

SECTION 051000 - STRUCTURAL STEEL

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Section includes fabrication and erection of structural steel indicated in the Contract Documents or otherwise required for proper completion of the work.

1.2 RELATED SECTIONS

- A. Section 013330 - Structural Submittals.
- B. Section 014525 - Structural Testing/Inspection Agency Services.
- C. Section 052000 - Steel Joists and Joist Girders.
- D. Section 053000 - Metal Decking.

1.3 REFERENCES

- A. AISC - Code of Standard Practice for Steel Buildings and Bridges.
- B. AISC 360-16 - Standard Specification for Structural Steel Buildings, 15th Edition.
- C. RCSC - Specification for Structural Joints Using High-Strength Bolts.
- D. AWS A5.1 - Specification for Carbon Steel Electrodes for Shield Metal Arc Welding.
- E. AWS A5.5 - Specification for Low-Alloy Steel Covered Arc Welding Electrodes.
- F. AWS A5.17 - Specification for Carbon Steel Electrodes and Fluxes for Submerged Arc Welding.
- G. AWS A5.20 - Specification for Carbon Steel Electrodes for Flux Cored Arc Welding.
- H. AWS D1.1 - Structural Welding Code.
- I. ASTM A36 - Standard Specification for Structural Steel.
- J. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- K. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- L. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

- M. ASTM F3125 – Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi and 150 ksi Minimum Tensile Strength, Inch and Metric Dimensions.
- N. ASTM A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Tubing in Rounds and Shapes.
- O. ASTM A501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
- P. ASTM A563 – Standard Specifications for Carbon and Alloy Steel Nuts.
- Q. ASTM A780 - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
- R. ASTM A992 - Standard Specification for Steel for Structural Shapes For Use in Building Framing
- S. ASTM F436 - Standard Specification for Hardened Steel Washers.
- T. ASTM F844 - Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use.
- U. ASTM A563 – Standard Specifications for Carbon and Alloy Steel Nuts.
- V. SSPC - Steel Structures Painting Manual.

1.4 SUBMITTALS

- A. Contact Design Professional prior to detailing structural steel shop drawings.
- B. Reproduction of Structural Drawings for shop drawings is not permitted. Electronic drawing files will not be provided to the Contractor.
- C. Submit shop drawings for review.
- D. Shop drawings shall clearly indicate the profiles, sizes, ASTM Grade, spacings and locations of all structural steel members, including connections, attachments, anchorages, framed openings, sizes and types of fasteners, method of tightening fasteners, cambers, and the number, type and spacing of the headed shear connectors.
- E. For connections and elements designed by the contractor, submit shop drawings and calculations sealed by an engineer licensed in the project state.
- F. For record only, submit written welding procedures for each type of welded joint used in accordance with Appendix E of the AWS Structural Welding Code. Submit manufacturer certifications for welding consumables/materials.
- G. Maintain at construction office mill certification that the steel supplied meets the specifications.

- H. Maintain at construction office certification that high strength bolts supplied meet the specifications.
- I. Submit certification that the fabricator meets the required qualifications. If fabricator must have an independent testing agency to inspect fabrication as required by these specifications, submit the name and qualifications of the independent testing agency.
- J. For each approved fabricator that is exempt from Special Inspections of shop fabrications and implementation procedures in accordance with Section 1704.2 of the Building Code, submit "Fabricator's Certificate of Compliance". Provide copies of fabricator's certification or building code evaluation services report and fabricator's quality control manual.
- K. Submit certification that the erector meets the required qualifications.
- L. Upon request, submit the erection sequence and procedures to be used by the steel erector.
- M. Manufacturer's recommendations for expansion anchor installation.
- N. Manufacturer's recommendations for adhesive anchor installation.
- O. Qualification Data: For Erector, manufacturer, professional engineer, land surveyor and testing agency.
- P. Surveys:
 - 1. Submit survey indicating elevations and locations of concrete and masonry-bearing surfaces and locations of anchor rods, bearing plates and other embedments to receive structural framing. Indicate discrepancies between actual installation and Contract Documents.
 - 2. Submit survey indicating final elevations and locations of columns and other major structural steel elements. Steel survey shall include column plumbness after structural steel erection. Indicate discrepancies between actual installation and Contract Documents. Have surveyor who performed surveys certify their accuracy.

1.5 QUALITY ASSURANCE

- A. Structural Testing/Inspection Agency shall perform the following quality related items:
 - 1. Anchor Bolts
 - a. Anchor bolt size, configuration, and embedment shall be verified prior to placement of concrete.
 - 2. Welded Connections
 - a. Inspection shall be in accordance with AWS Structural Welding Code.

