

SECTION 16441

STEEL STRUCTURES

PART 1 DESCRIPTION

- A. Fabricate and erect structural steel and other metals used for steel structures or for steel portions of structures.

PART 2 MATERIALS

2.01 BASE METAL

- A. Use metal that meets Item 16442, “Metal for Structures.”

2.02 APPROVED ELECTRODES AND FLUX-ELECTRODE COMBINATIONS

- A. Use only electrodes and flux–electrode combinations found on the list of approved electrodes and flux–electrode combinations maintained by the City. To request that a product be added to this list or to renew an expired approval, submit certified reports of all tests required by the applicable AWS A5 specification according to the applicable welding code (for most construction, AASHTO/AWS D1.5, *Bridge Welding Code*, or AWS D1.1, *Structural Welding Code—Steel*) to the City.

2.03 HIGH-STRENGTH BOLTS

- A. Use fasteners that meet Item 16447, “Structural Bolting.”

PART 3 CONSTRUCTION

3.01 GENERAL REQUIREMENTS

- A. Applicable Codes
 - 1. Perform all fabrication in accordance with AASHTO/NSBA Steel Bridge Collaboration S2.1, including fabrication of non-bridge members. Follow all applicable provisions of the appropriate AWS code (D1.5 or D1.1) except as otherwise noted in the plans or in this Item. Weld sheet steel (thinner than 1/8 in.) in accordance with ANSI/AWS D1.3, *Structural Welding Code—Sheet Steel*. Unless otherwise stated, requirements of this Item are in addition to the requirements of S2.1. Perform all bolting in accordance with Item 16447, “Structural Bolting.”
- B. Primary Members
 - 1. Primary members include:

- a. webs and flanges of plate, tub, and box girders;
 - b. rolled beams and cover plates;
 - c. floor beam webs and flanges;
 - d. arch ribs and arch tie beams or girders;
 - e. truss members;
 - f. diaphragm members for curved plate girders or beams;
 - g. pier diaphragm members for tub girders;
 - h. splice plates for primary members; and
 - i. any other member designated as “primary” or “main” on the plans.
- C. Responsibility
1. The Contractor is responsible for the correctness and completeness of shop drawings and for the fit of shop and field connections.
- D. Railroad Structures
1. Fabricate railroad underpass structures in accordance with the latest AREMA *Manual for Railway Engineering* and this Item. In the case of a conflict between this Item and the AREMA manual, the more stringent requirements apply.
- E. Qualification of Plant, Laboratories, and Personnel
1. Fabrication
 - a. The Department will evaluate fabrication plants for competence of the plant, equipment, organization, experience, knowledge, and personnel to produce acceptable work. Plants must be qualified in accordance with S2.1 (or equal acceptable qualification). When AISC certification is required, provide a copy of the certificate and a copy of the complete audit report, including the exit meeting report.
 2. Nondestructive Examination (NDE)
 - a. Personnel performing NDE must be qualified in accordance with the applicable AWS code. Testing agencies and individual third-party contractors must also successfully complete periodic audits for compliance. In addition, ultrasound technicians must pass a hands-on

test administered by the City. A technician who fails the hands-on test must wait 6 months before taking the test again. Qualification to perform ultrasonic testing for the City will be revoked when the technician's employment is terminated, and recertification based on a new hands-on test will be required.

3. Welding Procedure Qualification

- a. Laboratories performing testing for welding procedure qualification must successfully complete periodic audits.

F. Drawings

1. Erection Drawings

- a. Submit 2 copies of erection drawings before erection of railroad underpasses, trusses, field-spliced (welded or bolted) girders, arches, or other members for which erection drawings are required on the plans. Submit an additional copy of the drawings for railroad underpasses. Erection drawings are not required for rolled I beam units unless otherwise noted on the plans.
- b. Clearly indicate at least:
- (1). procedures;
 - (2). sequence of work;
 - (3). equipment to be used;
 - (4). location of falsework, erection cranes, and holding cranes;
 - (5). falsework design details;
 - (6). girder lifting points;
 - (7). adjacent structures loaded; and
 - (8). requirements for releasing cranes during erection that differ from the requirements of this Item or those shown on the plans.
- c. If site conditions differ from those assumed for these drawings, revise the drawings to reflect the actual conditions before continuing the erection work.

