

SECTION 05 12 00
STRUCTURAL STEEL FRAMING

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Galvanizers Association (AGA): Quality Assurance Manual.
2. American Institute of Steel Construction (AISC):
 - a. 207, Standard for Certification Programs.
 - b. 303, Code of Standard Practices for Steel Buildings and Bridges.
 - c. 325, Steel Construction Manual.
 - d. 326, Detailing for Steel Construction.
 - e. 341, Seismic Provisions for Structural Steel Buildings.
 - f. 360, Specification for Structural Steel Buildings.
 - g. 420, Certification Standard for Shop Application of Complex Protective Coating Systems.
3. American Welding Society (AWS):
 - a. D1.1/D1.1M, Structural Welding Code—Steel.
 - b. D1.8/D1.8M, Structural Welding Code—Seismic Supplement.
4. ASTM International (ASTM):
 - a. A6/A6M, Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
 - b. A36/A36M, Standard Specification for Carbon Structural Steel.
 - c. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
 - d. A123/123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - e. A143/A143M, Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.
 - f. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - g. A384/A384M, Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies.
 - h. A385/A385M, Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip).
 - i. A500/A500M, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
 - j. A563, Standard Specification for Carbons and Alloy Steel Nuts.

- k. A572/A572M, Standard Specification for High-Strength Low Alloy Columbium-Vanadium Structural Steel.
- l. A780/A780M, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
- m. A992/A992M, Standard Specification for Structural Steel Shapes.
- n. A1065/1065M, Standard Specification for Cold-Formed Electric Fusion (Arc) Welded High-Strength Low-Allow Structural Tubing in Shapes with 50 ksi [345 MPa] Minimum Yield Point.
- o. A1085/A1085M, Standard Specification for Cold-Formed Welded Carbon Steel Hollow Structural Sections (HSS).
- p. B695, Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.
- q. D6386, Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting.
- r. D7803, Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Powder Coating.
- s. F436, Standard Specification for Hardened Steel Washers.
- t. F959, Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners.
- u. F1136, Standard Specification for Zinc/Aluminum Corrosion Protective Coatings for Fasteners.
- v. F3125, Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions.
- w. F3148, Standard Specification for High Strength Structural Bolt Assemblies, Steel and Alloy Steel, Heat Treated, 144 ksi Minimum Tensile Strength, Inch Dimensions.
- 5. Occupational Safety and Health Administration (OSHA).
- 6. Research Council on Structural Connections (RCSC): Specification for Structural Joints using High-Strength Bolts.

1.02 SUBMITTALS

A. Action Submittals:

- 1. Provide Shop Drawing details showing:
 - a. Erection plans.
 - b. Members, including piece numbers, sizes, grades, dimensions, cambers, and connection details.
 - c. Anchor bolt layouts.
 - d. Hardened washer details.
 - e. Connection material specifications.
 - f. Indicate type, size, and length of bolts.

- g. Joint details for complete penetration welds.
- h. Indicate welds by standard AWS symbols, distinguishing between shop and field welds and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
- 2. Product specifications, including primer and other coatings.
- 3. Identify pretensioned and slip-critical high strength bolted connections.
- 4. Locations of Class A, or higher, faying surfaces.
- 5. Weld access hole dimensions, surface profile, and finish requirements.
- 6. Location of demand critical shop welds.
- 7. Locations and dimensions of protected zones.
- 8. Gusset plates drawn to scale when they are detailed to accommodate inelastic rotation.
- 9. Nondestructive testing (NDT) where performed by the fabricator.
- 10. Welding requirements as specified in AISC 341 Appendix W, Section W2.2 or AWS D1.8/D1.8M.

B. Informational Submittals:

- 1. Schedule for submittal of shop and erection drawings.
- 2. Name and address of manufacturer(s).
- 3. Mill Certificates of tests made in accordance with ASTM A6/A6M.
- 4. Manufacturers' testing procedures and standards.
- 5. Preparation and installation or application instructions, as appropriate.
- 6. Proposed method to resolve misalignment between anchor bolts and bolt holes in steel members.
- 7. High-Strength Bolts:
 - a. Manufacturer's Certificate of Compliance, in accordance with Section 01 67 00, Product Requirements, that products meet specified chemical and mechanical requirements.
 - b. Manufacturer's inspection test report results for production lot(s) furnished to include:
 - 1) Tensile strength.
 - 2) Yield strength.
 - 3) Reduction of area.
 - 4) Elongation and hardness.
 - c. Certified Mill Test Reports for Bolts and Nuts:
 - 1) Name and address of manufacturer.
 - 2) Bolts correctly marked.
 - 3) Marked bolts and nuts used in required mill tests and manufacturer's inspection tests.
- 8. Direct Tension Indicators (DTIs): Manufacturer's test report meeting requirements of ASTM F959.
- 9. Twist-Off-Type Tension-Control (TC) Bolts: Manufacturer's test report meeting requirements of ASTM F3125 Grade F1852.

