

SECTION 05120  
STRUCTURAL STEEL

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes structural steel, complete, in accordance with Contract Documents.
- B. Related work: Section 05300 - Metal Decking: accessories.

1.2 REFERENCES

- A. Except as modified by governing codes and by Contract Documents, comply with applicable provisions and recommendations of the following:
  - 1. AISC "Code of Standard Practice for Steel Buildings and Bridges."
  - 2. AISC "Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings."
  - 3. AWS "Structural Steel Code."
  - 4. Industrial Fastener Institute "Handbook on Bolt, Nut and Rivet Standards."
  - 5. SSPC "Steel Structures Painting Manual, Volume 2 Systems and Specifications."
  - 6. "Specifications for Structural Joints Using ASTM A325 or A490 Bolts," approved by research council on Riveted and Bolted Structural Joints of the Engineering Foundation.
  - 7. ASTM A6 "General Requirements for delivery of Braced Steel Plates, Steel Piling and bars for Structural Use."

1.3 SUBMITTALS

- A. Product Data: Include laboratory test reports and such other data required to show compliance with Contract Documents. Indicate by transmittal form that copy of each applicable instruction has been distributed to each Installer or Fabricator.
  - 1. Structural Steel: (each type) including certified copies of mill reports covering chemical and physical properties, country and rolling mill of origin, and including statement indicating that steel is new billet steel and that testing has been performed in accordance with ASTM standards. Correlate individual heat numbers with each specified section and location. Retest steel if test results are unsatisfactory.
  - 2. High Strength Bolts: (each type) including nuts and washers. Provide test reports for each production lot indicating proof load, tensile strength (wedge test), and hardness. Provide certified copies of mill reports covering chemical and physical properties, country and rolling mill of origin, and including statement indicating that steel is new billet steel and that testing has been performed in accordance with ASTM Standards. Retest bolts if test are unsatisfactory.
  - 3. Welding Electrodes: (each type).
  - 4. Shop Coat Primer paint: Field touch-up paint; manufacturer's specifications, performance data, and application instructions.

5. Shop applied shear stud connectors.
  6. Anchor Bolts.
- B. Shop Drawings: Submit Shop Drawings for the following items in accordance with Division 1 prepared under supervision of a Registered Professional Engineer with current registration in State of California, including complete details and schedules, all shop and erection details for fabrication and assembly, all connections and holes, bolts and welds. All welds, both shop and field shall be indicated by the AWS Standard Welding Symbols.
1. Provide shop fabrication drawings, which show details, schedules and other information necessary for fabrication of each member and for shop assembly of members of structure. Indicate type, size, location and extent of welds and bolts. Clearly distinguish between shop and field bolts and welds. Indicate member splices and plate splices on shop drawings, for both shop and field. Indicate AISC pre-qualified welds by designation that indicates root and bevel angles for partial and full penetration welds as well as the specific weld process and the fabricator's specific identification for the welding procedure specification, which includes preheating and other requirements.
  2. Provide field assembly and erection drawings which show field assembly prior to erection and after erection. Indicate details, schedules and diagrams showing field assembly. Procedures shall indicate intermediate surveys, cambers, member overlength, and allowances for temperature. Include setting drawings and templates for column base plates.
  3. Provide written procedure of each item and welding sequence including preheating and cool down at each joint to minimize effect of weld shrinkage residual stress, and to maintain erection tolerances.
  4. Identify each type and class of welding electrodes.
  5. Non-domestic fabrication shall be in accordance with shop drawings prepared domestically by structural steel detailers commonly providing services to domestic fabricators. Form and character of shop drawings shall be to Architect's satisfaction, be checked and complete. Reuse of the Contract Documents is not permitted.
- C. Testing and Inspection Reports.
- D. Welders Certifications, Welding Procedure Specifications, etc.
- E. Prior to fabrication, prepare and submit to Testing Agency and Architect written Quality Assurance Program including material identification, welder certifications/ re-certifications, welding procedure specifications, etc. as well as all procedures for shop fabrication and field connections for steel work. These procedures shall indicate Fabricator's quality control measures, monitoring and repair procedures. Weld details and procedures shall be in accordance with AISC and AWS pre-qualified details, procedures and standards, as well as, particularly pre-qualified welding procedures and particularly pre-qualified welder certifications for each complete penetration shop and field welding process and detail.

