SECTION 05 12 00

STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 SCOPE

A. This specification section governs the furnishing, storage and handling, and erection of structural steel and miscellaneous metal, including, but not be limited to, columns, beams, plates, and anchor bolts and grouting under base plates.

1.2 RELATED SECTIONS

Section 03 30 00 Cast-In-Place Concrete

1.3 REFERENCED CODES AND STANDARDS

A. Standards and References listed below apply where designation is cited in this Section. Where applicable year of adoption or revision is not listed below, the latest edition applies.

B. San Francisco Building Code (SFBC) 2019

C. American Association of State Highway and Transportation Officials (AASHTO)

1. LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, 1st Edition, with 2018 Interim Revisions

D. American Institute of Steel Construction (AISC)

1. Steel Construction Manual, 15th Edition
2. 303 – Code of Standard Practice for Structural Steel Buildings and Bridges
3. 348 – Specification for Structural Joints Using ASTM A325 or A490 Bolts

E. American Welding Society (AWS), latest edition

1. AWS D1.1 – Structural Welding Code – Steel
2. AWS D1.8 – Structural Welding Code – Seismic Supplement

F. American Society for Testing and Materials (ASTM) Standards, latest edition

1. A6 – Standard Specifications for General Requirements for Rolled Steel Plates, Shapes, Sheet Piling and Bars for Structural Use.
2. A36/A36M – Standard Specification for Carbon Structural Steel
3. A53/A53M – Standard Specification for Pipe, Steel Black and Hot-Dipped, Zinc Coated, Welded and Seamless
4. A123/A123M – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
5. A153 – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2009.
6. A307 – Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength

7. A325 – Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
8. A449 – Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use
9. A490 – Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength
10. A496 – Steel Wire, Deformed, for Concrete Reinforcements.
11. A500/A500M – Standard Specification for Cold Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
12. A563 – Standard Specification for Carbon and Alloy Steel Nuts
13. A572/a572M – Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
14. A780/A780M – Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
15. A992/A992M – Standard Specification for Structural Steel Shapes
16. C1107 – Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
17. F436 – Standard Specification for Hardened Steel Washers
18. F959 – Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners
19. F1554 – Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

G. American Welding Society (AWS)

1. AWS D1.1 – Structural Welding Code – Steel, latest edition
2. AWS D1.4 – Structural Welding Code – Reinforcing steel.
3. AWS D1.8 – Structural Welding Code – Seismic Supplement, latest edition

H. Society for Protective Coatings (SSPC)

1. SP 1 – Solvent Cleaning.
2. SP 2 – Hand Tool Cleaning
3. SP 3 – Power Tool Cleaning
4. SP 6 – Commercial Blast Cleaning

I. Occupational Safety & Health Administration (OSHA)

1. Regulations (Standards – 29 CFR) Part 1926 – Safety and Health Regulations for Construction

1.4 SUBMITTALS

A. Submittals shall be in accordance with Division 1.

B. Written procedures for pre-installation testing, installation, and pretensioning of high strength bolts.

C. Welder's Certificates: Documentation certifying welders employed on the work meet AWS qualifications.

D. Prior to fabrication submit the following as specified elsewhere in this Section:

1. Written Welding Procedure Specifications (WPSs) in accordance with AWS D1.1 for each proposed joint with the shop drawings.

2. Welder performance qualification records in accordance with AWS D.1.1 for all procedures qualified by testing.

3. Electrode manufacturer's data (cut sheets) and filler metal Charpy V-Notch test values with the written welding procedure submittal.

4. Power source (constant current or constant voltage).

E. Procedure Qualification Record (PQR) in accordance with AWS D 1.1M/D 1.1 for all procedures qualified by testing.

F. Product Data: For each type of product, including but not limited to:

1. Weld filler material.

2. Structural steel paint primer.

3. High-strength bolts, anchor bolts, including nuts and washers

G. Shop Drawings:

1. Contractor shall submit the structural steel shop drawings to City Representative for review and approval, showing list of materials, sizes, and dimensions.