10. Welding Procedures, Qualifications, and Inspection Reports: As specified in Section 05 05 23, Welding.
11. Hot-Dip Galvanizing: Certificate of compliance signed by galvanizer with description of material processed and ASTM standard used for coating.
12. AISC Quality Certification: AISC certificate showing name and address of certified firm, effective date, and category of certification; or, for erectors, documentation of similar project experience to include project name, location, date of completion, and name and phone number of Contracting Officer's contact person.
13. Charpy V-notch test results.
14. Nondestructive Testing (NDT) report.

1.03 QUALITY ASSURANCE

A. Qualifications:

1. Welding qualifications as specified in Section 05 05 23, Welding.
2. Galvanized Coating Applicator: Company specializing in hot-dip galvanizing after fabrication and following procedures of AGA's Quality Assurance Manual.

B. Certifications: Mill identification marks, heat number, size of section, and length in accordance with ASTM A6/A6M.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Load structural members in such a manner that they will be transported and unloaded without damage to coatings and without being excessively stressed, deformed, or otherwise damaged.

B. Storage:

1. Store materials to permit easy access for inspection and identification. Store in a dry area and keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.
 - a. Do not store materials in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials as directed.
2. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.
 - a. Fasteners may be repackaged provided testing and inspecting agency observes repackaging and sealing of containers.
 - b. Clean and lubricate bolts and nuts that become dry or rusty before use.

- c. Comply with manufacturer's written recommendations for cleaning and lubricating fasteners and for retesting fasteners after lubrication.
- C. Handle materials to avoid distortion or damage to members or supporting structures.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Recycled Content of Steel Products:
 - 1. Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than the following:
 - a. W-Shapes: 60 percent.
 - b. Channels, Angles, S-Shapes: 60 percent.
 - c. Plate and Bar: 25 percent.
 - d. Cold-Formed Hollow Structural Sections: 25 percent.
 - e. Steel Pipe: 25 percent.
 - f. All Other Steel Materials: 25 percent.
- B. Rolled Plates, Shapes except W-Shapes and Bars: ASTM A572/A572M Grade 50, unless indicated otherwise.
- C. W-Shapes: ASTM A992/A992M, unless indicated otherwise on the Drawings.
- D. Steel Pipe: ASTM A53/A53M, Grade B.
- E. Round Hollow Structural Sections (HSS): ASTM A500/A500M, Grade C (Fy equals 46 ksi).
- F. Square and Rectangular Hollow Structural Sections (HSS): ASTM A500/A500M, Grade C (Fy equals 50 ksi)
- G. For hot-dip galvanized steel that is exposed to view and does not receive paint, limit combined phosphorus and silicon content to 0.04 percent. For steels that require a minimum of 0.15 percent silicon, such as plates over 1.5 inches thick for ASTM A36/A36M and ASTM A572/A572M steels, limit maximum silicon content to 0.21 percent and phosphorous content to 0.03 percent.

2.02 FASTENERS

- A. Anchor Bolts: As specified in Section 05 50 00, Metal Fabrications.
- B. Post-Installed Anchors: As specified in Section 05 05 19, Post-Installed Anchors.
- C. High-Strength Bolts:
 - 1. ASTM F3125 Grade A325, Type 1, finish type as indicated on the Area Classification Table.
 - 2. Bolt Length and Thread Length: As required for connection type shown, with hardened washers as required.
- D. Twist-Off-Type Tension-Control (TC) Bolts:
 - 1. High-strength, ASTM F3125 Grade F1852, bolt Type finish type as indicated on the Area Classification Table.
- E. Nuts: ASTM A563, type to match bolt type and finish.
- F. Hardened Steel Flat and Beveled Washers: ASTM F436, type to match bolt finish.
- G. Stud Shear Connectors: As specified in Section 05 50 00, Metal Fabrications.

2.03 ANCILLARY MATERIALS

- A. Surface Preparation and Primer: As specified in Section 09 90 00, Painting and Coating.
- B. Grout: As specified in Section 03 62 00, Grouting.

