

D.8.6.6 The drawings prepared by the VENDOR/CONTRACTOR and all subsequent revisions etc. shall be at the cost of the VENDOR/CONTRACTOR for which no separate payment will be made.

D.8.7 FABRICATION

D.8.7.1 General:

All workmanship and finish shall be of the best quality and shall conform to the best approved method of fabrication. All materials shall be finished straight and shall be machined/ground smooth true and square where so specified. All holes and edges shall be free of burrs. Shearing and chipping, shall be neatly and accurately done and all portions of work exposed to view shall be neatly finished. Unless otherwise directed/approved, reference may be made to relevant IS codes for providing standard fabrication tolerance. Material at the shops shall be kept clean and protected from weather.

D.8.7.2 Connections:

D.8.7.2.1 Shop/field connections shall be as per approved fabrication drawings.

D.8.7.2.2 In case of bolted connections, taper washers or flat washers or spring washers shall be used with bolts as necessary. In case of high strength friction grip bolts, hardened washers be used under the nuts or the bolt heads whichever are turned to tighten the bolts. The length of the bolt shall be such that atleast one thread of the bolt projects beyond the nut, except incase of high strength friction grip bolts where this projection shall be atleast three times the pitch of the thread.

D.8.7.2.3 In all cases where bearing is critical, the unthreaded portion of bolt shall bear on the members assembled. A washer of adequate thickness may be provided to exclude the threads from the bearing thickness, if a longer grip bolt has to be used for this purpose.

D.8.7.2.4 All connections and splices shall be designed for full strength of members or loads indicated on ENGINEER'S design drawings. Column splices shall be designed for the full tensile strength of the minimum cross section at .the splice.

D.8.7.2.5 All bolts, nuts, washers, electrodes, screws etc. shall be supplied/brought to site 10% in excess of the requirement in each category and size. Rates shall cover the cost of this extra quantity.
D.8.7.2.6  All members likely to collect rainwater shall have drain holes provided.

D.8.7.3  **Straightening**:

All materials, shall be straight and, if necessary, before being worked shall be straightened and/or flattened by pressure and shall be free from twists. Heating or forging shall not be resorted to without the prior approval of the ENGINEER in writing.

D.8.7.4  Cutting, punching, drilling, welding and fabrication tolerances shall be generally as per relevant IS codes.

D.8.7.5  **Rolling and Forming**:

Plates, channels, R.S.J. etc. for circular bins, bunkers, hoppers, gantry girders, etc. shall be accurately laid off and rolled or formed to required profile/shape as called for on the drawings. Adjacent sections shall be match-marked to facilitate accurate assembly, welding and erection in the field.

D.8.7.6  **High Strength Friction Grip Bolting**:

D.8.7.6.1  Inspection after tightening of bolts shall be carried out as stipulated in the appropriate standards depending upon the method of tightening and the type of bolt used.

D.8.7.7  **Welding**:

D.8.7.7.1  Welding procedure shall be submitted to ENGINEER for approval. Welding shall be entrusted to only qualified and experienced welders who shall be periodically tested and graded as per IS : 817, IS : 7310 (Part 1) and IS : 7318 (Part 1).

D.8.7.7.2  While fabricating plated 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 members. Wherever weld reinforcement interferes with proper fit-up between components to be assembled for welding, these welds shall be ground flush prior to assembly.

D.8.7.7.3  Approval of the welding procedure by the ENGINEER shall not relieve the CONTRACTOR of his responsibility for correct and sound welding without undue distortion in the finished structure.

D.8.7.7.4  No welding shall be done when the surface of the members is wet nor during periods of high wind.

D.8.7.7.5  Each layer of a multiple layer weld except root and surfaces runs may be moderately peened with light blows from a blunt tool. Care shall be exercised to prevent scaling or flaking of weld and base metal from overpeening.