2. Contractor shall coordinate with architectural, structural, mechanical, and electrical Contract Drawings for the location of penetrations.

3. Structural steel shall not be fabricated or erected before the shop drawings are reviewed and approved by the City Representative, and returned to the Contractor. Such review does not relieve the Contractor from the full responsibility for both the accuracy of these shop drawings, and the accurate and complete erection of the work.

4. Shop drawings shall not be reproductions of the Contract Documents, nor shall they use or incorporate reproductions of parts of the Contract Documents.

5. Drawings shall be given an identifying number, shall be signed by the individual who is responsible for Drawings and dated with each issue. Changes shown on resubmittals shall be identified with a cloud and a revision number.

6. Review of drawings will be for adherence to overall basic design, and will not relieve Constructor from compliance with Contract Documents nor responsibility for correctness of dimensions, proper design of details, quantities and field fit.

H. Mill Test Reports: Certified mill test reports (tensile and bending), for each heat or melt of steel, showing physical and chemical analyses, shall be submitted to the City Representative for review and approval before the material delivery to the job site.

I. Weld Layout Diagrams: Provide diagrams to supplement shop drawings that tie weld symbols used on shop drawings to WPS for all DCW.

J. Manufacturer's Certificate: Submit certification that manufactured products (including bolts, nuts and washers) meet or exceed specified requirements. Manufactured products are to be delivered to the site in unopened containers. Certification numbers must appear on product containers for all bolts, nuts and washers and the numbers shall correspond to the identification numbers on the Manufacturer's Certificate. The Manufacturer's symbol and grade markings must appear on all bolts, nuts and washers.

1.5 QUALITY ASSURANCE

A. Conform to all provisions of American Institute of Steel Construction; "Specifications for Structural Steel Buildings – Load and Resistance Factor Design," "Structural Joints Using ASTM A325 or A490 Bolts" and "Code of Standard Practice,"

B. To ensure proper fitting of the work, field-verify critical dimensions at the jobsite prior to preparation of Shop Drawings and before product fabrication begins. Field fabrication not permitted.

C. Qualifications for Welding Work: Qualify welding procedures (WPS) and welding operators in accordance with AWS D1.1.

1. Qualify welders in accordance with AWS D1.1 for each process, position, and joint configuration.
2. WPS for each joint type shall indicate proper AWS qualification and be available where welding is being performed.
3. Welders shall have performed the applicable welding process on an ongoing basis since the WPQR test was conducted with no lapse of service exceeding six months or shall be re-qualified.
4. Welders who are making any DCW shall be qualified in accordance with AWS D1.8 Section 5. Welder shall have been qualified for the supplemental qualification test within the last 12 months or shall be qualified for the project.
5. Welders shall be duly qualified (test passed in the preceding 12 months) in the position in which they are to weld and the qualifications and specifications for workmanship shall comply with the AWS D1.1.
6. Welders whose work has a reject rate exceeding 5 percent shall be re-qualified before performing further welding.
7. Re-testing and re-qualification of welders shall be Contractor's responsibility.

D. Pre-fabrication/Pre-Erection Conference: Contractor shall schedule meeting with The City, Testing laboratory, Special Inspector(s) and the Fabricator and Erector's personnel supervising shop and field welding to review welding procedures and inspection requirements for DCW.

E. Certifications:

1. Prior to fabrication or shipment of materials to the job site, furnish certification of the manufacturer of the structural steel that materials furbished meets or exceeds requirements of ASTM standards specified or noted on drawings for each type of materials.
2. Prior to site welding operation, submit welders' written certification and qualification.

F. Tolerances: All steel exposed to view shall be architectural steel, and tolerances as minimum shall comply with section 10 of AISC Code of Standard Practice.