2.04 FABRICATION

- A. General:
 - 1. Fabricate as shown and in accordance with AISC 360 and AISC 303.
 - 2. Columns: Full-length members without splices, unless shown otherwise or approved by Contracting Officer.
 - 3. Mark and match mark materials for field assembly.
 - 4. Complete assembly, including bolting and welding of units, before start of finishing operations.
 - 5. Fabricate to agree with field measurements.
 - 6. Fabricate beams with rolling camber up.

B. Connections:

1. Shop Connections: Weld or bolt as shown on the Drawings.
2. Meet requirements of AISC 325 for bolted double-angle shear connections, unless indicated otherwise.
3. Meet OSHA requirements for one independent bolt at beams framing into column web connections.
4. Provide oversized holes for anchor bolts in column baseplate in accordance with AISC 325, unless indicated otherwise.

C. Welded Construction:

1. As specified in Section 05 05 23, Welding.
2. Groove and Butt Joint Welds: Complete penetration, unless otherwise indicated.

D. Interface with Other Work:

1. Holes:
 - a. As necessary or as indicated for securing other Work to structural steel framing, and for passage of other Work through steel framing members shall be approved by Contracting Officer.
 - b. No flame-cut holes are permitted without prior approval of Contracting Officer.
2. Weld threaded nuts to framing members, and other specialty items to receive other Work.

2.05 FINISHES

A. Shop Paint Primer:

1. Surface Preparation and painting as specified in Section 09 90 00, Painting and Coating.
2. Do not shop prime the following surfaces, unless indicated otherwise:
 - a. Within 2 inches of field-welded connections.
 - b. Steel members to be completely encased in reinforced concrete or coated with cementitious fireproofing.
 - c. Faying surfaces of slip critical bolted connections and bolted connections in Seismic Force Resisting Systems.
3. Apply shop primer to top flange surfaces of composite steel beams, unless indicated otherwise.

B. Galvanizing:

1. Fabricate steel to be galvanized in accordance with ASTM A143/A143M, ASTM A384/A384M, and ASTM A385/A385M.

Avoid fabrication techniques that could cause distortion or embrittlement of steel.

2. Surfaces of hot-dip galvanized iron and steel that will receive an application of powder coating materials, shall be prepared in accordance with ASTM D7803.
3. Surfaces of hot-dip galvanized iron and steel that will be painted, shall be prepared in accordance with ASTM D6386.
4. Remove welding slag, splatter, burrs, grease, oil, paint, lacquer, and other deleterious material prior to delivery for galvanizing.
5. Remove, by blast cleaning or other methods, surface contaminants and coatings not removable by normal chemical cleaning process in galvanizing operation.
6. Hot-dip galvanize steel members, fabrications, and assemblies after fabrication in accordance with ASTM A123/A123M.
7. Hot-dip galvanize ASTM F3125 Grade A325 bolts, nuts, washers, and hardware components in accordance with ASTM A153/A153M. Oversize holes to allow for zinc alloy growth. Shop-assemble bolts, nuts, and washers with special lubricant and test in accordance with ASTM F3125 and ASTM A563.
8. Mechanically zinc coat ASTM F3125 Grade F1852 twist-of-type tension-control (TC) bolts, nuts, and washers in accordance with ASTM F3125 and ASTM B695, Class 50.
9. Coat ASTM F3125 Grade F2280 twist-off-type tension-control (TC) bolts, nuts, and washers in accordance with ASTM F1136.
10. Galvanize components of bolted assemblies separately before assembly.

C. Slip Critical Bolted Connections:

1. Coated Faying Surfaces: Coat faying surfaces of slip critical bolted connections specified or shown with a paint primer with a Class A or Class B coating in accordance with the RCSC Specification for Structural Joints Using High-Strength Bolts and as specified in Section 09 90 00, Painting and Coating. Protect against overspray by use of masking. Remove inadvertent overspray from the faying surfaces.
2. Uncoated Faying Surfaces: Mask faying surfaces of slip critical (SC) bolted connections to be shop painted.
 - a. Faying surfaces shall be free of scale, except tight mill scale, and free of coatings, including inadvertent over spray in areas closer than one bolt diameter but not less than 1 inch from the edge of any hole and in all areas within the bolt pattern.
 - b. Blast clean Class B faying surfaces.
3. Galvanized Faying Surfaces: Prepare as required for Class A faying surface.

2.06 SOURCE QUALITY CONTROL

A. Welding:

1. Contractor's Certified Welding Inspector (CWI): Inspect and test fabrication welds as specified in Section 05 05 23, Welding.
2. Visually inspect fabrication welds in accordance with AWS D1.1/D1.1M, Section 6 and Table 6.1, Visual Inspection Acceptance Criteria.
3. An independent testing agency will be retained by Contracting Officer to perform the inspection and testing of fabrication welds as specified in Section 05 05 23, Welding.
4. Repair and retest defective welds as specified in Section 05 05 23, Welding.

