

**SECTION 440
STEEL STRUCTURES**

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440-1 DESCRIPTION

Construct steel structures and steel structure portions of composite structures in conformity with the lines, grades and dimensions shown in the plans and as specified in these specifications.

Furnish, fabricate, galvanize, deliver, place, erect, clean, shop paint and field paint structural metals and all other materials; furnish, erect and remove falsework; set bearings and anchorage; weld and furnish all materials for and assemble all structural joints. Structural metals include structural steels, metallic electrodes, steel forgings and castings, gray iron and malleable iron castings, drain pipes and any incidental metal construction.

Before starting work, inform the Engineer as to the proposed method of erection.

440-2 MATERIALS

Refer to Division 10.

Item	Section
Anchor Bolts	1072-4
Bearing Plate Assemblies	1072-3
Elastomeric Bearings	1079-2
High Strength Bolts, Nuts, Washers and Direct Tension Indicators	1072-5
Organic Zinc Repair Paint	1080-9
Preformed Bearing Pads	1079-1
Steel Pipe	1074-6
Structural Steel	1072
Welded Stud Shear Connectors	1072-6

440-3 HANDLING AND STORING MATERIALS

Move, handle and store all structural steel, in the shop, in the field and while being transported in accordance with Article 1072-9.

440-4 BEARINGS AND ANCHORAGES

Supply preformed bearing pads and elastomeric bearings, as required by the plans and in accordance with Section 1079.

Set steel masonry plates level in exact position with full and even bearing on the preformed bearing pad.

Accurately set anchor bolts in accordance with Subarticle 420-12(A).

Make sure that the location of anchors and setting of bearings take into account any variation from mean temperature at time of setting and anticipated lengthening of bottom flange due to dead load after setting, so at mean temperature and under dead load the bearings are in a vertical position and anchor bolts at expansion bearings center in their slots. Mean temperature is 60°F unless otherwise stipulated in the plans. Do not restrict full and free movement of the superstructure at the movable bearings by improperly setting or adjusting bearings or anchor bolts and nuts.

440-5 STRAIGHTENING BENT MATERIAL, HEAT CURVING AND HEAT CAMBERING

Straighten bent material, heat curve and heat camber as approved and in accordance with Article 1072-10.

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1 **440-6 FIELD ERECTION**

2 Report immediately any error in the shop fabrication or deformation resulting from handling
3 and transporting, which prevents the proper assembling and fitting up of parts by more than
4 the moderate use of drift pins or by more than a moderate amount of reaming, chipping or
5 cutting. Correct errors in the presence of the Engineer by approved methods.

6 Do not perform hammering which injures or distorts the members.

7 Limit the drifting during assembly to only that needed to bring the parts into position, and not
8 sufficient to enlarge the holes or distort the metal. If any holes require enlarging to admit the
9 bolts, ream or correct them by approved methods. Do not enlarge the holes more than 1/16"
10 over the nominal size hole called for without written approval.

11 Before assembling the members, clean and dry to touch all bearing surfaces and permanently
12 contacting surfaces.

13 For bolted splices and field connections, fill one half of the holes with bolts and cylindrical
14 erection pins, at least half pins, before placing permanent fasteners. For continuous units, pin
15 and bolt all beam and girder splices and bring the splices to the correct elevations before
16 permanently fastening. For bolted connections use fit-up bolts and optional shipping bolts
17 with the same nominal diameter as the permanent fasteners, and use cylindrical erection pins
18 which are 1/32" larger. Use permanent bolts as fit-up bolts if desired.

19 Use temporary bolts, including, but not limited to, shipping and fit-up bolts, supplied with
20 square or hexagon heads and square or hexagon nuts. The use of hexagon head temporary
21 bolts and nuts is allowed, but paint both the head and nut with a durable yellow paint before
22 installation.

23 Do not reuse permanent bolts for final installation unless the nut is easily turned onto the bolt
24 for the full threaded length by hand and without use of tools.