G. Testing and Inspections:

1. An independent testing and inspection agency shall be retained by the Contractor to provide shop and field testing and inspection per requirements in the approved construction documents. The Inspector/Engineer shall have free access to the work and may inspect all steel and fabrication equipment used in the work. The fact that steel work has not been rejected at the shop shall not preclude its final rejection at the site, even after it has been erected, if the steel work is found to be defective in any way. Any material or workmanship, which is rejected either at the shop or at the job site, shall be promptly replaced to the Engineer's satisfaction by the Contractor at his/her own expense.

2. Independent Welding Inspection: All shop and field welding shall be done under periodic inspection by the testing and inspection agency. Fillet and partial penetration welds may be subject to non-destructive testing at the discretion of the Engineer.

3. Full-penetration welds for all structures shall be inspected by magnetic particle testing (MT) or ultrasonic testing (UT), based on the thinnest mating material:

   MT for Thickness < 0.25 in.

   UT for Thickness > or = 0.25 in.

4. Full-penetration welds laminated tube-to-transverse-plate welds, fillet welds, and all other welding shall be inspected by MT, after the welding of each individual ply and after galvanizing. Full length of all full-penetration groove welds on all members of all structures shall be inspected.

5. Full-penetration groove welds, fillet welds, and all other welding shall be ultrasonically inspected for toe cracks after galvanizing.

1.6 DELIVERY, STORAGE AND HANDLING

A. Exercise care during unloading, storage and erection to avoid damage. Dumping on the ground is not permitted.

B. Support material stored at the site completely free to the ground, and cover to avoid damage from the elements.

PART 2 - PRODUCTS

2.1 GENERAL

A. To ensure proper fitting of the work, field-verify critical dimensions at the jobsite prior to preparing of Shop Drawings and before product fabrication begins. Field fabrication will not be permitted.

2.2 MATERIALS

A. Standard Structural Steel Shapes: ASTM A992. Fy = 50 ksi.

B. Other Hot-Rolled Structural Shapes: ASTM A36

C. Steel Bars and Plates: ASTM A572, Grade 50.

D. Hollow Steel Sections (HSS): ASTM A500, Grade C

E. Pipe: ASTM A53, Grade B

F. Tapered Pole, Mast Arm, Luminaire Arm (Caltrans or Custom), ASTM A572, Grade 55

G. Shear Stud Connectors: ASTM A108

H. Machine Bolts: ASTM A307, Grade A galvanized to ASTM A153, Class C for galvanized components.

I. Anchor Rods: ASTM F1554, Grade 55, unless otherwise noted on Drawings.

J. Threaded Rods: ASTM F1554, Grade 55, unless otherwise noted on Drawings.

K. High Strength Bolts, Nuts, and Washers: ASTM A325 or A490 galvanized to ASTM A153 for galvanized components, with matching ASTM A563 nuts and ASTM F436 washers; Type 1 alloy steel

L. Welding Filler Material: AWS D1.1 and D 1.8; type required for base metals being welded.

1. Electrodes for Welding: Comply with AWS D 1.8 code Low Hydrogen Electrodes (maximum diffusible hydrogen content of 16 mL per 100 grams of deposited weld metal meeting the requirement of H16) intended got applications subject to FEMA 353 and these specifications.

SMAW (stick)	FCAW-SS (Flux-Cored with self-shielding)
AWS A5.1 or A5.5	AWS A5.20
E70 Series	E7XT-X

M. Filler materials for DCW shall conform to the following additional requirements:

1. Be capable of producing welds with CVN of at least 20 ft-lbs at zero degree F, AWS A5.

2. Be capable of producing welds with CVN of at least 40 ft-lbs at 70 deg F AWS A5 and tested by AWS Annex A, WPS Heat Input Envelope Testing of Filler Metals for Demand Critical Welds method.