#### 1.4 QUALITY ASSURANCE

- A. Quality Assurance: Prepare and execute full and complete program of Quality Assurance including evaluation, material reports, sampling, appropriate types and quantities of testing, and detailed fabrication and erection drawings which provide no opportunity to complete unsatisfactory steel work. Perform retesting or evaluations by Quality Control Personnel due to deficient work, and similar work at no additional cost to Owner.
- B. Quality Control: Steel work is subject to evaluation and tests in shop and field by others. Evaluations and testing undertaken by others is strictly for random evaluation. Extent, duration and amount of testing and evaluation are entirely at discretion of others. Use of testing services, execution of testing or evaluation services by others shall in no way relieve sole responsibility to furnish materials and construction in full compliance with Contract Documents.

- C. Testing Agency: Owner will engage, at his expense, certified Testing Agency to inspect materials, fabrication, high strength bolted connections and welds, to perform test specified, and to submit reports to Architect and Local Building Authority.
1. Testing Agency will be responsible for conducting and interpreting tests, will state in reports whether test results comply with Contract Documents, will specifically note deviations there from, and will indicate corrective measures required and taken. Testing Agency inspectors shall keep daily records of work inspected and its disposition in accordance with form prescribed in "Structural Welding Code."
  2. Provide Testing Agency with the following:
    - a. Shop and erection drawings.
    - b. Cutting lists, order sheets, material bills, shipping bills and mill test reports.
    - c. Information as to time and place of rollings and shipment of material to shop.
    - d. Access to places where material is being fabricated or produced.
    - e. Representative sample pieces requested for testing.
    - f. Full and ample means and assistance for testing.
    - g. Proper facilities, including scaffolding, temporary work platforms and hoisting facilities for inspection of Work in mills, shop and field.
  3. Contractor shall provide and pay for corrective measures, including additional and more complete testing.
  4. Architect and Testing Agency may observe structural steel at plant before shipment; however, Architect reserves the right to reject material, at any time before final acceptance which does not conform to requirements of Contract Documents.
  5. Unless more stringent requirements are stated elsewhere, be responsible for extra cost due to:  
  
Inspections and testing required off-site greater than 75 miles from the job site.  
  
Inspections and testing required at more than one off-site location.  
  
Overtime inspections and testing incurred without Owner's Approval or for acceleration of work for Contractor's convenience.
- D. Source Quality Control:
1. General: Material delivered with certificates classified as identifiable; without certificates classified as unidentifiable. High strength steels shall be suitably identified on each piece and reviewed by the testing Agency in comparison to mill test certificates.
  2. Testing of Unidentifiable Material: By testing agency; paid for by Contractor.
  3. General: Test material not identifiable by heat number and mill test or other acceptable manufacturer's identification per ASTM A370 as follows:
    - 1) Structural shapes and plates: From coupons taken from material; one tensile test and one bend test per five tons of each shape.