2. Shop Drawings

- a. Before fabrication, prepare and submit shop drawings for each detail of the general plans requiring the use of structural steel, forgings, wrought iron, or castings.
 - (1). Bridge Structures
 - (a). Unless otherwise approved, prepare drawings in accordance with AASHTO/NSBA Steel Bridge Collaboration G1.3, “Shop Detail Drawing Presentation.” Print a bill of material on each sheet, including the Charpy V Notch (CVN) and fracture-critical requirements, if any, for each piece. Indicate joint details on shop drawings for all welds. Indicate fracture-critical areas of members.
 - (b). Show a title block in the lower right corner including:
 - I. project identification data including federal and state project numbers,
 - II. sheet numbering for the shop drawings,
 - III. name of the structure or stream,
 - IV. name of the fabricator or supplier, and
 - V. name of the Contractor.
 - (c). Submit 7 copies of shop drawings to the Owner’s Representative. Submit an additional copy if the owner is a non-City entity such as a railroad or a municipal or turnpike authority, and another copy if the designer is a private consultant. The Owner’s Representative may require additional sets.
 - (2). Non-Bridge Structures
 - (a). Prepare clear and legible shop drawings for the complete assembly on sheets 11 × 17 in. Full-size drawings may be reduced to half-scale size if they are clear and legible. At the left end, provide a 1 1/2 in. margin, with the other margins 1/2 in. wide. Indicate joint details on shop drawings for all welds. Provide a title block on each sheet in the lower right corner with the following information:

- I. sheet index data shown on the lower right corner of the project plans,
 - II. sheet numbering for the shop drawings,
 - III. name of the fabricator, and
 - IV. name of the Contractor.
- (b). Furnish 7 copies of completed shop drawings to the Owner's Representative.
- G. Welding and Fabrication Procedures
1. Welding Procedures
 - a. Before fabrication begins, submit welding procedures in accordance with the applicable AWS code to the City, and notify the Owner's Representative which procedures will be used for each joint or joint type.
 - b. Post the approved welding procedure specification for the welding being performed on each welding machine, or use another approved method of ensuring that the welder has access to the procedure information at all times.
 2. Fabrication Procedures
 - a. When primary bridge members are fabricated by welding or bolting, submit a fabrication procedure before fabrication begins. The fabrication procedure must include details required by S2.1 as well as:
 - (1). special processes such as planing or facing,
 - (2). details of heat treating and heat straightening procedures, and
 - (3). any other information required by the Owner's Representative.
 - b. Have a fabrication procedure approved for each type of structure (rolled beams with welded or bolted splices, plate girders with welded or bolted splices, tub girders with welded or bolted splices, box girders, plate girder bents, railroad thru-girders and plate girders, truss bridges, orthotropic deck segments, or other major bridge structure types) before starting fabrication.
- H. Submerged-Arc Welding (SAW)

1. Provide equipment with automatic guidance capable of maintaining the position of the arc and controlling the speed of travel so that, when once set by the operator, little manipulation is needed. Small adjustments to compensate for acceptable plate waviness, acceptable tilt of flange, etc. will be permitted. Do not use hand-held semiautomatic SAW for welding bridge members unless altered to provide automatic guidance or otherwise approved.

I. Inspection

1. Provide approved facilities, materials, and equipment required for inspection. Unless otherwise approved, provide an acceptable field office. Only 200 sq. ft. are required if fewer than 3 inspectors will be assigned to the facility. Provide desks, a layout table, a plan rack, and Internet service. Maintain the office and equipment so that it will continue to function properly for the intended use.
2. Provide the Inspector with the helpers and equipment needed to move material to allow inspection. QC is solely the responsibility of the Contractor. The Contractor must have a QC staff qualified in accordance with the applicable AWS code. The QC staff must provide inspection of all materials and workmanship prior to inspection by the Department.
3. When structural steel is fabricated outside of the contiguous 48 states, the additional cost of inspection will be paid by the Contractor.

