

SECTION 05100 - STRUCTURAL STEEL MATERIALS, FABRICATION & ERECTION

1.0 SCOPE OF THE WORK

- 1.1. The work included under this Section shall consist of furnishing all labor, tools, equipment, materials, services, and supervision necessary to perform connection design, prepare shop drawings, supply materials, shop fabricate, inspect, and deliver complete, all structural steel indicated on the drawings and/or as described in this Specification.
- 1.2. Except as modified herein, all requirements of Paragraph 1.1 shall be in accordance with the requirements of the American Institute of Steel Construction Specification for Structural Steel Buildings - Allowable Stress Design and Plastic Design (AISC Specification).
- 1.3. The work includes, but is not limited to, the following:
 - a. Design and detailing of all connections.
 - b. Fabrication, coating, touch-up and testing of all structural steel. The structural steel includes, but is not limited to, the following:
 - Columns
 - Beams
 - Braces
 - Stairs
 - Handrail
 - Grating
 - Floor Plate
 - c. All connections and their component parts for the above items.
 - d. Any additional structural or miscellaneous steel work required for proper completion of the work, unless specified under other sections.
- 1.4. Anchor bolts for structural steel shall be furnished by the Contractor as provided by Section 03150 - “Anchor Bolts and Embedded Items”.

2.0 APPLICABLE SPECIFICATIONS

- 2.1. The Fabrication Contractor shall follow the practices and standards described in the latest edition of the following specifications, which are made a part of this Specification.
- a. American Institute of Steel Construction (AISC):

Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings

Code of Standard Practice for Steel Buildings

Specification for Structural Joints Using ASTM A325 Bolts or A490 Bolts.
 - b. American Iron and Steel Institute:

Specification for the Design of Cold-Formed Steel Structural Members
 - c. American National Standards Institute (ANSI):

A14.3 Safety Requirements for Fixed Ladders

B18.22.1 Plain Washers

B46.1 Surface Texture (Surface Roughness, Waviness, and Lay)
 - d. The American Society for Testing and Materials (ASTM):

A36 Standard Specification for Carbon Structural Steel.

A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

A143 Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement

A307 Standard Specification for Low-Carbon Steel Externally & Internally Threaded Standard Fasteners

A325	Standard Specification for High-Strength Bolts for Structural Steel Joints, Including Suitable Nuts and Plain Hardened Washers.
A384	Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies
A385	Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip)
A490	Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength
A500	Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
A501	Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
A563	Standard Specification for Carbon and Alloy Steel Nuts
A992	Standard Specification for Steel for Structural Shapes For Use in Building Framing
A1011	Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability
F436	Standard Specification for Hardened Steel Washers

e. American Welding Society (AWS):

D.1.1 Structural Welding Code

f. All applicable local and state codes and regulations.

3.0 SUBMITTALS

3.1. The Contractor shall submit, as a minimum, the following documents for review and approval prior to the start of fabrication:

- a. Erection and shop drawings
 - b. Quality Control Program and Inspection Procedures
 - c. Welding Procedures
 - d. Welding Procedure Qualification Test Reports
- 3.2. A Shipping List (including total weight), a Bolt List, and a minimum of two sets of final erection and shop drawings shall accompany the first shipment of each release.
- 3.3. All final, as fabricated, erection and shop detail drawings, stamped "Certified for Construction" shall be sent prior to or concurrent with shipment of the fabricated steel.
- a. Three sets of final erection and shop drawings
- 3.4. The Contractor shall submit, as a minimum, the following documents for record purposes:
- a. Records of Quality Control inspection test reports-

4.0 QUALITY ASSURANCE

- 4.1. All work covered by this specification shall conform to the AISC Code of Standard Practice for Steel Buildings and Bridges and the AISC Specification for Structural Steel Buildings: Allowable Stress Design and Plastic Design.
- 4.2. The materials and workmanship to be furnished under this specification shall be subject to inspection in the mill and shop by the Owner.
- 4.3. Inspection and acceptance, or failure to inspect, shall in no way relieve the Contractor from his responsibility to furnish materials and workmanship in accordance with contract requirements. When materials and/or workmanship do not conform to the specification requirements, the Owner reserves the right to reject such material and/or workmanship at any time before final acceptance of the structure.
- 4.4. The Contractor shall guarantee free access to the fabrication shop for the purpose of inspecting the steel work.
- 4.5. Inspection of shop welding shall be in accordance with the AISC Specification for Buildings, and high-strength steel shall be marked in accordance with the AISC Specification for Buildings.
- 4.6. The Owner shall be notified well in advance of start of shop work in order to schedule inspections if desired.