- 2) High Strength Bolts: Each lot of 100 bolts; tensile tests on two bolts in full size and one tensile test on half-inch diameter machined specimen.
- E. Bolted connections shall be inspected by Testing Agency in accordance with AISC Specification for "Structural Joints using ASTM A325 and A490 Bolts."
1. All bolts shall be inspected as "fully-tensioned" unless specifically identified on the drawings that the bolt may be only tightened to "snug-tight" condition.
- F. Welding shall be inspected and tested by Testing Agency during fabrication and erection of structural steel in accordance with AWS as follows:
1. Certify welders and make inspections and tests as required. Record types and locations of defects found in Work, and measures required and performed to correct such defects.
  2. In addition to visual inspection of welds, magnet particle and ultrasonic inspection shall be made. Magnetic particle inspection shall be made on root pass and finish weld.
  3. Method of magnetic particle inspection shall be in accordance with ASTM E109. Cracks or zones of incomplete fusion or penetration not acceptable. Equipment shall be capable of locating cracking below surface of welds. Check a minimum of 15% of all fillet welds distributed throughout the work and 25% of all fillet welds of built-up sections. 100% of fillet welds for moment resisting frames and braced frames shall be magnetic particle tested.
  4. Perform ultrasonic inspection in accordance with AWS D1.1. 100% of all partial and complete penetration shop and field welds shall be ultrasonically tested.
  5. All welding inspection and testing of moment resisting frame welds shall be performed by an experienced deputy welding inspector qualified at NDT Level II for ultrasonic and magnetic particle testing. In addition, inspectors shall have supplemental qualifications as defined in FEMA 353 Appendices E and F.
- G. Testing Agency shall inspect structural steel for laminations or other discontinuities by ultrasonic methods.
1. Ultrasonic testing shall be performed on all sections in ASTM A6 Groups 4 and 5 and in Group 3 where flange or web thickness exceeds 1 1/2". In addition, all plates exceeding 2" in thickness shall be tested.
  2. Testing shall be performed in accordance with ASTM A435 for plates and ASTM A898 for rolled sections.
  3. The test area shall consist of a column flange zone extending at least 3" above and below each beam flange CPJ connection. Column webs shall be similarly tested for weak axis connections. Similar zones for plates in built-up sections and base plates shall also be tested. Tests shall be performed prior to fabrication and after final welding.
  4. For plates any discontinuity causing total loss of back reflection that cannot be contained within a circle 3" in diameter or 1/2 the plate thickness, whichever is greater, shall be rejected. For rolled shapes ASTM A898 Level I criteria are applicable.
- H. Each bolting crew and welder shall be assigned identifying symbol or mark. Shop and field connections shall be identified so that inspector can refer back to crew or person making connection.
- I. Testing Agency shall confirm qualification of welders, AWS procedures are followed, welding equipment is used per manufacturer's recommendations, preheating is properly used, proper use of runout plates, jigs, and fit-up, and structural steel complies with specific dimensional standards.
- J. Where inspections reveal defects, extent of inspection will be increased as necessary to assure that full extent of defects in joint has been found and to assure that same defects are not present in welds made on similar parts or under similar circumstances.

## 1.5 HANDLING

- A. Comply with the requirements of Division 1.
- B. Plan method and sequence to avoid delay or damage to steel work or work of other trades.
- C. Be responsible for steel shipment to site and storage of fabricated steel at job site. Material stored at job site shall not exceed design loads on structures so that members will not be distorted or otherwise damaged; and shall be protected against corrosion or deterioration.
- D. Stack materials out of mud and dirt and provide for proper drainage. Protect from damage or soiling by adjacent construction operations.
- E. Provide temporary shoring, bracing the guy lines to adequately protect all persons and property and to ensure proper alignment.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Structural Steel:
  - 1. Structural steel for rolled wide flange shapes shall comply with provision of ASTM Specifications appropriate for grades indicated. Provide ASTM A992 steel, unless noted otherwise.
  - 2. Structural steel plates, angles and channels shall be ASTM A36 or ASTM A572-50 as indicated on the drawings.
  - 3. Dimensional Standards: ASTM A6; welded shapes per dimensional standards of mill rolled sections.
  - 4. Quality: Sound, free from loose mill scale, cracks, laminations and slag inclusions.
  - 5. Column sections and plates thicker than 1 1/2" inches shall be fine grained killed steel.
- B. Welding Electrodes: Comply with provisions of AWS "Structural Welding Code" and Specification A5.1, A5.5, A5.17, A5.18, A5.20 and A5.29.
- C. High strength bolts and high strength bearing bolts, nuts and washers: Comply with provisions of:
  - 1. ASTM A325 or A490, as noted.
  - 2. AISC Specification for "Assembly of Structural Joints Using High Strength Bolts."
  - 3. All bolts in slip critical frame connections shall be hex head without beak-off splines, etc. unless direct tension indicating washers are provided at all slip critical connections. Use of break-off spline bolts in non-frame gravity connections acceptable.
- D. Welded Studs: By Tru-Weld, Nelson Stud Welding Div. of Gregory Industries, and Stud Welding and Rebar Splicing Division of Erico Products, Inc. complying with the following.
  - 1. Standard steel studs for welding by automatically timed stud-welding equipment, furnished complete with an arc shield (ferrule) of heat-resistant ceramic for all studs, and, for studs 5/16 in. diameter or larger, a deoxidizing and arc stabilizing flux; not painted, galvanized, or cadmium-plated prior to welding and all finished by cold-heading, cold-rolling or machining.

