SECTION 05 12 00 - STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This section includes designing the connections and members not fully detailed on the Drawings, and furnishing and installing the structural steel work as shown including:

1. Structural steel horizontal and vertical framing members, structural steel support members, structural steel bracing members, hangers which form part of the structural framing, steel canopy framing, complete with the required bracings, connections, turnbuckles, welds, washers, nuts, shims, bolts, anchor bolts, and anchor bolt templates.
2. Baseplates, cap plates, splice plates, stiffener plates, bent plates, edge angles, brackets and all connections as required or as indicated on the drawings.
3. All shop prime and/or galvanizing as indicated on the drawings and/or specified.

1.3 RELATED WORK

A. Related Work of Other Sections:

1. Division 01 Section – Testing Laboratory Services
2. Division 03 Section – Cast-In-Place Concrete.
3. Division 05 Section – Steel Decking.
4. Division 05 Section – Steel Joist Framing.
5. Division 05 Section – Metal Fabrications for miscellaneous metal fabrications, including lintels, ladders, and similar fabrications.
6. Division 06 Section – Rough Carpentry.
7. Division 09 Section – Paints and Coatings.
8. Division 14 Section – Electric Traction Elevators
9. Division 21, 22, 23 Sections: Mechanical and plumbing systems and equipment.
10. Division 26 Sections: Electrical systems
11. Division 27 Sections: Data and telephone communication systems and equipment.

1.4 REFERENCES

A. Referenced Standards: Except as otherwise noted, comply with the applicable provisions of the following:

B. ASTM: American Society for Testing and Materials.

1. A 6 (A 6M) - Specification for General Requirements for Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use.
2. A 108 - Steel Bars, Carbon, Cold-Finished, Standard Quality.
3. A 123 - Zinc (Hot-Dipped) Coatings on Iron and Steel Products.
4. A 153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
5. A 325 - High-Strength Bolts for Structural Steel Joints.

6. A 385 - Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip).
7. A 386 - Zinc-Coating (Hot-Dip) on Assembled Steel Products.
8. A 500 - Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
9. A 501 - Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
10. A 992/A 992M - Standard Specification for Steel for Structural Shapes For Use in Building Framing.
11. B 695 - Coating of Zinc Mechanically Deposited on Iron and Steel.
12. F 959 - Compressible-Washer - Type Direct Tension Indicators for Use with Structural Fasteners.

C. AWS: American Welding Society.

1. D1.1-94 - Structural Welding Code Steel.

D. AISC: American Institute of Steel Construction, Inc.

1. Load and Resistance Factor Design (LFRD) Specification for Structural Steel Buildings.
2. Specification for Load and Resistance Factor Design of Single-Angle Members.
3. Specification for Architecturally Exposed Structural Steel (where exposed to view in the finished construction).
4. Research Council on Structural Connections' (RCSC) Specification for Structural Joints Using ASTM A 325 or A 490 Bolts.
5. Research Council on Structural Connections' (RCSC) Load and Resistance Factor Design Specification for Structural Joints Using ASTM A 325 or A 490 Bolts.

E. SSPC: Steel Structures Painting Council.

1. Steel Structures Painting Manual. Vol. 1. Good Painting Practice.
2. Steel Structures Painting Manual. Vol. 2. Systems and Specifications.

F. FS: Federal Specifications.

1. SSPC Paint 25 - Primer Coating, Alkyd, Corrosion Inhibiting, Lead and Chromate Free, VOC Compliant.

G. OSHA: Occupational Safety and Health Administration.

1. 29 CFR Part 1926 Subpart R “Safety Standards for Steel Erection.”

1.5 DESIGN/PERFORMANCE REQUIREMENTS

A. Connections: Provide details of simple shear connections required by the Contract Documents to be selected or completed by structural-steel fabricator to withstand the LRFD-service loads and to comply with other information and restrictions indicated.

1. Select and complete the connections using the indicated schematic details and the AISC's "Manual of Steel Construction, Load and Resistance Factor Design," Volume 2, Part 9.
2. Engineering Responsibility: Fabricator's responsibilities include using a qualified professional engineer to prepare the structural design for the structural-steel connections.