D.8.7.7.6  No welding shall be done on base metal at a temperature below - 5 Deg. C. Base metal shall be preheated to the temperature as per relevant IS codes.
D.8.7.7 Electrodes other than low-hydrogen electrodes shall not be permitted thickness of 32 mm and above.

D.8.7.8 Inspection of Welds

All welds shall be inspected for flaws by any of the methods described under clause 8 “Inspection”. The choice of the method adopted shall be determined by the PURCHASER/ENGINEER.

D.8.7.9 The correction of defective welds shall be carried out as directed by the ENGINEER without damaging the parent metal. When a crack in the weld is removed, magnetic particle inspection or any other equally positive means as prescribed by the ENGINEER shall be used to ensure that the whole of the crack and material upto 25 mm beyond each end of the crack has been removed. Cost of all such tests and operations incidental to correction shall be to the VENDOR/CONTRACTOR’S account.

D.8.8 Tolerances

The dimensional and weight tolerances for rolled shapes shall be in accordance with IS: 1852 for indigenous steel and equivalent applicable codes for imported steel. The tolerances for fabrication of structural steel shall be as per IS:7215.

D.8.9 End Milling

Where compression joints are specified to be designed for bearing, the bearing surface shall be milled true and square to ensure proper bearing and alignment.

D.8.8.1 INSPECTION :

D.8.8.1.1 The VENDOR/CONTRACTOR shall give due notice to the PURCHASER/ENGINEER in advance of the works getting ready for inspection. All rejected material shall be promptly removed from the shop and replaced with new material for the PURCHASER’S/ENGINEER’S approval/inspection. The fact that certain material has been accepted at the VENDOR/CONTRACTOR’S shop shall not invalidate final rejection at site by the PURCHASER/ENGINEER if it fails to conform to the requirements of these specifications, to be in proper condition or has fabrication inaccuracies which prevents proper assembly nor shall it invalidate any claim which the PURCHASER may make because of defective or unsatisfactory materials and/or workmanship.

D.8.8.1.2 No materials shall be painted or dispatched to site without inspection and by the PURCHASER/ENGINEER unless such inspection is waived in writing by the ENGINEER.

D.8.8.1.3 The VENDOR/CONTRACTOR shall provide all the testing and inspection services and facilities for shop work except where otherwise specified.
D.8.8.1.4 For fabrication work carried out in the field the same standard of supervision and quality control shall be maintained as in shop fabricated work. Inspection and testing shall be conducted in a manner satisfactory to the Engineer.

D.8.8.2 Inspection and tests on structural steel members shall be as set forth below:

D.8.8.2.1 Material Testing
If mill test reports are not available for any steel materials the same shall be got tested by the VENDOR/CONTRACTOR to the ENGINEER’S satisfaction to demonstrate conformity with the relevant specification.

D.8.8.3 Tests on Welds

D.8.8.3.1 Magnetic Particle Test
Where welds are examined by magnetic particle testing, such testing shall be carried out in accordance with relevant IS codes. If heat treatment is performed, completed weld shall be examined after the heat treatment. All defects shall be repaired and re-tested. Magnetic particle tests shall be carried out using alternating current. Direct current may be used with the permission of the ENGINEER.

D.8.8.3.2 Liquid Penetrant Inspection
In the case of welds examined by Liquid Penetrant Inspection, such tests shall be carried out in accordance with relevant IS Code. All defects shown shall be repaired and rechecked.

D.8.8.3.3 Radiographic Inspection
All full strength butt welds shall be radiographed in accordance with the recommended practice for radiographic testing as per relevant IS code.

D.8.8.4 Dimensions, Workmanship & Cleanliness
Members shall be inspected at all stages of fabrication and assembly to verify that dimensions, tolerances, alignment, surface finish and painting are in accordance with the requirements shown in the VENDOR / CONTRACTOR’s approved fabrication drawings and the ENGINEER’s drawings.