2. Provide studs of uniform quality and condition, free of injurious laps, fins, seams, cracks, twists, bends not indicated, rust, rust pits, scale, oil and other injurious defects or substances.
  3. Steel shall be Grade C-1015, C-1017 or C-1020, cold-drawn, conforming to ASTM A 108 and having minimum 60,000 psi tensile strength with 20% elongation in 2 in. and 50% area reduction.
- E. Paint:
1. Paint shall be confirmed to meet all Code requirements.
  2. Prime Paint: Tnemec's No. 10-99 Red Primer.
  3. Zinc rich primer for painted steel exposed to the elements: Tnemec No. 90-97; weight not less than 21 pounds per gallon.
  4. Hot dip galvanized all steel work permanently exposed to the exterior including bolts, nuts, washers, etc.
- F. Miscellaneous Materials:
1. Provide miscellaneous materials or accessories as indicated or required for good construction practice.
  2. Provide supplemental structural steel support framing for metal deck where normal deck bearing is precluded by column flange plates or other framing members and around minor floor openings where indicated.
  3. High Strength Anchor Bolts – ASTM A354 Gr BD or ASTM A449 as indicated on the drawings.

## 2.2 FABRICATION

- A. General: Fabricate per AISC Specifications. Properly mark materials where field assembly requires. Sequence material shipments to expedite erection and minimize field handling.
- B. Planning and milling:
1. Mill bearing surfaces to true planes. Mill ends of columns perpendicular to centerline axis connected mid depth points at ends of member. Milled surfaces shall be completely assembled or welded before milling. Cut and fit column and bearing stiffeners to give full bearing over cross section.
  2. Column Base Plates:  
  
From 2 inches through 4 inches thickness: Straighten by pressing.  
  
Over 4 inches thickness: Plane top for column bearing; Plane bottom when bearing on steel.
- C. Holes, Cutout and Filling: Provide where indicated for other trades. No additional holes, cutouts, or fittings permitted without written permission.
- D. Camber: Fabricate beams, girders and assemblies with natural camber upward, unless otherwise indicated.
- E. Connections shall be as indicated. Alternate connections may be required due to erection or other conditions. Connections for shop or field connections or splicing shall be shown on shop fabrication drawings for review prior to fabrication.
- F. Detail connections by fabricator based on information indicated and considerations of shipment and erection. Detailing shall be performed using rational engineering design and standard practice in accordance with AISC. Details indicated on Drawings may be subjected to minor changes during detailing.
- G. No combination of bolts and welds shall be used for stress transmission in same faying face of connections.