J. Documentation

1. Before beginning fabrication, provide a completed Material Statement with supporting documentation (such as mill test reports), issued by the producing mill and verified by qualified personnel. Ensure that the documentation legibly reflects all information required by the applicable ASTM specifications.
2. As material is shipped or placed in approved storage, provide a copy of the shipping or storage invoice that reflects:
 - a. member piece mark identification and calculated weight per piece from the contract drawings,
 - b. number of pieces shipped or in storage,
 - c. total calculated weight for each invoice per bid item, and
 - d. the unique identification number of the shipping or storage invoice.
3. The acceptance of material or finished members by the Owner's Representative will not prohibit subsequent rejection if the material or

members are found to be damaged or defective. Replace rejected material promptly.

K. Material Identification

1. Assembly-mark individual pieces and issue cutting instructions to the shop using a system that will maintain identity of the original piece.
2. Identify structural steel by standard and grade of steel. Also differentiate between material toughness requirements (CVN, fracture-critical) as well as any other special physical requirements. In addition, identify structural steel for primary members by mill identification numbers (heat numbers). Use an approved identification system. Use either paint or low-stress stencils to make identification markings on the metal. Mark the material as soon as it enters the shop and carry the markings on all pieces through final fabrication. Transfer the markings before cutting steel for primary members of bridge structures into smaller pieces. Loss of identification marking on any piece, with no other positive identification, or loss of heat number identification on any primary member piece will render the piece unacceptable for use. Unidentifiable material may be approved for use after testing to establish acceptability to the satisfaction of the Owner's Representative. Have testing performed by an approved testing facility, and have results signed and sealed by a licensed professional engineer.

3.02 WELDING

A. Details

1. Rolled Edges
 - a. Trim plates with rolled edges used for webs by thermal cutting.
2. Weld Tabs
 - a. Use weld tabs at least 2 in. long for manual and semi-automatic processes and at least 3 in. long for automatic processes, and in all cases at least as long as the thickness of the material being welded. Use longer weld tabs as required for satisfactory work.
3. Weld Termination
 - a. Terminate fillet welds approximately 1/4 in. from the end of the attachment except for galvanized structures and flange-to-web welds, for which the fillet weld must run the full length of the attachment unless otherwise noted on the plans.
4. No-Paint Areas at Field-Welded Connections

- a. Keep surfaces within 4 in. of groove welds or within 2 in. of fillet welds free from shop paint.
5. Galvanized Assemblies
- a. Completely seal all edges of tightly contacting surfaces by welding before galvanizing.
- B. Shop Splices
1. Shop Splice Locations
- a. Keep at least 6 in. between shop splices and stiffeners or crossframes and at least 6 in. between web and flange shop splices. Do not add optional splices to plates shown on the plans as 40 ft. long or shorter unless necessary to obtain the required geometry or otherwise approved. Obtain approval for shop splices added after shop drawings are approved.
 - (1). Continuous Multiple-Span Structures
 - (a). Unless otherwise shown on the plans or approved, do not locate tension flange splices within $0.05S$ of an interior bearing, within $0.10S$ of the centerline of an interior span, or between $0.30S$ and $0.50S$ from an end bearing, where S is the span length between centers of bearings.
 - (2). Single-Span Structures
 - (a). Unless otherwise shown on the plans or approved, do not locate tension flange splices within $0.10S$ of the centerline of the span.
2. Grinding Splice Welds
- a. Grind shop groove welds in flange plates smooth and flush with the base metal on all surfaces whether the joined parts are of equal thickness or of unequal thickness. Grind so that the finished grinding marks run in the direction of stress, and keep the metal below the blue brittle range (below 350°F). Groove welds in web plates, except at locations of intersecting welds, need not be ground unless shown on the plans except as required to meet AWS welding code requirements.
- C. Joint Restraint
1. Never restrain a joint on both sides when welding.