- b. Visually inspect all field welded connections. Visual inspection of welded joints includes periodic examination of fitup.
 - c. Ultrasonically inspect 100% of the complete penetration welds.
 - d. Review approved welding procedures. Verify that welding procedures are being adhered to during field welding.
 - e. Verify welder qualifications.
- 3. Bolted Connections
 - a. Inspection and testing shall be in accordance with RCSC Specification for Structural Joints Using High-Strength Bolts.
 - b. Prior to visual and physical testing, tension testing using a calibration device must indicate tensions at least 5% in excess of the AISC minimum. Structural steel erector shall supply the tension calibration device.
 - c. Test a minimum of 10% of the bolted connections.

- B. The Structural Testing / Inspection Agency shall provide special inspections as required by Chapter 17 of the building code as required by Specification 01 4525.

1.6 FABRICATOR'S QUALIFICATIONS

- A. Steel fabricator shall be certified by the American Institute of Steel Construction (AISC) Quality Certification Program for Conventional Steel Buildings (BU).
- B. Fabricator not certified by the AISC Quality Certification Program shall have fabrication procedures and fabricated steel tested and inspected by the Materials Testing and Special Inspection Agency contracted by the Owner. Payment of these tests and inspections shall be by the fabricator. Tests and inspections shall be performed by AWS Certified Welding Inspectors. Prior to delivery of structural steel to the project, submit copies of the inspection reports to the Design Professional. The purpose of this inspection is to enable the testing/inspection agency to verify that, in general, the steel is being fabricated in accordance with the Contract Documents. A minimum of one trip per week is recommended. The first trip should be scheduled at the first requirement for inspections as required by IBC Chapter 17. Contact Design Professional prior to initial inspection. Tests and inspections shall include the following:
 - 1. Examine mill test reports and verify that material being used is the same as the mill test reports.
 - 2. Review the fabricator's written welding procedures. Verify that the fabricator's welding procedures are being followed. Verify that welders are certified with current papers and that they demonstrate proper techniques.
 - 3. Observe high strength bolting procedures. Verify that shop installation of high strength bolts conform to AISC specifications.
 - 4. Examine joint preparation for complete penetration joints. Ultrasonically inspect 100% of the complete penetration welds.
 - 5. Examine fillet welds for proper size, profile, throat, porosity and end returns.
 - 6. Examine steel members for lamellar tearing. Spot check dimensions and hole sizes.
 - 7. Examine bolted areas for burrs.

1.7 ERECTOR'S QUALIFICATION

- A. Erector shall be experienced in erecting structural systems similar in complexity to this project as evidenced by 10 completed projects.
- B. Erector shall have a minimum of 5 years' experience in the erection of structural steel or is an AISC Certified Advanced Steel Erector.

1.8 WELDER'S QUALIFICATIONS: Qualify procedures and personnel in accordance with AWS D1.1.

1.9 STORAGE

- A. Store materials off ground to permit easy access for inspection and identification. Store steel members and packaged items in a manner that provides protection against contact with deleterious materials.

PART 2 - PRODUCTS

2.1 ANCHOR ROD

- A. Anchor rods shall conform to ASTM F1554, Grade 36 (unless noted otherwise on drawings) and shall be a headed rod or threaded rod with a double heavy hexagonal nut at the bottom of the threaded rod, Grade A563A, unless noted otherwise.
- B. Provide two heavy hexagonal nuts at the base of the anchor rod conforming to ASTM A563 Grade C with one plain steel washer between conforming to ASTM F844. Provide one hexagonal nut at the top with plate washer listed below.
- C. Provide 3/8-inch-thick plate washers (3-inch x 3-inch) in lieu of top steel washer on base plates with oversized holes conforming to ASTM A36, unless noted otherwise on drawings.

2.2 ROLLED STEEL WIDE FLANGE, CHANNEL AND WT SHAPES

- A. Rolled steel wide flange, channels and WT shapes shall conform to ASTM A992.

2.3 PLATES, ANGLES AND BARS

- A. Plates, angles and bars shall conform to ASTM A36.

2.4 ROUND STRUCTURAL STEEL TUBING

- A. Round structural steel tubing shall conform to ASTM 500, Grade C, 46 ksi minimum yield strength.

2.5 RECTANGULAR STRUCTURAL STEEL TUBING

- A. Rectangular structural steel tubing shall conform to ASTM A500, Grade C, 50 ksi minimum yield strength.

2.6 NON-HIGH-STRENGTH FASTENERS

- A. Non-high-strength bolts shall conform to ASTM A307, Grade A, 60 ksi minimum, where noted on the Structural Drawings.
- B. Hardened steel washers shall conform to ASTM F436.