- H. Automatic or semi-automatic welding may be used per AWS procedure.
- I. Welding, filler metal, welding techniques, qualified welders, and procedures shall be in accordance with AISC Specification for "Design, Fabrication and Erection of Structural Steel for Buildings," and AWS "Structural Welding Code" and "Filler Metal Specifications."
- J. Clean steel in areas where paintings, welding, bolting, stud welding, metal deck welding will be performed.
- K. Welding processes other than shielded metal arc and submerged arc may be used provided procedure qualification tests in accordance with American Welding Society are made for intended application of such process. Testing and Submittal for test reports shall be submitted with proposed locations of use for review prior to Shop Drawings Submittal and shall have been identified during bidding and reviewed.
- L. Built-up sections assembled by welding shall be free of warpage and axes shall have alignment within specified tolerances.
- M. Welds not specified shall be continuous fillet weld, using not less than minimum size and specified by AWS.
- N. Welding sequences shall be such to reduce residual stresses due to welding to minimum value.
- O. Toughness and notch sensitivity of steel shall be considered in formation of welding procedures to prevent brittle and premature fracture.
  - 1. Welding procedures for complete penetration welds shall include sequences for placing each weld bead as well as pre-heat and post-heating, electrode selection, etc.
  - 2. Welding procedures shall be written and shall be prepared by a qualified welding engineer.
  - 3. Welding procedures shall account for all fabrication orientations and welding conditions, material grades, mill certifications, member sizes, etc.
- P. Detail and design welded connections to minimize accumulation and concentration of through-thickness strains due to weld shrinkage.
- Q. Detailing of copes/access holes at full penetration welds shall follow FEMA 350 Fig. 3-5.
  - 1. The web cope details shall be compatible with the weld process. The bottom flange web cope shall permit as much welding as possible under the cope and beyond the web.
  - 2. The cope details shall be developed with the consultation of the qualified welding engineer who developed with the consultation of the qualified welding engineer who develops the written welding procedure specification for the welds.
- R. Repairs: Remove defects, re-weld, and grind welds flush; method of repairs shall be acceptable to Testing Laboratory. In lieu of repairs, materials with defects may be replaced with new at Contractor's option and expense.

### 2.3 SHOP PAINTING

- A. General: Do not paint when ambient temperature is below 40 degrees Fahrenheit. Paint in dry weather or under cover. Apply paint by brush or spray over dust free surface per manufacturer's directions. Do not thin paint in excess of manufacturer's recommendations. Allow paint to dry before handling the shipment of structural steel.
- B. Shop-coat structural steel except the following:
  - 1. Members to be incased in concrete.
  - 2. Contact surfaces of welded connections and areas within 2 inches of field welds.

3. Contact surfaces of high-strength bolted connections.
  4. Surface receiving sprayed-on fireproofing.
- C. Prime Paint:
- Surface Preparation: Clean surfaces of loose mill scale, dirt, rust and other foreign matter by use of suitable tools; hand tool cleaner per SSPC-3, commercial blast cleaning per SSPC SP-6 for steel exposed to the elements. Remove oil and grease with cleaners per SSPC SP-1.
1. Application: Apply one coat to dry film thickness not less than 4.0 mils.
  2. Zinc Rich Primer Application: Apply one coat to dry film thickness not less than 4.0 mils.
- D. Machine Finished Surfaces: Carefully protect against corrosion with coat of white lead and tallow or similar protection; apply per AISC requirements prior to shipments.
- E. Concealed Surfaces: Paint parts inaccessible after assembly or erection with two coats of primer paint, or different colors.
- F. Field Painting:
1. Field paint bolt heads and nuts, welds, abrasions, and unpainted steel work.
  2. Field paint with primer paint.
  3. Clean completed steel work of foreign materials.
- G. Unpainted Surfaces: Remove oil and grease with solvent cleaners; remove dirt and other foreign material by sweeping with wire brushes.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. : Examine substrates, adjoining construction, and conditions under which Work is to be installed. Correct satisfactory conditions before proceeding with erection.

### 3.2 PREPARATION

- A. Field Measurements: Establish permanent benchmarks and verify elevations of concrete on which structural steel is to be placed and anchor bolt locations and projections using California-licensed Surveyor. Report discrepancies to Architect before proceeding with Work. Perform remedial work in the shop prior to shipment to the Project.

### 3.3 ERECTION

- A. Be responsible for accurate setting and leveling of bearing plates. Furnish templates for accurate setting of anchor bolts. Bearing plates shall be leveled on steel wedges or shims or as otherwise detailed. Grout bearing plates as specified in Section 03600-Grout.
- B. Notify grout manufacturer at least twenty-four hours prior to grouting. Do no grouting without grout manufacturer's representative present at site, for initial test plate and initial production work. Train workmen in preparation, placing curing, etc. to the satisfaction of inspector.



- C. Erect building frame true and level. Erect columns in manner to allow for shrinkage of girders after welding. Check plumbness after erection of each tier. Maintain structural stability of frame during erection; provide temporary bracing where necessary to maintain frame stability and to support required loads, including equipment and its operation.