- 4.7. Joint welding procedures shall be prequalified or tested in accordance with AWS qualification procedures.
- 4.8. Welders must be currently certified under American Welding Society qualification procedures.
- 4.9. Regulatory Requirements

Unless other requirements of governing authorities or particular requirements of this specification are more stringent, comply with provisions of the following:

- a. AISC Code of Standard Practice for Steel Buildings and Bridges.
 - b. AISC Specification for Design, Fabrication, and Erection of Structural Steel for Buildings, with Commentary and Supplements.
 - c. AWS D1.1 Structural Welding Code - Steel.
- 4.10. Testing and Inspection Agency
 - a. The Owner reserves the right engage an independent testing and inspection agency to perform testing, to inspect and evaluate connections, and prepare test reports.
 - b. Deficiencies in the structural steel work identified by the testing and inspection agency will be corrected at no additional expense to the Owner. Subsequent tests to confirm the adequacy of corrected work will be at the Contractor's expense.

5.0 PERFORMANCE REQUIREMENTS

All work covered by this specification shall conform to the AISC Code of Standard Practice for Steel Buildings and Bridges and the AISC Specification for Structural Steel Buildings: Allowable Stress Design and Plastic Design.

6.0 DRAWINGS

- 6.1. The Contractor shall furnish erection and shop detail drawings pertaining to all shop fabrication and field erection.
 - a. Engineer reviewed and corrected shop detail drawings showing shop welding details and shop connection details.
 - b. Erection drawings shall show the complete structure, field connection details, piece marks, and any field notes contained on the Engineer's drawings.

- c. Shop drawings and erection drawings shall be prepared in accordance with the AISC documents listed in this specification.
- d. Erection drawings shall reference the corresponding design drawings and every steel piece on the shop drawings shall reference the appropriate erection drawing.
- e. Erection and shop drawings shall be grouped in sets and identified separately for each building, structure or area.
- f. Erection drawings shall clearly show the mark number and position for each member.
- g. The Owner's purchase order number shall be shown on all erection and shop drawings.
- h. Shop drawings shall state the welding electrode to be used.
- i. Surface preparation and shop applied coatings, including areas to be masked, shall be noted on the shop drawings.
- j. Contractor shall provide a Bolt List showing the number, grade, size, and length of field bolts for each connection. This Bolt List may be shown on either the shop drawings or on separate sheets.
- k. In the event that drawing revisions are necessary, the Supplier shall clearly flag on the shop drawings all changes showing the latest revisions.
- l. A master shipping list showing the total quantity of each piece, individual section, or assemble required, the piece number, and the drawing on which each piece, section, or assembly is detailed. The master shipping list pages shall be numbered consecutively.

7.0 RECORDS

The records listed below shall be available for examination by the Owner or his representative at the time of inspection:

- a. Mill test reports or certificates of all materials.
- b. Welding procedures and the results of the welding procedure and operator qualification tests.
- c. Pyrometer charts or other detailed records of heat treatment, if applicable.
- d. Certificate of origin of high-strength bolts.