1.6 SUBMITTALS

A. Submit shop drawings detailing fabrication of structural steel components.

1. Clearly indicate the profiles, sizes, spacings and locations of all structural steel members, including: connections, attachments, anchorages, framed openings, sizes and types of fasteners, cambers, loads, and the proposed shop paint primer. Clearly indicate the galvanized components and the coating designation.
2. Include details of cuts, connections, splices camber, holes and other pertinent data.
3. Include welds by standard AWS symbols, distinguishing between shop and field welds, and show the size length and type of each weld.
4. Indicate bolted connections by clearly indicating the type, number, size and locations of all bolts. Clearly specify and label the connections as "bearing" type or "slip-critical" type in accordance with the RCSC Specifications for Structural Joints Using ASTM A 325.
5. Load indicating devices (LIW): Submit the manufacturer's certifications for review of all load indicating washers, bolts, nuts, and structural washers supplied for use with the load indicator washers.
6. Indicate all the necessary details and information for the fabrication and erection of the structure complete as required, shown or as indicated on the drawings.
7. Should the Architect/Engineer in reviewing the shop drawings and erection diagrams make any corrections or modifications that would cause incorrect fitting of any part, or result in insufficient strength or stability for the construction involved, then the Contractor shall notify the Architect/Engineer at once in writing, in order to modify the review before the actual work involved is started. Should the Contractor fail or neglect to give timely notice, then the sole responsibility of these corrections or modifications shall rest with the Contractor.
8. Make modification of the details of fabrication only after receiving a review from the Architect/Engineer.

B. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of the completed projects with project names and addresses, names and addresses of the architects/engineers and owners, and other the information specified.

C. Mill test reports signed by the manufacturers certifying that their products, including the following, comply with the specified requirements.

1. Structural steel, including chemical and physical properties.
2. Bolts, nuts, and washers, including mechanical properties and chemical analysis.
3. Direct-tension indicators.
4. Shear stud connectors.
5. Shop primers.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced Installer who has completed structural steel work similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

1. A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE.

B. Fabricator Qualifications: Engage a firm experienced in fabricating structural steel similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to fabricate structural steel without delaying the Work.

1. A qualified fabricator who participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category Sbd.

C. Professional Engineer Qualifications: A professional engineer who is legally authorized to practice in the jurisdiction where this Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for projects with structural steel framing that are similar to that indicated for this Project in material, design, and extent.

1. Details shown are typical; similar details apply to similar conditions.
2. Verify dimensions at the Site whenever possible without causing delay in work.
3. Promptly notify the Architect/Engineer whenever design of the members and connections for any portion of the structure are not clearly indicated.

D. Engineering Responsibility: Engage a fabricator who utilizes a qualified professional engineer to prepare calculations, Shop Drawings, and other structural data for the structural steel connections.

1. The design of the members and the end connections for any portion of the structure not indicted in the Drawings shall be completed by the fabricator and indicated on the shop drawings. Such connections shall conform to the AISC specifications.

E. Welding Standards: Comply with applicable provisions of AWS D1.1 "Structural Welding Code--Steel."

1. Present evidence that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification within the past six months.

F. Contractor's Certification Testing:

1. Provide 1 tensile and 1 bend test for each 10 tons, or fraction thereof, of local stock structural steel material of unknown heat or melt numbers and unknown mill analysis.
2. Test and stamp each piece of high strength local stock steel (Unknown heat or melt numbers and unknown lill analysis).
3. Arrange with the testing laboratory for the certification and recertification of all welders in accordance with AWS D1.1.

G. Fastener Supplier Technical Support: Arrange for a representative of the bolt manufacturer to be present at the beginning of the bolting start-up to demonstrate the proper installation procedures and verify the proper inspection procedure with the Independent Testing Laboratory.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver structural steel to the Project site in such quantities and at such times to ensure continuity of installation.

B. Store materials to permit easy access for inspection and identification. Keep steel members off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.

1. Store fasteners in a protected place. Conform to the requirements of the current edition of the "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts". Clean and relubricate bolts and nuts that become dry or rusty before use.
2. Do not store materials on the structure in a manner that might cause distortion or damage to the members or supporting structures. Repair or replace damaged materials or structures as directed.