D.8.8.5 Test Failure
In the event of failure of any member to satisfy inspection or test requirement, the CONTRACTOR shall notify the ENGINEER or his authorised representative. The VENDOR/CONTRACTOR must obtain permission from the ENGFNEER before repair is undertaken. The quality control procedures to be followed to ensure satisfactory repair shall be subject to approval by the ENGINEER.

D.8.8.6 The ENGINEER has the right to specify additional testing as he deems necessary, and the additional cost of such testing shall be borne by the PURCHASER, only in case of successful testing.
D.8.8.7 The VENDOR/CONTRACTOR shall maintain records of all inspection and testing which shall be made available to the ENGINEER or his authorised representative.

D.8.9 SHOP MATCHING:

For structures like bunkers, tanks, etc. shop assembly is essential. For other steelwork, such as columns along with the tie beams/bracings may have to be shop assembled to ensure satisfactory fabrication, obtaining of adequate bearing areas etc. if so desired by the ENGINEER. All these shop assemblies shall be carried out by VENDOR/CONTRACTOR at no extra cost to the PURCHASER.

D.8.10 DRILLING HOLES FOR OTHER WORKS:

As a part of this Contract, holes in members required for installing equipment or steel furnished by other manufacturers or other contractors shall be drilled by the VENDOR/CONTRACTOR at no extra cost to the PURCHASER. The information for such extra holes will be supplied by the PURCHASER/ENGINEER.

D.8.11 MARKING OF MEMBERS:

D.8.11.1 After checking and inspection, all members shall be marked for identification during erection. This mark shall correspond to distinguishing marks on approved erection drawings and shall be legibly painted and stamped on it. The erection mark shall be stamped with a metal dye with figures at least 20 mm high and to such optimum depth as to be clearly visible.

D.8.11.2 All erection marks shall be on the outer surface of all sections and near one end, but clear of bolt holes. The marking shall be so stamped that they are easily discernible when sorting out members. The stamped marking shall be encircled boldly by a distinguishable paint to facilitate easy location.

D.8.11.3 Erection marks on like pieces shall be in identical locations. Members having lengths of 7.0 m or more shall have the erection mark at both ends.

D.8.12 ERRORS

Any error in shop fabrication which prevents proper assembling and fitting up of parts in the field by moderate use of drift pins or moderate amount of reaming will be classified by the ENGINEER as defective workmanship. In case ENGINEER rejects such material or defective workmanship, the same shall be replaced by the materials and workmanship conforming to the ENGINEER’S requirements by VENDOR/CONTRACTOR free of cost at site.

D.8.13 PAINTING

All fabricated steel material, except those galvanised shall receive protective paint coating as specified in specification.
D.8.14  METHOD OF MEASUREMENT

D.8.14.1 For the purpose of payment, the weight of the actual completed structures shall be calculated from the approved drawings for different items of work. The VENDOR/ CONTRACTOR shall submit to the PURCHASER relevant material list containing weight of each item.

D.8.14.2 No allowances will be permitted for bolts, nuts, washers, studs, screws etc, galvanizing, welding or for rolling margins. One tonne for the purpose of payment shall mean ONE METRIC TONNE i.e. 1000 Kg.

D.8.14.3 The weight of a member made out of standard rolled section such as beams, channels, angles, etc. shall be based on the standard IS:808 without deductions for holes, notches, bevel cuts, etc. Where a component consists of a cut joist or channels, the full weight of the rolled section shall be considered only if more than half the depth of the original section is used. Otherwise, only half the section unit weight shall be considered for calculation of the weight of the components. Deduction shall be made in the weight of gussets /plates of cuts and notches of 900 sq.cm or larger.

D.8.14.4 For gussets / plates used in trusses, bracings, columns, beams, etc, the area shall be that of the minimum circumscribing rectangle except as stated in 14.3 above.

D.8.14.5 The weight of any built-up members shall be based on the weight of each component.