- D. Stiffener Installation
1. Flange Tilt
 - a. Members must meet combined tilt and warpage tolerances before the installation of stiffeners. Cut stiffeners to fit acceptable flange tilt and cupping. Minor jacking or hammering that does not permanently deform the material will be permitted.
 2. Stiffeners Near Field Splices
 - a. Tack-weld intermediate stiffeners within 12 in. of a welded field splice point in the shop. Weld the stiffeners in the field in accordance with Item 16448, "Structural Field Welding," after the splice is made.
- E. Nondestructive Examination (NDE)
1. Perform magnetic particle testing (MT), radiographic testing (RT), and ultrasonic testing (UT) at the Contractor's expense for bridge structures. The Owner's Representative will periodically witness, examine, verify, and interpret NDE. Additional welds may be designated for NDE on the plans. Retest repaired groove welds per the applicable AWS code after repairs are made and have cooled to ambient temperature. Complete NDE and repairs before assembly of parts into a member but after any heat-correction of weld distortion.
 - a. Radiographic Testing
 - (1). Radiographs must have a density of at least 2.5 and at most 3.5, as confirmed by a radiographer. The density in any single radiograph showing a continuous area of constant thickness must not vary in this area by more than 0.5. Use only ASTM System Class I radiographic film as described in ASTM E 1815. Use low-stress stencils or other acceptable means to make radiograph and location identification marks on the steel. The Owner's Representative will examine and interpret all results of RT.
 - b. Ultrasonic Testing
 - (1). Have UT equipment calibrated yearly by an authorized representative of the equipment manufacturer or by an approved testing laboratory.
 - c. Magnetic Particle Testing

- (1). Orient the prod or pole position normal or parallel to the weld unless otherwise approved. When using the yoke method, use half-wave rectified DC unless otherwise approved.
 - d. Extra-high Strength Steel
 - (1). For shop welds on steel that has a nominal yield strength over 70,000 psi, perform RT on all flange and web splices in addition to any requirements of the applicable AWS code. Wait at least 48 hours after completing these welds before inspecting them.
- F. Testing of Galvanized Weldments
1. If problems develop during galvanizing of welded material, the Owner's Representative may require a test of the compatibility of the combined galvanizing and welding procedures in accordance with this Section and may require modification of one or both of the galvanizing and welding procedures.
 2. If testing is required, prepare a test specimen with a minimum length of 12 in. using the same base material, having the same joint configuration, and using the welding procedure proposed for production work. Clean and galvanize this test specimen using the same conditions and procedure that will be applied to the production galvanizing.
 3. After galvanizing, examine the test specimen. There must be no evidence of excessive buildup of zinc coating over the weld area. Excessive zinc coating buildup will require modification of the galvanizing procedure.
 4. Remove the zinc from the weld area of the test specimen in accordance with ASTM A 90, and visually examine the weld area. There must be no evidence of loss of weld metal or any deterioration of the base metal due to the galvanizing or welding procedure. If there is evidence of deterioration or loss of weld metal, modify the galvanizing or welding procedure as required and run a satisfactory retest on the modified procedures before production work. Report procedures and results on the galvanized weldment worksheet provided by the Department.

3.03 BOLT HOLES

- A. Detail holes on shop drawings 1/16 in. larger in diameter than the nominal bolt size shown on the plans unless another hole size is shown on the plans.
- B. Thoroughly clean the contact surfaces of connection parts in accordance with Section 16447.4.B, "General," before assembling them for hole fabrication. Make holes in

primary members full-size (by reaming from a subsize hole, drilling full-size, or punching full-size where permissible) only in assembly unless otherwise approved.

- C. Ream and drill with twist drills guided by mechanical means unless otherwise approved. If subpunching holes, punch them at least 3/16 in. smaller than the nominal bolt size. When numerically controlled (N/C) equipment is used, submit for approval the proposed procedures to accomplish the work from initial drilling or punching through check assembly. Use thermal cutting for holes only with permission of the Owner's Representative. Permission for thermal cutting is not required for making slotted holes, when slotted holes are shown on the plans, by drilling or punching two holes and then thermally cutting the straight portion between them. Perform all thermal cutting in accordance with Section 16441, Part 3, 3.05 A. "Thermal Cutting."
- D. Slightly conical holes that naturally result from punching operations are acceptable provided they do not exceed the tolerances of S2.1. The tolerance for anchor bolt hole diameter for bridge bearing assemblies is +1/8 in., -0.