8.0 MATERIALS

- 8.1. All materials shall be new and shall conform to the respective specifications and other requirements listed below:
- 8.2. Structural steel “W”, “WT” and “S” shapes shall conform to ASTM A992, Grade 50. All channels, angles and plates shall conform to ASTM A36, unless noted otherwise.
- 8.3. Hot-formed steel tubing shall conform to ASTM A501.
- 8.4. Cold-formed steel tubing shall conform to ASTM A500, Grade B.
- 8.5. Steel pipe shall conform to ASTM A53, Type E or S, Grade B.
- 8.6. Bolts ½” or smaller in diameter shall conform to ASTM A307. Plain washers conforming to ANSI B18.22.1 shall be provided in connections using these bolts. Bolts, nuts and washers shall be hot dip galvanized.
- 8.7. All bolts ⅝” or larger in diameter shall be high strength bolts conforming to ASTM A325 or A490. Bolts, nuts and washers shall conform to ASTM A325 or A490, ASTM A563 DH, and ASTM F436 respectively. Bolts, nuts and washers shall be hot dip galvanized.
- 8.8. Welding Electrodes for manual shielded metal-arc welding shall conform to the #70XX series of the “Specification for Mild Steel Covered Arc-Welding Electrodes”, AWS A5.1 or the “Specification for Low-Alloy Steel Covered Arc-Welding Electrodes”.
- 8.9. Bar Grating
 - a. Grating shall be welded steel bar type with serrated 1 ¾” x ⅜” bearing bars spaced at 1 ⅜” center to center, unless noted otherwise. Cross bars shall be spaced at 4” center to center. All bearing bars and cross bars shall be welding quality mild carbon steel and shall conform to ASTM A1011.
 - b. Grating shall be attached to the structural framing using mechanically galvanized GFI G-clips as manufactured by Grating Fasteners, Inc. Mechanically galvanized saddle clips may be used at locations in which G-clips are not able to be attached, such as on the web side of a channel.
 - c. No tack welding of grating shall be allowed.

- d. Each piece of grating shall be banded on all sides with $\frac{3}{16}$ " thick galvanized flat bar of the same depth as the grating.
- e. All openings in grating greater than 6" diameter or 6" square shall be banded with continuous $\frac{3}{16}$ " flat bar and shall extend 4" above top of grating. Location of all openings through grating plate shall be coordinated with the respective trade requiring the opening, prior to fabrication.
- f. Grating, where indicated, shall be removable or hinged, and shall be arranged in sizes to be readily lifted. Frames to receive the grating shall be fabricated of structural shapes by welding with exposed welds ground smooth. Both the frames and the grating shall finish flush with the adjacent floors.
- g. Grating shall be fabricated in panels of sizes suitable for delivery and installation.
- h. Grating shall be hot-dip galvanized after fabrication in accordance with the applicable provisions of ASTM A123, A143, A384 and A385. Care shall be taken not to cut grating after galvanizing has been applied. If field modification of the grating is required, all damaged hot-dip areas shall be coated with brush applied ZRC cold galvanizing compound or equal. Minimum dry film thickness to be 2.5 mils achieved in minimum of two applications. Surface preparation shall be in accordance with manufacturer's recommendations.
- i. Exposed ends of grating at ladder entrance shall be banded with a bar the size of the bearing bars. Exposed end of grating at the top of stairs to have nosing to match stair treads.

8.10. Stairs

- a. Steel stairs, complete with structural or formed channel stringers, grating threads, landings, columns, handrails, and necessary bolts and other fastenings shall be constructed in accordance with the metal stair manual of the National Association of Architectural Metal Manufacturers and shall conform to the following requirements:
- b. Stair treads shall be rectangular pattern welded grating with serrated $1\frac{1}{4}$ " x $\frac{3}{16}$ " bearing bars spaced at $1\frac{3}{16}$ " center and bent floor plate nosing. Bars to be welded to $\frac{3}{16}$ " carrier plates and not be supported by carrier angles.
- c. Treads shall be capable of sustaining a superimposed load of 100 pounds per square foot.

- d. Structural steel for framing of landings shall be furnished as part of the stair work.

8.11. Handrails

- a. Steel railings shall be constructed from 1½” diameter, Schedule 40 steel pipe conforming to ASTM A500, Grade 50.
- b. Joints shall be welded joints made by fitting post to top rail and intermediate rail to post, elbow corners, groove welding joints, and grinding smooth. Rail splices shall be butted and reinforced by a tight-fitting interior sleeve not less than 6" long. See structural steel drawings for dimensional details.