25 The use of erection bolts for field welded joints is allowed. Use erection bolts that are
26 galvanized when the finish paint is applied in the structural steel fabrication shop and meet
27 AASHTO M 164. Supplement these bolts with clamps as necessary to meet the
28 AWS Specifications. Where unpainted AASHTO M 270 Grade 50W structural steel is used,
29 use erection bolts meeting AASHTO M 164 for Type 3 bolts.

30 After field welding the connection, leave the erection bolt in place with at least the minimum
31 bolt tension shown in Table 440-1. Use holes that are 3/16" larger than the nominal erection
32 bolt diameter.

33 **440-7 FIELD WELDING**

34 Perform field welding only when called for in the plans and in accordance with
35 Article 1072-18.

36 Remove paint, galvanizing or other coating at the location of field welds by blast cleaning
37 (SSPC SP-6 finish), hand cleaning (SSPC SP-2 finish) or power tool cleaning (SSPC SP-3
38 finish) just before welding. Clean sufficiently to prevent contamination of the weld by the
39 coating.

40 **440-8 CONNECTIONS USING HIGH STRENGTH BOLTS**

41 **(A) General**

42 This article covers the assembly of structural joints using plain or galvanized high
43 strength carbon steel bolts with suitable nuts and washers tightened to a high tension.
44 Use bolt holes that conform with Article 1072-16.

45 Protect bolts, nuts and washers from moisture during storage and so they show no signs
46 of rust at the time of installation.

1 Make sure that plain bolts and washers have a thin coat of lubricant at the time of
2 installation.

3 Use nuts that are pre-waxed by the producer or supplier before shipping to the project.

4 Apply beeswax, stick paraffin or other approved lubricant to the threads of galvanized
5 bolts just before installing the bolts.

6 Use bolt, nut and washer (when required) combinations from the same rotational-capacity
7 lot.

8 Perform the rotational capacity test described in Subarticle 1072-5(D)(4) on each
9 rotational-capacity lot before the start of bolt installation. Use hardened steel washers as
10 required by the test.

11 (B) Bolted Parts

12 Make sure that the slope of surfaces of bolted parts in contact with the bolt head and nut
13 does not exceed 1:20 with respect to a plane normal to the bolt axis. Make sure bolted
14 parts fit solidly together when assembled and are not separated by gaskets or any other
15 interposed compressible material. Provide contact surfaces, including those adjacent to
16 the bolt heads, nuts or washers, that are free of scale, dirt, burrs, oil, lacquer, loose rust,
17 rust inhibitor, other foreign material and other defects that prevent solid seating of the
18 parts.

19 (C) Installation

20 (1) Bolt Tensions

21 Tighten each fastener to provide at least the minimum bolt tension shown in
22 Table 440-1. Tighten fasteners with direct tension indicators in accordance with
23 Subarticle 440-8(C)(5), or if permitted, by the use of load indicating bolts as
24 provided in Subarticle 440-8(C)(3).

Bolt Size, Inches	Minimum Bolt Tension, Pounds
1/2	12,050
5/8	19,200
3/4	28,400
7/8	39,250
1	51,500
1 1/8	56,450
1 1/4	71,700
1 3/8	85,450
1 1/2	104,000

25 If necessary, because of bolt entering and wrench operation clearances, tighten by
26 turning the bolt while preventing the nut from rotating. Use impact wrenches, if
27 necessary, with adequate capacity and sufficiently supplied with air to perform the
28 required tightening of each bolt in approximately 10 seconds.

29 (2) Washers

30 Make sure all fasteners have a hardened washer under the element, nut or bolt head,
31 turned in tightening. Use galvanized washers when galvanized nuts and bolts are
32 required. As an exception to the above, use special washers for oversize, short-
33 slotted and long-slotted holes in accordance with Subarticle 1072-16(H).