1.9 SEQUENCING

A. Supply anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, templates, instructions, and directions, as required, for installation.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Structural Steel Shapes, Plates and Bars: As follows:

1. High-Strength, Low-Alloy Columbium-Vanadium Steel, All Plates Up to and Including 4 Inches Thick, and All Shapes Unless Noted Otherwise: ASTM A 992, Grade 50.

B. Cold Formed Structural Steel Tubing: ASTM A 500, Grade B.

C. Hot Formed Structural Steel Tubing: ASTM A 501.

D. Steel Pipe: ASTM A 53, Type E or S, Grade B.

E. Anchor Bolts, Structural Bolts, Nuts and Washers:

1. Headed Bolts (Slip Critical Joints, If Specified): ASTM A 325, Type 1, heavy hex steel structural bolts and heavy hex carbon-steel nuts.
2. Carbon Steel Bolts (60ksi Tensile Strength): ASTM A 307 with cut threads, for all anchor bolts unless noted otherwise.
3. Hardened Steel Washers: ASTM F 436.

F. Welding Electrodes: Comply with AWS Welding Code.

G. Shop Primer: Fabricator's standard fast curing, lead and chromate free, VOC compliant, corrosion resistant primer complying with the performance requirements of FS TT-P-664.

H. Hot-dip galvanize all structural steel that with permanent exterior exposure and as indicated, or at fabricators option, provide Commercial Blast Cleaning in accordance with SSPC SP6, and two individual sprayed-on cured coats of Tnemec "90-97 Tneme-Zinc" applied at the rate of 3.5 mils DFT to all structural steel members embedded in exterior wall construction and with permanent exterior exposure and to all field welds.

I. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds and repair painting galvanized steel, with dry film containing not less than 93 percent zinc dust by weight, and complying with DOD-P-21035A or SSPC-Paint 20.

2.2 FABRICATION

A. Fabricate structural steel in accordance with AISC Specifications referenced in this Section and in the final shop drawings. See Structural General Notes for additional requirements.

1. Camber: Camber structural steel members where indicated.
2. Identify high-strength structural steel according to ASTM A 6 and maintain markings until steel has been erected.
3. Mark and match-mark materials for field assembly.
4. All work shall be fitted together at the shop as far as possible, and delivered complete and ready for erection.
5. Fit stiffeners neatly between flanges, and cut the ends of the stiffeners true to ensure an even bearing against abutting surfaces. All cut joints shall bear throughout their length.
6. Intermittent and continuous welding and straightening of built-up sections shall be done in a manner to minimize internal stresses.
7. Fabricate for delivery a sequence that will expedite erection and minimize field handling of the structural steel.
8. Provide openings in structural members as required for other building components. Reinforce openings with steel plates sized and welded in place to restore the members to their original integrity and strength. Locate and reinforce the holes so as not to cause any reduction in the strength of the members.
9. Complete structural steel assemblies, including welding of units, before starting shop-priming operations.
10. Comply with fabrication tolerance limits of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for structural steel.

B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible. Plane thermally cut edges to be welded.

C. Finishing: Accurately mill ends of columns and other members transmitting loads in bearing.

D. Holes: Provide holes required for securing other work to structural steel framing and for passage of other work through steel framing members, as shown on Shop Drawings.

1. Cut, drill, or punch holes perpendicular to metal surfaces. Do not flame-cut holes or enlarge holes by burning. Drill holes in bearing plates.
2. Weld threaded nuts to framing and other specialty items as indicated to receive other work.

2.3 SHOP CONNECTIONS

A. Connections, General: Weld or bolt shop connections, as shown. Bolt field connections, except where welded connections or other connections are shown. Provide high-strength threaded fasteners for the principal bolted connections, except where unfinished bolts are shown.

1. Connections using other than ASTM A 307 unfinished bolts shall be used in connections for supports of mechanical equipment, machinery, trucks or other live loads which produce impact.

B. Shop install and tighten non high-strength bolts, except where high-strength bolts are indicated.

C. Shop install and tighten high-strength bolts according to RCSC's "Load and Resistance Factor Design Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

1. Bolts: ASTM A 325 high-strength bolts, unless otherwise indicated.
2. Connection Type: Snug tightened, unless indicated as slip-critical, direct-tension, or tensioned shear/bearing connections.

D. Weld Connections: Comply with AWS D1.1 for procedures, appearance and quality of welds, and methods used in correcting welding work.