9.0 DELIVERY AND STORAGE

- 9.1. Deliver all material to the job site properly piece-marked for identification and corresponding to the markings indicated on the shop drawings.

10.0 FABRICATION

- 10.1. All structural steel shall be in accordance with the lines, dimensions, grades, details, and notes shown on the drawings and as specified herein.
- 10.2. Substitutions of sections or modifications of details, or both, and the reasons therefore, shall be submitted with the shop drawings for approval. Approved substitutions, modifications, and necessary changes in related portions of the work shall be coordinated by the Contractor and shall be accomplished at no additional cost to the Owner.
- 10.3. Structural steel sections shall be continuous in length. No splicing, welding, or joining pieces of short lengths shall be permitted without written approval of the Engineer.
- 10.4. The Contractor shall be responsible for all errors of detailing, fabrication, and for the correct fitting of the structural members.
- 10.5. Generally, camber requirements shall be in accordance with Section L1 of the AISC Specification for Buildings. Special camber requirements, if any, are shown on the drawings.
- 10.6. In general, connections shall be shop welded and field bolted. All welded connections shall be made with E-70 electrodes. All bolted connections shall be made with ¾” diameter A325 H.S. bolts, unless otherwise noted on the design drawings.

10.7. Fabrication shall be in accordance with Section M2 of the AISC Specifications for Buildings. Said Section M2 consists of the following headings:

- M2.1 Cambering, Curving and Straightening
- M2.2 Thermal Cutting
- M2.3 Planing of Edges
- M2.4 Welded Construction
- M2.5 High Strength Bolted Construction - Assembling
- M2.6 Compression Joints M2.7
Dimensional Tolerances
- M2.8 Finishing of Column Bases

10.8. Welds shall be made only by welders who have qualified by tests as prescribed in the “Code for Welding in Building Construction” of the American Welding Society, to perform the type of work required.

10.9. The design of connections for any part of the structure not indicated on the design drawings shall be completed by the Contractor. Unless otherwise shown, all beam connections shall be standard frame or seated connections as shown in Part 4 of the AISC Manual of Steel Construction. Unless greater reactions are indicated on the design drawings, connections shall develop the full “T” distance of the beam web, with a maximum dimension of 3” between rows of bolts. Clip angle connections for beams shall be two sided connections with a minimum clip angle thickness of $\frac{3}{8}$ ” and a minimum bolt size of $\frac{3}{4}$ ”. End connections for bracing shall develop the loads shown on the design drawings or one-half the strength of the member in tension, whichever is greater, but shall in no case include less than 4-bolts for horizontal WT braces, 6-bolts for vertical WT braces and 2-bolts for angle braces.

10.10. All ends of steel members with clip angle(s) attached shall be completely sealed with a $\frac{1}{8}$ ” seal weld. The $\frac{1}{8}$ ” seal weld is in addition to the required structural weld.

10.11. All holes in steel members shall be made by means of cutting, drilling, or punching at right angles to surface of metal. Do not make or enlarge holes by burning.

10.12. All cut, sheared, sawed, or burned edges and shop generated vertical and horizontal corners of all structural members (beams, columns, clip angles, etc.) shall have the edges ground smooth so that a round corner exists.

10.13. All welds shall be uniform in size and shall be in accordance with the AISC Specification for Architecturally Exposed Structural Steel. Welds that do not represent a reasonably smooth surface will be ground.

- 10.14. No pinholes, slag, or burrs shall be left on welds or steel.
- 10.15. Copes of beams shall be rounded and not squared.
- 10.16. Identification of steel by piece-mark shall be by a permanent welded on tag or other Engineer-approved method.
- 10.17. All holes shall be flush with face of steel.
- 10.18. Stiffeners, gusset plates, and like shall be coped to fit. No snipe corners will be allowed.