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- 1 Where an outer face of the bolted parts has a slope of more than 1:20 with respect to
2 a plane normal to the bolt axis, use a smooth beveled washer to compensate for the
3 lack of parallelism.
- 4 (3) Load Indicating Bolts
- 5 Tightening by use of a load indicating bolt system is permitted provided it can be
6 demonstrated by an accurate direct measurement procedure that the bolt is tightened
7 in accordance with Table 440-1. Tighten by approved methods and procedures.
- 8 (4) Galvanized High Strength Bolts
- 9 Use mechanically galvanized high strength bolts in all bolted connections for painted
10 structural steel.
- 11 Install galvanized high strength bolts carefully so shop painted surfaces are not
12 scarred or otherwise damaged.
- 13 Repair galvanized surfaces that are abraded or damaged by thoroughly wire brushing
14 the damaged area and removing all loose and cracked coating, after which give the
15 cleaned area 2 coats of organic zinc repair paint.
- 16 (5) Direct Tension Indicators
- 17 Supply direct tension indicators in accordance with ASTM F959 and Article 1072-5.
- 18 Furnish the Engineer with at least one metal feeler gauge for each container of direct
19 tension indicators shipped before beginning installation.
- 20 Make sure that the lot number on the containers of direct tension indicators is for the
21 same lot number tested as indicated on the test documents.
- 22 Furnish to the Engineer 3 samples of load indicating washers from each lot number,
23 each size and type for tests and 2 each of the metal feeler gauges required for
24 performing the tests.
- 25 Install the direct tension indicator under the bolt head. If it is necessary to install the
26 direct tension indicator under the nut, or if the bolt head shall be turned, install
27 additional hardened washers between the nut or bolt head and the direct tension
28 indicator.
- 29 Provide a tension indicating device on the project for determining the tension
30 imposed on a fastener when the protrusions on direct tension indicator are properly
31 compressed.
- 32 Test 3 samples from each lot of direct tension indicators in the presence of the
33 Engineer. Achieve a minimum bolt tension of 5% greater than that required by
34 Table 440-1 of Article 440-8.
- 35 Do not substitute direct tension indicators for hardened steel washers required with
36 short slotted or oversized holes. If desired, use direct tension indicators in
37 conjunction with hardened steel washers.
- 38 Install direct tension indicators initially to a snug tight condition. After initial
39 tightening, fully tighten beginning at the most rigid part of the joint and continuing
40 toward its free edges.
- 41 For tightening fasteners containing direct tension indicators, use a clean and
42 lubricated wrench. Maintain air supply and hoses in good condition and provide air
43 pressure of at least 100 psi at the wrench.

1 When tightening the fasteners, ensure that the part of the fastener being restrained
 2 from turning does not rotate during the tightening process. Ensure that no portion of
 3 the direct tension indicator protrusions is accidentally partially flattened before
 4 installing in the structural steel joints.

5 Do not reuse direct tension indicators. If it is necessary to loosen a bolt previously
 6 tensioned, discard and replace the direct tension indicator.

7 (D) Inspection

8 Allow the Engineer the opportunity to observe installation of bolts to determine that the
 9 selected tightening procedure is properly used. The Engineer determines when bolts are
 10 properly tightened and in the case of direct tension indicator bolts that the correct
 11 indication of tension is achieved. After properly tightening bolts, make sure that the end
 12 of the bolt is flush with or extended beyond the outer face of the nut.

13 Do not begin painting in the area of tightened bolts until after bolt inspection is complete.

14 When using direct tension indicators, proper tension of bolts is inspected by the Engineer
 15 by inserting a 0.005" thickness feeler gauge into the openings between adjacent flattened
 16 protrusions of the direct tension indicator. Proper tension is obtained when the number of
 17 spaces for which the gauge is refused is equal to or greater than the value shown in
 18 Table 440-2.

Number of Spaces in Washer	Number of Spaces Gauge is Refused
4	2
5	3
6	3
7	4

19 The gauge shall be refused in all spaces when the direct tension indicator is used under
 20 the turned element.

21 When using direct tension indicators, do not tighten bolts to a no visible gap condition.

22 Inspections of direct tension indicator installations are made by the Engineer by the use
 23 of the metal feeler gauges provided by the Contractor. At least 10%, but no less than 2 of
 24 the bolts in each connection are inspected with feeler gauges. Additionally, all remaining
 25 bolts in each connection are visually inspected for proper tightening.