2.7 HIGH-STRENGTH FASTENERS

- A. High-strength bolts shall conform to ASTM F3125 Type 1, 120 ksi as noted on the Structural Drawings.
- B. Provide 3/4-inch minimum diameter bolts, unless noted otherwise.
- C. Hardened steel washers shall conform to ASTM F436.
- D. Spline-type tension control bolts, plain hardened washers and suitable nuts are an acceptable alternate design bolt assembly.
- E. Do not use load indicating washers.

2.8 HEADED STUDS

- A. Headed steel studs shall conform to the requirements of AWS D1.1.
- B. Provide 3/4-inch diameter headed steel studs, unless noted otherwise.
- C. Provide heat-resistant ceramic arc shields with studs.

2.9 EXPANSION ANCHORS

- A. Expansion anchors shall have been evaluated by the ICC Evaluation Services, Inc. (ICC-ES) or IAPMO Uniform ES (UES) with a published evaluation report. Anchors shall be evaluated by ICC-ES Acceptance Criteria 193 and be specifically approved for use in cracked concrete. All anchors shall be approved for resisting wind and seismic loads.

2.10 ADHESIVE ANCHORS

- A. Adhesive anchors shall consist of:
 - 1. An all-thread steel anchor conforming to ASTM A307, Grade A or ASTM A36, zinc plated in accordance with ASTM B633, unless noted otherwise on the Structural Drawings, and
 - 2. An adhesive conforming to ASTM C881-02, Type IV, Grade 3, CLASS A, B, & C except gel times and epoxy content. Adhesive shall consist of a two-component adhesive system contained in side-by-side packaging connected to a mixing nozzle which thoroughly mixes the components as it is injected into the hole.

Adhesive shall have passed ICC Evaluation Services, Inc. Acceptance Criteria 308 for long term creep and be specifically approved for use in cracked concrete.

2.11 WELD ELECTRODES

- A. E-70 series low hydrogen electrodes shall conform to AWS A5.1, A5.5, A5.17, or A5.20.
- B. Properly store electrodes to maintain flux quality.

2.12 PAINT

- A. Oxide primer shall conform to AISC Specifications, Code of Standard Practice, and SSPC Steel Structure Painting Manual, unless indicated otherwise.
- B. Paint primer shall be free of lead and chromate and shall comply with State and Federal volatile organic compound (VOC) requirements.
- C. Paint primer shall be compatible with finish coating.

2.13 GALVANIZING

- A. Galvanized coating shall conform to ASTM A123.
- B. Galvanize bolts, nuts, and washers in accordance with ASTM A153 when used to connect steel members that are specified to be galvanized.
- C. Expansion anchors or adhesive anchors specified to be galvanized shall be mechanically galvanized in accordance with ASTM B695, Class 65, Type I.

PART 3 - EXECUTION

3.1 GENERAL

- A. Fabricate and erect structural steel in accordance with AISC Specifications and Code of Standard Practice.
- B. Notify Design Professional and Structural Testing/Inspection Agency at least 48 hours prior to structural steel fabrication and erection.

3.2 ANCHOR BOLT SETTING

- A. Provide templates for setting anchor bolts. Position anchor bolts by using templates with two nuts to secure in place prior to placement of concrete.
- B. Do not erect steel where anchor bolt nuts will not have full threads.

3.3 CONNECTIONS

- A. Provide a minimum of two fasteners at each bolted connection.

- B. Ensure fasteners are lubricated prior to installation.
- C. Provide high-strength bolted connections in accordance with RCSC Specification for Structural Joints Using High-Strength Bolts using ASTM F3125 Bolts.
- D. Provide connections for expansion and contraction where steel beams connect to concrete walls or concrete columns and at expansion joints. Secure nuts on bolts against loosening. (Dent threads with a chisel.)

3.4 FASTENER INSTALLATION

- A. Bolts shall be installed in holes of the connection and brought to snug tight condition. Tighten connection progressing systematically from the most rigid part to the free edges of the connection to minimize relaxation of the bolts.
- B. High-strength bolts installed shall have a hardened washer under the element turned in tightening.
- C. Installation and tightening of bolts shall conform to the RCSC Specification for Structural Joints Using High-Strength Bolts

3.5 HEADED STUDS

- A. Headed studs shall be welded in accordance with AWS D1.1.
- B. Locate shear studs directly over the web of beams with flanges less than 0.3 inches thick.
- C. The minimum center spacing shall be 6 diameters along the longitudinal axis of the beam and 4 diameters transverse to the longitudinal axis of the beam.
- D. Where double rows of shear studs are required, begin double rows at each end of the beam.
- E. Remove shields after welding studs.