3.04 DIMENSIONAL TOLERANCES

- A. Meet tolerances of the applicable AWS specifications and S2.1 except as modified in this Section.
 - 1. Rolled Sections
 - a. Use ASTM A 6 mill tolerances for rolled sections, except that D1.5 camber tolerances apply to rolled sections with a specified camber.
 - 2. Flange Straightness
 - a. Ensure that flanges of completed girders are free of kinks, short bends, and waviness that depart from straightness or the specified camber by more than 1/8 in. in any 10 ft. along the flange. Rolled material must meet this straightness requirement before being laid off or worked. Plates must meet this requirement before assembly into a member. After straightening a bend or buckle, inspect the surface of the metal for evidence of fracture. The Owner's Representative may require nondestructive testing.
 - 3. Alignment of Deep Webs in Welded Field Connections
 - a. For girders 48 in. deep or deeper, the webs may be slightly restrained while checking compliance with tolerances of S2.1. In the unrestrained condition, webs 48 in. deep or deeper must meet the tolerances of Table 1. Girders under 48 in. deep must meet the alignment tolerances of S2.1.

Table 1
Web Alignment Tolerances for Deep Girders

Web Depth (in.)	Maximum Web Misalignment (in.)
48	1/16
60	1/8
72	1/4
84	5/16
96	5/16
108	3/8
120	7/16
132	7/16
144	1/2

4. Bearings

- a. Correct bearing areas of shoes, beams, and girders using heat, external pressure, or both. Grind or mill only if the actual thickness of the member is not reduced by more than 1/16 in. below the required thickness.

(1). I Beams, Plate Girders, and Tub Girders

- (a). The plane of the bearing area of beams and girders must be perpendicular to the vertical axis of the member within 1/16 in. in any 24 in.

(2). Closed Box Girders

- (a). Meet these tolerances:

I. The plane of the bearing areas of the box girder is perpendicular to the vertical axis of the girder within 1/16 in. across any horizontal dimension of the bearing.

II. The planes of the beam supports on the box girder are true to the vertical axis of the supported beams or girders to 1/16 in. in any 24 in.

- (b). In the shop, verify the plane of all bearing areas with the box placed on its bearings to field grade, using an approved process for verification.

(3). Shoes

- (a). Meet these tolerances:
 - I. The top bolster has the center 75% of the long dimension (transverse to the girder) true to 1/32 in., with the remainder true to 1/16 in., and is true to 1/32 in. across its entire width in the short dimension (longitudinal to the girder).
 - II. The bottom bolster is true to 1/16 in. across its diagonals.

5. End Connection Angles

- a. For floor beams and girders with end connection angles, the tolerance for the length back to back of connection angles is $\pm 1/32$ in. If end connections are faced, do not reduce the finished thickness of the angles below that shown on the shop drawings.

3.05 OTHER FABRICATION PROCESSES

A. Thermal Cutting

- 1. Use a mechanical guide to obtain a true profile. Hand-cut only where approved. Hand-cutting of radii for beam copes, weld access holes, and width transitions is permitted if acceptable profile and finish are produced by grinding. Provide a surface finish on thermal-cut surfaces, including holes. Obtain approval before using other cutting processes.

B. Oxygen-Gouging

- 1. Do not oxygen-gouge ASTM A 588 or A 709 Gr. 50W steel or material with nominal yield strength over 70 ksi.

C. Annealing and Normalizing

- 1. Complete all annealing or normalizing (as defined in ASTM A 941) before finished machining, boring, and straightening. Maintain the temperature uniformly throughout the furnace during heating and cooling so that the range of temperatures at all points on the member is no greater than 100°F.

D. Machining

- 1. Machine the surfaces of expansion bearings so that the travel direction of the tool is in the direction of expansion.