11.0 CONNECTIONS

- 11.1. Where structural joints are made using high-strength bolts, hardened washers, and nuts tightened to a high tension, the materials, methods of installation and tension control, type of wrenches to be used, and inspection methods shall conform to “Specification for Structural Joints using ASTM A325 or A490 Bolts”.
- 11.2. Special care shall be taken to provide joint surfaces free from loose mill scale, dirt, oil, burrs, pits, or other defects which would prevent solid seating.
- 11.3. Slip critical connections shall be clearly defined on the erection drawings. When contact surfaces are galvanized, surfaces shall be scored with a wire brush prior to assembly.
- 11.4. Primary field connections shall be bolted, using ¾“ diameter ASTM A325-N galvanized bolts, bearing type connection with threads included in the shear plane, with one heavy hexagonal structural nut and one galvanized plain, hardened washer (U.N.O.).
- 11.5. Beam connections shall be furnished in accordance with Part 4 of the AISC Manual of Steel Construction, eighth edition, (U.N.O.). All material in the connection shall be sized to accommodate the shear values shown for ASTM A325 bolts, using values for bearing type bolts with threads included in the shear plane.
- 11.6. Open holes shall be 1³/₁₆” diameter, (U.N.O.). All shop and field holes shall be drilled, cut or punched, not burned.
- 11.7. Shop connections shall be welded, or high strength bolted connections may be substituted if approved by the Engineer. For manual ARC, welding electrodes shall conform to AWS A5.1 or A5.5, E70XX series.
- 11.8. All connections shall be sized to develop the load or number of bolts indicated on the drawings, or as stated in Section 10.9 above, whichever is greater.

- 11.9. The steel fabricator shall furnish erection bolts, clip angles, and temporary fasteners required for erection.
- 11.10. Minimum clip angle thickness shall be $\frac{3}{8}$ " (U.N.O.).
- 11.11. Bracing members meeting at a point shall have their gravity axes meeting at one point if practical; if not, provisions shall be made for bending stresses due to eccentricity.
- 11.12. Gusset plates shall be $\frac{3}{8}$ " thick, minimum (U.N.O.).
- 11.13. Each high strength bolt that is loosened or removed from a connection after it has been fully tightened shall not be reused.

12.0 COLUMN BASES AND BEARING PLATES

- 12.1. Base plates or bearing plates shall be provided under columns, beams, girders, and any other steel members resting on concrete or masonry work. Base and bearing plates may be attached or loose as shown on the drawings. Loose base plates, leveling plates, and bearing plates shall be delivered to the job site along with detailed setting plans for placing and grouting by others.
- 12.2. Column bases shall be finished in accordance with Section M2.8 of the AISC Specification for Buildings.
- 12.3. Columns shall be milled or saw-cut to provide full bearing.
- 12.4. Base and cap plates shall be straight and true.

13.0 GALVANIZING

- 13.1. All structural steel including, but not limited to all framing, ladders, handrail, and stair stringers, stair treads, and bar grating shall be hot-dip galvanized.
- 13.2. Galvanizing of structural steel shall be in accordance with the applicable provisions of ASTM A123, A143, A384 and A385.
- 13.3. All damaged hot dip galvanized areas shall be coated with brush applied ZRC cold galvanizing compound or equal. Surface preparation shall be in accordance with the manufacturer's recommendations.

14.0 SHOP QUALITY CONTROL

- 14.1. Testing and Inspection
 - a. General. Provide access to the testing and inspection agency so that specified testing and inspection can be safely accomplished.

- b. Shop Bolted Connections. Comply with testing and verification procedures in AISC Specification for Structural Joints, except test not less than 100 percent of bolts in each bolted connection.
 - c. Shop Welded Connections. Inspect and test shop-fabricated welds as follows:
 - d. Perform visual inspection of all welds.
 - e. Inspect 100% of full penetration welds, using test method as follows:
 - a. Ultrasonic Testing (ASTM E164).
 - b. Inspect 100% of fillet welds visually.
- 15.3. The Owner will notify the Fabricator of any damage resulting from handling and transportation or errors due to improper fabrication that prevent the proper assembly and fitting of the steel upon discovery. The cost of any corrections will be charged to the fabricator and made at no additional cost to the Owner.