3.6 EXPANSION ANCHOR INSTALLATION

- A. Install in accordance with manufacturer's recommendation.
- B. Minimum embedment shall be equal to 4.5 times the anchor diameter unless noted otherwise.

3.7 ADHESIVE ANCHOR INSTALLATION

- A. Install in accordance with manufacturer's recommendation.
- B. Minimum embedment shall be equal to 4.5 times the anchor diameter unless noted otherwise.

3.8 WELDING

- A. Comply with AWS D1.1 Structural Welding Code. Use prequalified weld procedures.
- B. Provide end returns where fillet welds terminate at end or sides. Returns shall be continuous for a distance of not less than two times the nominal size of the weld.
- C. Complete penetration joints shall be back gouged to sound metal before the second side is welded or have 1/4-inch root opening with 3/16 x 1 inch backing bar. Access holes are required. Filling access holes is not required.
- D. Remove all slag and weld splatter from deposited weld metal.

3.9 SPLICING

- A. Splice members only where indicated unless authorized in writing by the Design Professional.
- B. Provide shim plates at bottom flange splice at continuous beam splices with different depths.

3.10 CUTTING

- A. Do not use flame cutting to correct errors unless authorized in writing.
- B. Re-entrant corners shall have a minimum radius of one inch and be free of notches. Notches and gouges resulting from flame cutting shall be finished to a smooth appearance.

3.11 MILL SCALE

- A. Remove loose mill scale.

3.12 BOLT HOLES

- A. Cut, drill, or punch holes perpendicular to metal surfaces. Do not enlarge holes by burning. Drill or punch holes in bearing plates. Remove burrs.

3.13 PAINTING

- A. Paint steel that is not encased in concrete, plaster, or sprayed fireproofing. Do not shop paint in areas to be field welded, contact surfaces of slip critical connections, or areas to receive special finishes.
- B. Field paint as required steel that has been welded or that is unpainted after connections have been tightened.

3.14 GALVANIZING

- A. Galvanize shelf angles that support the exterior building veneer, for example brick shelf angles.

- B. Galvanize environmentally exposed steel, for example mechanical equipment or balcony supports.
- C. Touch-up welds and abrasions in galvanized members in accordance with ASTM A780.

3.15 EXAMINATION

- A. Before Erection begins, survey elevations and plan locations of concrete and masonry bearing surfaces and locations of anchor rods, bearing plates, and other embedments to receive structural framing, with Erector present, for compliance with requirements and specified tolerances.
 - 1. Engage land surveyor to perform surveying.
 - 2. Survey submittals shall indicate elevations and plan locations, and discrepancies between actual installation and Contract Documents.
 - 3. Connections to surveyed items cannot be made until submittal has been approved by Design Professional and unsatisfactory conditions have been corrected.
- B. As erection proceeds, survey final elevations and plan locations of columns, beams and other major structural steel elements for compliance with requirements and specified tolerances.
 - 1. Engage land surveyor to perform surveying.
 - 2. Steel frame survey submittals shall indicate final elevations and plan locations of columns, beams and other major framing, as well as column plumbness. Indicate discrepancies between actual installation and the contract Documents.
 - 3. Placement or application of other materials which might obscure or restrain surveyed elements cannot be made until submittal has been approved by the Design Professional and unsatisfactory conditions have been corrected.
- C. Contractor shall check all architecturally exposed structural steel members upon delivery for twist, kinks, gouges or other imperfections which may result in rejection of the appearance of the member. Coordinate remedial action with the fabricator prior to erecting steel.

3.16 REPAIR

- A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing, and repair galvanizing to comply with ASTM A780.
- B. Touchup Painting:
 - 1. Immediately after erection, clean exposed areas where primer is damaged or missing, and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - a. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

2. Touchup Priming: Cleaning and touchup priming are specified in Section 099600 "High-Performance Coatings."

3.17 FIELD QUALITY CONTROL

- A. Special inspector to perform the following special inspections in accordance with specification section 01 4525

1. Bolted Connections: Inspect bolted connections in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
2. Welded Connections: Visually inspect field welds in accordance with AWS D1.1.
 - a. In addition to visual inspection, test and inspect field welds in accordance with AWS D1.1 and the following inspection procedures, at testing agency's option:
 1. Liquid Penetrant Inspection: ASTM E165.
 2. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
 3. Ultrasonic Inspection: ASTM E164.
 4. Radiographic Inspection: ASTM E94.

END OF SECTION 051000