1. Assemble and weld built-up sections by methods that will maintain true alignment of axes without warp.
2. Intermittent and continuous welding and straightening of built-up sections shall be done in a manner to minimize internal stresses.

2.4 SHOP FINISHING

A. Shop paint surfaces of all structural steel work, except the following:

1. Surfaces of members or portions of members to be embedded in concrete or mortar.
2. Paint embedded steel, which is partially exposed, on exposed portions and initial 2" of embedded areas only.
3. Do not paint contact surfaces that are to be welded, high-strength bolted with friction-type connections, hot-dip galvanized, or to receive sprayed-on fireproofing.

B. Surface Preparation: Clean surfaces to be painted. Remove loose rust, loose mill scale, and spatter, slag, or flux deposits. Prepare surfaces according to SSPC specifications as follows:

1. SSPC-SP 2 "Hand Tool Cleaning."
2. SSPC-SP 3 "Power Tool Cleaning."

C. Priming: Immediately after surface preparation, apply primer according to manufacturer's instructions and at a rate recommended by SSPC to provide a dry film thickness of not less than 1.5 mils (0.038 mm). Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
2. Apply 2 coats of shop paint to inaccessible surfaces after assembly or erection. Change color of second coat to distinguish it from first.

D. Hot-Dip Galvanized Finish (Structural Members): Provide zinc coating by the hot-dip process to items indicated, according to ASTM A 123.

2.5 SOURCE QUALITY CONTROL

A. The Owner will engage an independent testing and inspecting agency to perform various shop inspections and tests and to prepare test reports.

1. Testing agency will conduct and interpret the tests and state in each report whether the test specimens comply with or deviate from the specified requirements.
2. Provide testing agency with access to places where structural steel Work is being fabricated or produced so that the required inspection and testing can be accomplished.

B. Correct deficiencies in or remove and replace structural steel that inspections and test reports indicate do not comply with the specified requirements.

C. Additional testing, at Contractor's expense, will be performed to determine compliance of the corrected Work with the specified requirements.

D. Shop-bolted connections will be tested and inspected according to RCSC's "Load and Resistance Factor Design Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

1. Direct-tension indicator gaps will be verified to comply with ASTM F 959, Table 2.

E. In addition to visual inspection, shop-welded connections with full penetration welds will be inspected and tested according to AWS D1.1 as follows:

1. Ultrasonic Inspection: ASTM E 164.

F. In addition to visual inspection, shop-welded shear connectors will be inspected and tested according to the requirements of AWS D1.1 for stud welding and as follows:

1. Bend tests will be performed when visual inspections reveal either less than a continuous 360-degree flash or welding repairs to any shear connector.
2. Tests will be conducted on additional shear connectors when weld fracture occurs on shear connectors already tested, according to requirements of AWS D1.1.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify elevations of the concrete and masonry bearing surfaces and locations of anchorages for compliance with the specified requirements.

B. Do not proceed with erection until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep the structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to the design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place.

3.3 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC specifications referenced in this Section. Refer to Structural General Notes for additional requirements.

1. Set structural steel accurately to line and level, brace securely in position until the floor and roof framing have been placed and all other construction operations that could load the structure are complete.
2. The member working points for all column (interior and exterior) pieces may be displaced from the established column center line no more than 1/4 inch away from the established column center line. The corresponding adjustments, to the other structural steel members, must be recorded and the work must be accomplished in such a manner to easily accommodate all other pertinent modifications.
3. Make adequate provisions for all erection and lateral loads, and provide sufficient temporary bracing to maintain a safe and plumb structure until the completion of erection, the installation of the necessary permanent bracing and the finalizing of all the structural frame connections.
4. Do not field cut or alter any structural members without the review of the Architect/Engineer.

B. Base and Bearing Plates: Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen surfaces before setting base and bearing plates. Clean bottom surface of base and bearing plates.

1. Set base and bearing plates for structural members on wedges, shims, or setting nuts as required.
2. Tighten anchor bolts after the supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of the base or bearing plate prior to packing with grout.
3. Pack the grout solidly between bearing surfaces and plates so no voids remain. Finish exposed surfaces, protect installed materials, and allow to cure. Comply with grout manufacturer’s instructions.
4. Remove all the temporary erection bracings, clips, and other devices, and grind any burrs left after their removal flush with the parent metal on all structural members.

C. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."

1. Maintain erection tolerances of architecturally exposed structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."

D. Align and adjust various members forming part of the complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure.

E. Splice members only where indicated. The use of a cutting torch in the field to provide openings or to correct fabricating errors will not be permitted. Cutting may be done only with the Architect/Engineer's written approval.

F. Do not use thermal cutting during erection.

G. Finish sections thermally cut during erection equal to a sheared appearance.

H. Do not enlarge unfair holes in members by burning or by using drift pins. Ream holes that must be enlarged to admit bolts. Correct poor matching of the shop drilled holes by drilling to the next larger size, and by the use of larger size bolts. Welding or redrilling will not be permitted without the review of the Architect/Engineer.

3.4 FIELD CONNECTIONS

A. Install and tighten non high-strength bolts, except where high-strength bolts are indicated.

B. Install and tighten high-strength bolts according to RCSC's "Load and Resistance Factor Design Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

1. Bolts: ASTM A 325 high-strength bolts, unless otherwise indicated.
2. Connection Type: Snug tightened, unless indicated as slip-critical, direct-tension, or tensioned shear/bearing connections.
3. Washers: Washers under the head and/or nut shall be used as required by the bolt specification previously cited.
4. Vendor Quality Assurance: A representative of the bolt manufacturer shall be present at the beginning of the bolting start-up to demonstrate the proper installation procedures and to verify the proper inspection procedure with the Independent Testing Laboratory.

C. Tension Device Calibration: A tension-measuring device shall be available at the job site where bolts in slip-critical joints or connections are subject to direct tension and are being installed and tightened. The tension measuring device shall be used to confirm:

1. The suitability of the device to satisfy the tension requirements of the complete fastener assembly, including the necessity of lubrication to be used.
2. Calibration of wrenches, if applicable.
3. The understanding and the proper use by the bolting crew of the tightening method to be used.
4. The frequency of confirmation testing, the number of tests to be performed and the test procedure shall be as specified above.
5. The accuracy of the tension-measuring device shall be confirmed annually through calibration by an approved testing agency.

D. Weld Connections: Comply with AWS D1.1 for procedures, appearance and quality of welds, and methods used in correcting the welding work.

1. Comply with AISC specifications referenced in this Section for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.
2. Assemble and weld built-up sections by methods that will maintain true alignment of the axis without warp.
3. Remove unsatisfactory welding by chipping or arc-air method.
4. Where beams are groove welded directly to columns in the field, these welds shall be completed before the final shear connections are made.

5. Promptly remove welders from the Site producing unsatisfactory work, even though having passed the qualification tests.

E. Bearing pads shall be adhesively applied to the back-up surfaces to prevent the displacement of the pads. Adhesive shall be as recommended by the bearing pad manufacturer and reviewed by the Architect/Engineer.

3.5 FIELD QUALITY CONTROL

A. Owner will engage an independent testing and inspecting agency to perform field inspections and tests and to prepare test reports.

1. Testing agency will conduct and interpret the tests and state in each report whether the tested Work complies with or deviates from requirements. See Section 01 45 29 – Testing Laboratory Services for requirements.

B. Correct deficiencies in or remove and replace structural steel that inspections and test reports indicate do not comply with the specified requirements.

C. Additional testing, at the Contractor's expense, will be performed to determine compliance of the corrected Work with the specified requirements.

D. Field-bolted connections will be tested and inspected according to RCSC's "Load and Resistance Factor Design Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

1. Direct-tension indicator gaps will be verified to comply with ASTM F 959, Table 2.

E. In addition to visual inspection, field-welded connections will be inspected and tested according to AWS D1.1 and the inspection procedures listed below, at testing agency's option.

1. Liquid Penetrant Inspection: ASTM E 165.
2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
3. Radiographic Inspection: ASTM E 94 and ASTM E 142; minimum quality level "2-2T."
4. Ultrasonic Inspection: ASTM E 164.

3.6 CLEANING

A. Touch-up Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on structural steel are included in Section 09 90 00, "Painting and Coating."

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and apply galvanizing repair paint according to ASTM A 780.

END OF SECTION 05 12 00