3. H16 (diffusible hydrogen), AWS A4.3 or 5.2.

4. Electrode packaging and protection shall conform to AWS D1.8 .

N. Shear Connectors: Shear stud connectors shall be AWS D1.1M/1.1 type “B” headed studs made from ASTM A108, Grade 1015 or 1020 cold-finished low carbon steel with dimensions complying with AWS D1.1M/1.1 for length and sizes shown.

O. Paint (Primer): Fast-dry, lead- and chromate-free, rust-inhibitive shop primer; gray color.

1. Primer and methods of primer application shall comply with applicable air-quality and environmental regulations.

P. Paint (Finish Coat): Fast-dry, lead- and chromate-free, rust-inhibitive paint; gray color.

Q. Touch-Up Primer for Galvanized Surfaces: Fabricator's standard, complying with VOC limitations of authorities having jurisdiction.

R. Grout: Non-shrink, non-metallic aggregate type, complying with ASTM C1107/C1107M and capable of developing a minimum compressive strength of 7,000 psi (48 MPa) at 28 days.

S. Tubular Railing: Conform to requirements of NAAMM Pipe Railing Systems Manual where same covers points not otherwise detailed or specified. Size as noted on the Contract Drawings.

PART 3 - EXECUTION

3.1 PREPARATION

A. Verification of Conditions:

1. Verify anchor bolt locations, grouting and elevation of base and setting plates, and other material set by other Trades before commencing work.

2. Notify City Representative of Work set by others which does not comply with specified tolerances. Do not erect materials upon such work until it has been satisfactorily corrected.

B. Examine surfaces for defects that would impair installation.

C. Obtain City Representative's approval before site cutting, field welding, or making non-scheduled adjustments.

D. Clean steel items to bare metal where site welding is scheduled.

E. Prepare for erection loads with temporary bracing; keep work in alignment.

F. Supply setting templates for items required to be cast into concrete.

G. Unless otherwise specified, use only metal braces, supports, and other items to position and align embedded metalwork, which will be embedded in concrete. Do not use wooden braces, supports, or other items to position and align embedded metalwork if they will also be embedded in concrete.

3.2 ERECTION

A. Erect work to the proper lines and levels, plumb and true, and in correct relation to other work. Maintain this condition to completion.

B. Erect structural steel in compliance with AISC "Code of Standard Practice for Steel Buildings and Bridges".

C. Install all miscellaneous fabricated items in accordance with manufacturer's published instructions and as shown on the Drawings.

D. Fastening to In-Place Construction: Provide anchorage devices, fasteners, and manufacturer's templates where necessary for securing miscellaneous metal fabrications to in-place construction. Include threaded fasteners for concrete inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors as required.

E. Allow for erection loads, and provide sufficient temporary bracing to maintain structure in safe condition, plumb, and in true alignment until completion of erection and installation of permanent bracing.

F. OSHA Section 1926.755 may require additional anchor bolts for stability during construction.

G. Field weld components and shear studs indicated on shop drawings.

H. Use carbon steel bolts only for temporary bracing during construction, unless otherwise specifically permitted on drawings. Install high-strength bolts in accordance with AISC "Specification for Structural Joints Using ASTM A325 or A490 Bolts".

I. Do not field cut or alter structural members without approval of City Representative.

J. Cut, drill, or punch holes perpendicular to metal surfaces. Do not flame-cut holes or enlarge holes by burning. Drill holes in bearing plates.

K. After erection, prime welds, abrasions, and surfaces not shop primed, except surfaces to be in contact with concrete.

L. Paint shall be applied to welded and bolted connection (if unprimed) after completion of installation.

M. Touch-Up Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint. Apply paint to exposed areas using same material as used for shop painting.

N. Prime coat all fabricated structural steel that will not be fireproofed before delivery, using two coats. Remove loose mill scale and rust, and completely remove oil, grease and foreign matter, as required by SSPC-SP2 or SSPC-SP3. Apply specified primer to provide a uniform, dry film thickness of 2 mils over all areas to be painted. Application shall be in strict accordance with the manufacturer’s instructions. Do not paint steel surfaces in contact with concrete. After steel is erected, touch up scarred and abraded shop painting.