26 **440-9 SURFACE PREPARATION AND PROTECTION OF WEATHERING STEEL**

27 After fabrication, shop clean all weathering steel remaining in the unpainted condition in the
 28 completed structure to a SSPC SP-6 finish. Provide a contact surface condition in accordance
 29 with Subarticle 442-7(B) at the time of bolt installation.

30 Protect the structural steel during concreting and any other operations that are particularly
 31 hazardous with respect to soiling the steel. Remove any foreign matter which gets on the steel
 32 as soon as possible by either solvent cleaning, hand tool cleaning, power tool cleaning, blast
 33 cleaning or a combination thereof, as necessary to restore the surfaces to the specified
 34 condition.

35 **440-10 MEASUREMENT AND PAYMENT**

36 *Approx. ____ Lbs. Structural Steel* will be measured and paid at the contract lump sum price.
 37 The approximate quantity shown in the contract pay item is an estimate based on the
 38 computed weight of the structural steel necessary to complete the work. No measurement for
 39 payment will be made for this pay item, and no adjustment in the contract lump sum price will
 40 be made for any variation from the approximate quantity shown except for revisions in the
 41 plans which affect the quantity of structural steel necessary to complete the work.

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- 1 When revisions in the plans have been made which affect the quantities of structural steel,
- 2 adjustments in compensation will be made by supplemental agreement.
- 3 When the contract includes the item of *Painting of Structural Steel*, all work of painting
- 4 except for shop painting will be paid as provided in Article 442-15 and payment for shop
- 5 painting will be included in the contract lump sum price for *Approx. ____ Lbs. Structural*
- 6 *Steel*. When the contract excludes the item of *Painting of Structural Steel*, payment at the
- 7 contract lump sum price for *Approx. ____ Lbs. Structural Steel* will be full compensation for
- 8 both shop and field painting.
- 9 *Elastomeric Bearings* will be paid as provided in Article 430-8.
- 10 The price and payment will be full compensation for all items required to construct steel
- 11 structures including, but not limited to, those items contained in Article 440-1.
- 12 Payment will be made under:

Pay Item	Pay Unit
Approx. ____ Lbs. Structural Steel	Lump Sum

SECTION 442
PAINTING STEEL STRUCTURES

442-1 DESCRIPTION

16 Paint steel structures and properly prepare metal surfaces; apply, protect and dry paint
 17 coatings; protect pedestrian, vehicular, water or other traffic upon or underneath the structure;
 18 protect all portions of the structure and adjacent work against disfigurement by splatters,
 19 splashes, overspray and smirches of paint or of paint materials; apply paint in the shop and
 20 field; and furnish blast cleaning equipment, paint spraying equipment, brushes, rollers, paint
 21 cleaning abrasives, cleaning solvents, tools, tackle, scaffolding, labor and any other materials,
 22 hand or power tools, inspection equipment and personal protective and safety equipment
 23 necessary for the entire work.

442-2 MATERIALS

25 Refer to Division 10.

Item	Section
Abrasive Materials for Blast Cleaning	1080-13
Paint and Paint Materials	1080

442-3 DEFINITIONS

27 Define “corner” as the intersection of 2 surfaces that are not in the same plane. Define
 28 “inaccessible areas” as partially or completely enclosed surfaces, the majority of which are
 29 not visible without the use of special devices such as mirrors. Define “sharp edge” as a corner
 30 on a steel section that ends in a point or edge and appears able to cut human flesh. Define
 31 “stripe coat” as an additional coat of paint applied to the edges, outside corners and areas
 32 difficult to coat by spray before or after a full coat is applied to the surface.

442-4 SUBMITTALS

34 Submit quality control plan, work schedule and Department test reports for each batch of
 35 paint to be used on the project. Submit product data sheets and MSDS sheets for paint and
 36 solvents used. Submit paint repair procedures for review and approval before commencing
 37 work.