E. Camber

1. Complete cambering in accordance with S2.1 before any heat-curving.

F. Heat Curving

1. Heat-curve in accordance with S2.1. The methods in the AASHTO bridge construction specifications are recommended. Attach cover plates to rolled beams before heat-curving only if the total thickness of one flange and cover plate is less than 2 1/2 in. and the radius of curvature is greater than 1,000 ft. For other rolled beams, attach cover plates only after heat-curving is completed. Locate and attach connection plates, diaphragm stiffeners, and bearing stiffeners after curving, unless girder shrinkage is accounted for.

G. Bending of Quenched and Tempered Steels

1. The cold-bending radius limitations for HPS 70W in S2.1 apply to all quenched and tempered steels.

3.06 NONCONFORMANCE REPORTS (NCRS)

A. When the requirements of this Item are not met, submit an NCR to the Owner's Representative for approval. Include on the NCR:

1. date of submittal, nonconformance report number, and IFM number (when applicable);
2. project information (county; control, section, and job numbers; project number; shop order number; structure name, etc.);
3. member identification (member number, or piece or erection mark);
4. description of problem including references to sections of specifications not met;
5. explanation of why the problem occurred and plan for preventing future occurrences (if applicable);
6. detailed description (including drawings) of proposed solution including a repair proposal; and
7. diagrams detailing all pertinent dimensions and locations on relevant sections of shop drawings, including title blocks.

B. Do not begin repairs before approval is received. Perform all repair work in strict compliance with the approved repair procedure.

3.07 SHOP ASSEMBLY

A. General Shop Assembly

1. Shop-assemble field connections of primary members of trusses, arches, continuous beam spans, bents, towers (each face), plate girders, field connections of floor beams and stringers (including for railroad structures), field-bolted diaphragms for curved plate girders and railroad underpasses, and rigid frames. Complete fabrication, welding (except for shear studs), and field splice preparation before members are removed from shop assembly. Obtain approval for any deviation from this procedure. The Contractor is responsible for accurate geometry.
2. Use a method and details of preassembly consistent with the erection procedure shown on the erection plans and camber diagrams. The sequence of assembly may start from any location in the structure and proceed in one or both directions. An approved method of sequential geometry control is required unless the full length of the structure is assembled.
3. Verify by shop assembly the fit of all bolted and welded field connections between bent cap girders and plate girders or between plate girders and floor beams.
4. Do not measure horizontal curvature and vertical camber for final acceptance until all welding and heating operations are completed and the steel has cooled to a uniform temperature. Check horizontal curvature and vertical camber in a no-load condition.

B. Bolted Field Connections

1. Each shop assembly, including camber, alignment, accuracy of holes, and fit of milled joints, must be approved before the assembly is dismantled.
2. Assemble with milled ends of compression members in full bearing. Assemble non-bearing connections to the specified gap. Ream all subsize holes to the specified size while the connections are assembled, or drill full size while the connections are assembled. Notify the Owner's Representative before shipping if fill plates or shims are added. Adding or increasing the thickness of shims or fill plates in bearing connections requires approval. Use drift pins and snug-tight bolts during the drilling process to ensure that all planes of the connection (webs and flanges) can be assembled simultaneously. Do not use tack welds to secure plates while drilling.
3. If parts are not completely bolted in the shop, secure them by temporary bolts to prevent damage in shipment and handling. Never use tack welds in place of temporary bolts.

4. Match-mark connecting parts in field connections using low-stress stencils in accordance with the diagram in the erection drawings.

C. Welded Field Connections

1. Mill or grind bevels for groove welds. Do not cut into the web when cutting the flange bevel adjacent to the web. End preparation, backing, and tolerances for single V groove welds for framing beams or girders must conform to the applicable AWS code unless otherwise shown on the plans.
2. In the shop, prepare ends of beams or girders to be field-welded taking into account their relative positions in the finished structure due to grade, camber, and curvature. Completely shop-assemble and check each splice. While the splice is assembled, match-mark it with low-stress stencils in accordance with the diagram in the erection drawings.