B. Hot-Dip Galvanizing:

1. An independent testing agency will be retained by Contracting Officer to inspect and test hot-dip galvanized fabricated items.
2. Visually inspect and test for thickness and adhesion of zinc coating for minimum of three test samples from each lot in accordance with ASTM A123/A123M and ASTM A153/A153M.
3. Reject and retest nonconforming articles in accordance with ASTM A123/A123M and ASTM A153/A153M.

PART 3 EXECUTION

3.01 ERECTION

A. General:

1. Meet requirements of AISC 360 and AISC 303, with exceptions as specified.
2. Install Contractor-designed temporary construction bracing to provide necessary support until components are in place and construction is complete.
3. Provide additional field connection material as required by AISC 303.
4. Splice members only where indicated and accepted on Shop Drawings.

B. Field Assembly:

1. Clean bearing surfaces and other surfaces that will be in permanent contact before assembly.
2. Set structural frames accurately to lines and elevations shown.
3. Align and adjust various members forming a part of a complete frame or structure before permanently fastening.

4. Level and plumb individual members of structure within tolerances shown in AISC 303.
5. Establish required leveling and plumbing measurements on mean operating temperature of structure. Make allowances for difference between temperature at time of erection and mean temperature at which structure will be completed and in service.
6. Perform necessary adjustments to compensate for minor discrepancies in elevations and alignment.

C. Setting Baseplates and Bearing Plates:

1. Clean concrete and masonry bearing surfaces of bond reducing materials and roughen to improve bond to surfaces.
2. Clean bottom surface of baseplates and bearing plates.
3. Set loose and attached baseplates and bearing plates for structural members on wedges, shims, leveling nuts, or other adjustable devices. Use leveling plates where indicated.
4. Tighten anchor bolts after supported members have been positioned and plumbed. Do not remove wedges or shims, but if protruding, cut off flush with edge of base or bearing plate prior to placing grout. Weld plate washer to baseplate where indicated.
5. Grout Under Baseplate: As specified in Section 03 62 00, Grouting, prior to placing loads on structure.

D. Anchor Bolts:

1. Coordinate installation of anchor bolts and other connectors required for securing structural steel to in-place work.
2. Provide templates and other devices for presetting bolts and other anchors to accurate locations.
3. Projection of anchor bolts beyond face of concrete and threaded length shall be adequate to allow for full engagement of threads of hold-down nuts, adjustment of leveling nuts, washer thicknesses, and construction tolerances, unless indicated otherwise.
4. Placement Tolerances:
 - a. As required by AISC 303, unless indicated otherwise.
 - b. Embedded anchor bolts shall not vary from dimensions shown on the Drawings by more than the following:
 - 1) Center-to-Center of Any Two Bolts Within an Anchor Group: 1/8 inch.
 - 2) Center-to-Center of Adjacent Anchor Bolt Groups: 1/4 inch.
 - 3) Variation from Perpendicular to Theoretical Bearing Surface: 1:50.

E. Connections:

1. High-Strength Bolted:
 - a. Tighten in accordance with RCSC Specification for Structural Joints Using High-Strength Bolts.
 - b. Pretension all bolts unless noted otherwise on the Drawings.
 - c. Hardened Washers:
 - 1) Provide at locations required by Washer Requirements section of RCSC Specification for Structural Joints Using High Strength Bolts, to include pretensioned and slip critical connections using slotted or oversized holes or F3125 Grade A490 bolts.
 - 2) Use beveled style and extra thickness where required by RCSC Specification.
 - 3) Use square or rectangular beveled washers at inner flange surfaces of American Standard beams and channels.
 - 4) Do not substitute DTIs for hardened flat washers required at slotted and oversize holes.
 - d. For snug-tightened connections (N, X), tighten to snug tight condition. Use hardened washer over slotted or oversize holes in outer plies.
2. Pretensioned Bolted:
 - a. Use DTIs or twist-off-type tension-control (TC) bolts at slip critical (SC) and pretensioned bearing-type connections.
 - b. Final tightening bolts begin at most rigid part of bolted connection and progress toward free edges until final twist-off-type tension-control (TC) bolts or until DTIs have been compressed to an average gap equal to or less than shown in ASTM F959, Table 2.
3. Welded:
 - a. As specified in Section 05 05 23, Welding.
 - b. Groove and Butt Joint Welds: Complete penetration, unless otherwise indicated.