O. Grout solidly between column plates and bearing surfaces, complying with manufacturer's instructions for nonshrink grout. Trowel grouted surfaces smooth, splaying neatly to 45 degrees.

P. Connections:

1. Machine Bolting:

   a. Fair-up holes with pins to align holes before bolting.

   b. Ream holes that must be enlarged to admit bolts.

   c. Do not enlarge unfair holes in members by burning or using drift pins.

   d. Draw bolts up tight after members are aligned and leveled, and set or deform threads to prevent loosening.

2. Welding:

   a. Weld by shielding arc method per AWS standard code for arc and gas welding in building construction.

   b. Submit certification that welders have passed AWS code qualification tests.

   c. Certification must be dated no earlier than 3 months prior to beginning of project.

   d. Refer to Shop Drawings for weld size and dimensions.

   e. Close joints exposed to weathering with continuous 1/8 inch weather welds.

   f. Grind smooth exposed welds, but grinding shall not reduce weld strength or required cross-section.

g. Protect finish material from damage due to welding.

h. Remove unsatisfactory welds by chipping or arc air method.

i. Where backing plates are permitted by the City to remain, attach with continuous fillet weld except where otherwise noted by drawings.

j. For DCW, cut runoff plates 1/8” at continuity plates from edges and grind smooth to a surface roughness of Sample 4, or better, of AWS C4.1.

3. Connect members temporarily and align completely before making permanent connections.

a. Temporary conditions shall consist of bolts in not less than 1/3 of the holes and in no case less than 3 bolts in any single connection.

b. Surfaces in contact shall be thoroughly clean when assembled.

c. Provide necessary temporary bracing and guying to align the structure properly for permanent connection and to safely resist erection dead load and wind stresses.

d. Remove bracing and guys only after permanent alignment and assembly and structure are capable of completely sustaining design and temporary construction loads.

4. Hand-hole welds and other welds attaching appurtenances to poles or arms.

a. Welds shall be continuous in areas of high stress concentrations. Starting and stopping of the welding process shall be limited to areas of lowest stress. For reinforced hand holes and appurtenances in poles and arms, the best locations for starting and stopping the welding process are at points located on a longitudinal axis of symmetry of the tube coinciding with the axis of symmetry of the hand hole or appurtenance (e.g., the top and bottom of the hand-hole rim or appurtenance in vertical poles). The Structural Engineer of Record may approve other weld start and stop locations based on sound engineering practices.

b. Reinforcing bars used around hand holes shall be made continuous using a full penetration butt weld, ground finish.

Q. Exposed Steel:

1. Verify the condition of exposed steel after erection.

2. Exert particular care to provide a neat, accurate installation with members straight and true, corners and edges square, sharp and free from burrs and irregularities, adjacent members perfectly matched and no bolts or rivets exposed.

3. Removed erection bolts and seats and plug weld and grind holes smooth.

4. All exposed steel shall be hot-dipped galvanized.

R. Field Painting:

1. Spot paint abrasions, field bolts and field welds with same paint used for shop coat.

S. Coating:

1. Repair damaged and uncoated areas of hot-dip galvanized coating according to ASTM A780.

3.3 FIELD QUALITY CONTROL

A. An independent testing and inspection agency shall be retained by the Contractor to perform field quality control tests, as specified in Section 01 45 00, and per construction documents.

B. High-Strength Bolts: Provide testing and verification of field-bolted connections in accordance with AISC "Specification for Structural Joints Using ASTM A325 or A490 Bolts."

C. Welded Connections: See General Structural Notes for more information on testing, quality control, and materials for welded connections

3.4 CLEANING

A. During the course of work and on completion of the work, remove excess materials, equipment and debris and dispose of away from premises

B. Leave work ready to receive fireproofing when applicable.

END OF SECTION