3.08 FINISH AND PAINTING

A. Shop Painting

1. On new steel items to be painted (except for the coatings on box and tub girder interiors), grind corners that are sharp or that form essentially 90° angles to an approximately 1/16 in. flat surface before blast cleaning. (A corner is the intersection of two plane faces.) This requirement does not apply to punched or drilled holes. Apply shop paint in accordance with Item 16446, "Cleaning and Painting Steel." Do not omit shop paint to preserve original markings.

B. Bearing and Faying Surfaces

1. Clean and prepare all bearing and faying surfaces of bolted connections, including those in railroad structures, in accordance with Item 16447, "Structural Bolting," before shipment.

C. Girder Interiors

1. Paint the inside of all box and tub girders in accordance with applicable provisions of Item 16446, "Cleaning and Painting Steel."

D. Weathering Steel

1. Provide an SSPC SP 6 blast in the shop to all fascia surfaces of unpainted weathering steel beams. Fascia surfaces include:
 - a. exterior sides of outermost webs and undersides of bottom flanges of plate girders and rolled beams,

- b. all outer surfaces of tub girders and box girders,
 - c. all surfaces of truss members,
 - d. webs and undersides of bottom flanges of plate diaphragms,
 - e. bottom surfaces of floor beams, and
 - f. any other surfaces designated as “fascia” on the plans.
2. Do not mark fascia surfaces. Use one of the following methods as soon as possible to remove any markings or any other foreign material that adheres to the steel during fabrication and that could inhibit the formation of oxide film:
 - a. Solvent Cleaning
 - b. Hand Tool Cleaning
 - c. Power Tool Cleaning
 - d. Brush-off Blast Cleaning
 3. Do not use acids to remove stains or scales. Feather out touched-up areas over several feet.
- E. Machined Surfaces
1. Clean and coat machine-finished surfaces that are in sliding contact, particularly pins and pinholes, with a non-drying, water-repellent grease-type material containing rust-inhibitive compounds. Ensure that the coating material contains no ingredients that might damage the steel. Protect machined surfaces from abrasive blasting.

3.09 HANDLING AND STORAGE OF MATERIALS

- A. Prevent damage when storing or handling girders or other materials. If damage to material is caused by handling devices or improper storage, remove or repair the material by acceptable means in accordance with ASTM A 6 and the applicable AWS code.
- B. Place stored materials on skids or acceptable dunnage above the ground. Keep materials clean. Shore girders and beams to keep them upright and free of standing water. Place support skids close enough to prevent excessive deflection in long members such as columns. Do not stack completed girders or beams at the jobsite.
- C. Protect structural steel from salt water or other corrosive environments during storage and transit.

3.10 MARKING AND SHIPPING

- A. Mark all structural members in accordance with the erection drawings. If a surface is painted, make the marks over the paint. Do not use impact-applied stencils to mark painted surfaces.
- B. Mark the weight directly on all members weighing more than 3 tons.
- C. Keep material clean and free from injury during loading, transportation, unloading, and storage. Pack bolts of each length and diameter, and loose nuts or washers of each size, separately and ship them in boxes, crates, kegs, or barrels. Plainly mark a list and description of the contents on the outside of each package.

3.11 FIELD ERECTION

A. Methods and Equipment

- 1. Do not tack-weld parts instead of using erection bolts. Do not tack-weld parts to hold them in place for bolting. Provide falsework, tools, machinery, and appliances, including drift pins and erection bolts. Provide enough drift pins, 1/32 in. larger than the connection bolts, to fill at least 1/4 of the bolt holes for primary connections. Use erection bolts of the same diameter as the connection bolts.
- 2. Securely tie, brace, or shore steel beams or girders immediately after erection as shown on the plans and the erection drawings. Maintain this bracing or shoring until the diaphragms are in place. Protect railroad or roadway traffic that may be beneath erected girders or beams from falling objects during erection of the members and diaphragms, placement of the deck concrete, and erection and removal of forms. Use nets or flooring with openings no larger than 1 in. for this protection.

B. Falsework

- 1. Design and construct falsework for the anticipated loads, including wind, and properly maintain this falsework.