3.02 MISFITS

A. At Bolted Connections:

1. Immediately notify Contracting Officer for approval of one of the following methods of correction:
 - a. Ream holes that must be enlarged to admit bolts and use oversized bolts.
 - b. Plug weld misaligned holes and redrill holes to admit standard size bolts.
 - c. Drill additional holes in connection, conforming to AISC for bolt spacing and end and edge distances, and add additional bolts.

- d. Reject member containing misfit, incorrect sized, or misaligned holes and fabricate new member to ensure proper fit.
2. Do not enlarge incorrectly sized or misaligned holes in members by burning or by use of drift pins.

B. At Anchor Bolts:

1. Resolve misalignments between anchor bolts and bolt holes in steel members in accordance with approved Shop Drawing.
2. Do not flame cut to enlarge holes without prior approval of Contracting Officer.

C. Gas Cutting:

1. Do not use gas cutting torches in field for correcting fabrication errors in structural framing.
2. Secondary members not under stress and concealed in finished structure may be corrected by gas cutting torches, if approved by Contracting Officer.
3. Finish flame-cut sections equivalent to sheared and punched appearance.

3.03 REPAIR AND CLEANING

- A. Clean shop primer from field welds, bolted connections, and abraded areas immediately after erection.
- B. Remove and grind smooth tack welds, fit-up-lugs, and weld runoff tabs.
- C. Remove weld back-up bars and grind smooth where indicated on the Drawings.
- D. Apply touchup paint primer by brush or spray of same thickness and material as that used in shop application and as specified in Section 09 90 00, Painting and Coating.
- E. Hot-Dip Galvanized Coating Repair:
 1. Conform to ASTM A780/A780M.
 2. For minor repairs at abraded areas, use sprayed zinc conforming to ASTM A780/A780M.
 3. For flame cut or welded areas, use zinc-based solder, or zinc sticks, conforming to ASTM A780/A780M.
 4. Use magnetic gauge to determine thickness is equal to or greater than base galvanized coating.

3.04 FIELD FINISH

- A. Field finish in accordance with Section 09 90 00, Painting and Coating.

3.05 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

- A. Contracting Officer-Furnished Quality Assurance, in accordance with IBC Chapter 17 requirements, is provided in Statement of Special Inspections Plan in Supplement located at end of Section 01 45 33, Special Inspection, Observation, and Testing. Contractor responsibilities and related information are included in Section 01 45 33, Special Inspection, Observation, and Testing.
- B. Contractor-Furnished Quality Control: Inspect and test as required in Section 01 40 00, Quality Requirements.
- C. High-Strength Bolted Connections:
 - 1. An independent testing agency will be retained by Contracting Officer to perform the following inspection and testing in accordance with the RCSC Specification for Structural Joints Using High-Strength Bolts:
 - a. Marking identification and conformance to ASTM standards.
 - b. Alignment of bolt holes.
 - c. Placement, type, and thickness of hardened washers.
 - d. Tightening of bolts.
 - 2. Snug-Tightened Connections (N, X): Snug tight condition with plies of joint in firm contact.
 - 3. Pretensioned Bearing and Slip Critical (SC) Connections:
 - a. Conduct preinstallation test.
 - b. Monitor installation and tightening of DTIs or TC bolts.
 - c. Monitor condition of faying surfaces for slip critical connections.
 - 4. Preinstallation Test:
 - a. Conduct test in accordance with Specification for Structural Joints Using ASTM F3125 Grade A325 or Grade A490 bolts prior to using bolt tension measuring device.
 - b. Select representative sample of not less than three bolts of each diameter, length, and grade.
 - c. Include DTIs and flat hardened washers as required to match actual connection assembly.
 - 5. Nondestructive Testing (NDT): Inspect bolted connections and perform corrections as required to meet code acceptance criteria per RCSC Specification for Structural Joints Using High-Strength Bolts.
 - 6. Defective Connections: Correct and reinspect defective and improperly tightened high-strength bolted connections. Retest pretensioned bolts as necessary to demonstrate compliance of completed work.

D. Welding:

1. Contractor's Certified Welding Inspector (CWI): Inspect and test field welds as specified in Section 05 05 23, Welding.
2. Visually inspect field welds in accordance with AWS D1.1/D1.1M, Section 6 and Table 6.1, Visual Inspection Acceptance Criteria.
3. An independent testing agency will be retained by Contracting Officer to perform inspection and testing of field welds as specified in Section 05 05 23, Welding.
4. Repair and retest defective welds as specified in Section 05 05 23, Welding.

E. Special inspection will be provided by Contracting Officer as indicated.

END OF SECTION