#### 3.4 ERECTION TOLERANCES

- A. Be responsible for correct fitting of structural members and for elevation and alignment of finished structure per AISC Code of Standard Practice (minimum). Be responsible for adjustments to steel work because of discrepancies in elevations and alignments. Furnish shim plates or developed fills where required to obtain fit and alignment.
- B. Unless noted otherwise, plumb structure to accuracy of 1 to 1000, but not to exceed ½ inch per two-story tier. Overall vertical plumbness not to exceed 1 to 500, but not to exceed 1-inch maximum. Level horizontal members to accuracy of 1 to 1000 not to exceed +/- ¼ inch at columns.
- C. Measurements relating to above shall be on theoretical centerline of members.

#### 3.5 CONNECTIONS

- A. Do no welding or bolting until as much of structure as will be stiffened by welding or bolting has been properly aligned.
- B. Do not use drift pins to enlarge unfair holes in main material. Ream holes that must be enlarged to admit bolts. Use of burned holes for bolted connections not permitted and main structural members with burned holes will be rejected. Drifting may be used to align unfair holes in secondary bracing members only, when acceptable to Architect. Maintain minimum edge distances at enlarged holes.
- C. When high strength bolts or high strength bearing bolts are used, AISC Specifications shall apply including values as noted therein, and installation shall be to full torques (not snug –tight) be either “turn of the nut tightening” or with torque wrenches. In using manual torque wrenches, required torque can be read from wrench dial. Care should be taken that wrench is properly calibrated. Nuts shall be in motion when torque is measured. In using power wrenches, follow recommendations of manufacturer. Calibrate manual and power torque wrenches at least once daily and for each lot of bolts.
- D. Alternative bolting may be accomplished by utilizing Coronet Load Indicator washers as “direct tension indicators” in accordance with current specifications as indicated in AISC, UBC-ICBO Report No. 2885, and manufacturer’s recommendations whichever are more stringent. Proposers shall indicate their cost with and without use of indicators for bolting and for use on friction bolted connections only.
- E. Pre-qualified welders using pre-qualified welding procedures shall perform all field welding All field welding of moment resisting frame complete penetration welds of beam flanges to columns and complete penetration column splices shall be performed by particularly pre-qualified welders and pre-qualified welding procedures. Pre-qualification of frame welders shall be by procedures and criteria as described in FEMA 353 Appendix B. Equipment, electrodes and procedures shall be identical to those used in the field production welds. Weld deposition rates of field production welds shall not exceed those of the successfully performed test. The test coupon shall be placed at an elevation and orientation such that the welder works in a position that replicates field conditions. Each shall frame welder shall successfully complete one beam-column coupon and one column splice coupon prior to being permitted to perform field production welds.
  - 1. ---- Welding shall proceed only based on written procedure specifications prepared by a qualified welding engineer.
  - 2. ---- The written procedure specifications shall account for field conditions, material grades, member sizes, etc.

3. -- The written procedure specifications shall include specific diagrams of different job conditions showing the sequence of placements of weld beads, extension/ backup/ runoff material, locations of tack welds, start/ stop locations, etc. as well as cleaning, grinding etc. between passes.
4. The procedure shall indicate the sequence for progression of welding within the building as a whole, within frame lines and within individual connections. Sequences shall minimize locked in tensile stresses due to weld shrinkage to the greatest extent possible.
5. The written procedure specification shall indicate pre-heat and post-heat requirements based on the full chemical composition of the abutting steels, field conditions, electrode and weld process, etc. The procedure shall indicate the locations of measurement of temperatures and frequency of measurements.
6. The written procedure specification shall indicate that the bottom flange welds be built up to full size by welding alternately in a uniform manner on both sides of the web. Stops and starts shall be avoided below the web and weld shall proceed under the web cope and beyond as much as possible.
7. The written procedure specification shall indicate removal of extension/ backup/ runoff materials attendant with the top and bottom flange connections as well as gouging the weld to remove any incomplete penetration, slag, etc. of the root passes and reinforcing the bottom of the weld.
8. The written procedure shall indicate the field fit up requirements and tolerances of the root opening.

END OF SECTION