C. Handling and Assembly

- 1. Accurately assemble all parts as shown on the plans and the approved shop drawings. Verify match-marks. Handle parts carefully to prevent bending or other damage. Do not hammer if doing so damages or distorts members. Do not weld any member for transportation or erection unless noted on the plans or approved by the Owner's Representative.

a. Welded Connections

- (1). Before releasing the erection cranes, weld flange splices to 50% of their thickness and meet the minimum erection bracing and support requirements shown on the plans and on the submitted erection plans. Field-weld in accordance with Item 16448, "Structural Field Welding."
- b. Bolted Connections.
- (1). Before releasing the erection cranes:
 - (a). install 50% of the bolts in the top and bottom flanges and the web with all nuts finger-tight,
 - (b). meet the minimum erection bracing and support requirements shown on the plans and on the submitted erection plans, and
 - (c). for tub girders, install top lateral bracing across the connection and fully tension the bolts connecting the bracing to the top flanges.
- c. Install high-strength bolts, including erection bolts, in accordance with Item 16447, "Structural Bolting." Clean bearing and faying surfaces for bolted connections in accordance with Item 16447. Clean the areas of the outside ply under washers, nuts, and bolt heads before bolt installation. Ensure that the required faying surface condition is present at the time of bolting.
- D. Misfits
1. Correct minor misfits. Ream no more than 10% of the holes in a plate connection (flange or web), and ensure that no single hole is more than 1/8 in. larger than the nominal bolt diameter. Submit proposed correction methods for members with defects that exceed these limits or that prevent the proper assembly of parts. Straighten structural members. Make all corrections in the presence of the Owner's Representative at no expense to the City. Do not remove and reweld gusset plates without approval.
- E. Bearing and Anchorage Devices
1. Place all bearing devices such as elastomeric pads, castings, bearing plates, or shoes on properly finished bearing areas with full and even bearing on the concrete. Place metallic bearing devices on 1/4 in.-thick preformed fabric pads to the dimensions shown on the plans. Provide holes in the pad that are no more than 1/4 in. larger than the bolt diameter.

2. When the concrete bearing area has been placed below grade, build it up to the correct elevation using mortar that meets Item 03310, "Structural Concrete," and provide adequate curing. For buildups between 1/8 in. and 3/8 in. thick, use only mortar. If the bearing area must be raised more than 3/8 in., use galvanized steel shims or other approved shim materials in conjunction with mortar.
3. Provide at least 75% contact of flange to shoe with no separation greater than 1/32 in. for beams and girders. Make corrections using heat or pressure in accordance with S2.1, or with galvanized shims. Correct small irregularities by grinding.
4. Provide at least 85% contact between the rocker plate and the base plate. Adjust the location of slotted holes in expansion bearings for the prevailing temperature. Adjust the nuts on the anchor bolts at the expansion ends of spans to permit free movement of the span. Provide lock nuts or burr the threads.
5. Remove all foreign matter from sliding or machine-finished surfaces before placing them in the structure.
6. Restore distorted bearing pads or expansion bearings to an equivalent 70°F position after completion of all welded or bolted splices, using an approved method of relieving the load on the bearing devices.

F. Erecting Forms

1. Do not erect forms until all welding or bolting is complete and the unit is positioned and properly set on the bearing unless otherwise noted on the plans.

G. Field Finish

1. Paint in accordance with Item 16446, "Cleaning and Painting Steel." For weathering steel that will remain unpainted, after all welding and slab concrete placement has been completed, restore the steel to a uniform appearance by solvent cleaning, hand cleaning, power brush, or blast cleaning. As soon as possible, remove from all unpainted weathering steel fascia surfaces (as defined in Section 16441, Part 3, 3.08 D. "Weathering Steel") any foreign material, including markings, that adheres to the steel and could inhibit formation of oxide film. Feather out touched-up areas over several feet. Do not use acids to remove stains or scales.

PART 4 MEASUREMENT AND PAYMENT

- A. The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured or paid for directly but will be subsidiary to pertinent Items.

END OF SECTION