Colorado Project No. August 27, 1999
Project Code Xxxxx

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Revision of Section 509
Steel Structures

Permanent Changes to Project Dated Special Provisions

Revision of Section 509 Steel Structures

Date	Author	Description of Change
8/27/99	DLD	Created. Revisions to Standard Specifications for bolting and painting.
04.11.2023	M. Kayen	Revisions to make spec online accessibility-compliant. 5.22.23 Additional accessibility work.

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Revise Section 509 of the Standard Specifications for this project as follows:

Replace subsection 509.08 with the following:

509.08 High Strength Bolts. All bolts used in fastening structural steel connections shall conform to the requirements of AASHTO M 164 (ASTM A 325), commonly known as High Strength Structural Bolts (HS). Heavy Hex Structural or Tension Control Bolts with suitable Heavy Hex Nuts and Plain Hardened Washers shall be provided. Type 1 bolts shall be provided for painted and Type 3 bolts for weathering (AASHTO M 222) structural steel. The length of bolts shall be such that the end of bolt will be flush with or outside the face of the nut when properly installed. Sufficient thread shall be provided to prevent the nut from encountering thread runout.

When the plans require bolts for structural steel connections to conform to the requirements of AASHTO M 164M (ASTM A 325M), bolts shall be substituted as outlined in the following table:

AASHTO M 164M	AASHTO M 164
Bolt Diameter, mm	Bolt Diameter, Inch (mm)
M16	5/8 (15.9)
M20	7/8 (22.2)
M22	7/8 (22.2)
M24	1 (25.4)

The hardness for bolt diameters of 1/2 inch (12.7 mm) to 1 inch (25.4 mm) inclusive shall conform to the following:

Hardness Number	Minimum	Maximum
Brinell	248	311
Rockwell C	24	33

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Bolt proof load tests (ASTM F 606, Method 1) and wedge tests (ASTM F 606) on full size bolts are required. Minimum frequency of testing shall be as specified in AASHTO M 164.

All nuts shall be Heavy Hex and conform to the requirements of AASHTO M 292 (ASTM A 194), heat treated grade 2H, or AASHTO M 291 (ASTM A 563), heat treated grade DH. Proof load tests of all nuts in accordance with the requirements of ASTM F 606 are required. Minimum frequency of testing shall be as specified in AASHTO M 291 or AASHTO M 292.

All washers shall conform to the requirements of AASHTO M 293 (ASTM F 436).

Compressible-Washer-Type Direct Tension Indicators, if used, shall conform to the requirements of ASTM F 959.

Rotational capacity (Lubrication) tests are required and shall be performed on all bolt, nut, and washer assemblies by the manufacturer or distributor prior to shipment to the project. Washers are required as part of the test. The rotational capacity tests shall be performed in accordance with the procedure defined in AASHTO M 164 and the following:

(a) Each combination of bolt production lot, nut lot, and washer lot shall be tested as an assembly.
(b) A rotational capacity lot number shall be assigned to each combination of lots tested.
(c) The minimum frequency of testing shall be two assemblies per rotational capacity lot.
(d) The bolt, nut, and washer assembly shall be tested in a Skidmore-Wilhelm Calibrator or an acceptable equivalent device.
(f) The minimum rotation, from a snug tight condition (10% of the specified proof load), shall be:
    (1) 240 degrees (2/3 of a turn) for bolt lengths less than 4 diameters.
    (2) 360 degrees (1 turn) for bolt lengths greater than 4 diameters and less than 8 diameters.
    (3) 480 degrees (1 1/3 turns) for bolt lengths greater than 8 diameters.
(g) The tension reached at the above rotation shall be equal to or greater than 1.15 times the required installation tension. The installation tension and the tension for the turn test are shown below:

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Diameter Inch (mm)	Installation Tension Kips (kN)	Turn Test Tension Kips (kN)
1/2 (12.7)	12 (56.5)	14 (62.3)
5/8 (15.8)	19 (84.5)	22 (97.9)
3/4 (19.1)	28 (124.5)	32 (142.3)
7/8 (22.2)	39 (173.5)	45 (200.2)
1 (25.4)	51 (226.8)	59 (262.4)

(h) After the required installation tension listed above has been exceeded, one reading of tension and torque shall be taken and recorded. The torque value shall conform to the following:

Torque ▫ 0.25 PD

Where:
Torque = Measured Torque (foot-pounds)
P = Measured Bolt Tension (pounds)
D = Bolt Diameter (feet)

Bolts which are too short to be tested in the Skidmore-Wilhelm Calibrator may be tested in a steel joint. The Installation Tension requirements need not apply. The maximum torque shall be computed using a value of P equal to the Turn Test Tension.

Bolts, nuts, and washers (where required) from each rotational capacity lot shall be shipped in the same container. Each container shall be permanently marked with the rotational capacity lot number such that identification is possible at any stage prior to installation.

The Division's QA Inspector shall be provided with the following documents prior to shipment of structural steel to the project:

(a) Certified Mill Test Reports for all mill steel used in the manufacture of the bolts, nuts, and washers. The mill test report shall indicate where the material was melted and manufactured.

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(b) Certified Laboratory Test Reports for the following:

(1) Bolt Hardness tests.
(2) Bolt proof load tests.
(3) Bolt wedge tests.
(4) Nut proof load tests.
(5) Rotational capacity tests.

Subsection 509.10 shall be replaced with the following:

509.10 Anchor Bolts. All anchor bolts with suitable hex nuts and plain hardened washers shall conform to the requirements of ASTM A 449 and shall be galvanized in accordance with the requirements of AASHTO M 232 (Class C) or zinc coated in accordance with ASTM B 695, Class 50.

Subsection 509.19(c) shall include the following:

Stiffeners shall not be mechanically forced into position.

Subsection 509.20(a) shall include the following:

Trapezoidal steel box girder fabrication:

(1) The exterior web to flange welds on trapezoidal box members, in which the included angle is less than 90 degrees, shall be welded using the flux cored arc welding process (FCAW).
(2) The interior web to flange welds, which have included angles greater than 90 degrees, may be welded by either the submerged arc welding process (SAW) or the flux cored arc welding process.

Subsection 509.21 shall include the following:

The field connections of all members (girders and diaphragms) of plate girder systems with a radius of less than 800 feet and steel box girder systems shall be assembled in the shop and the holes match drilled while the connections are assembled.

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Shop assembly may be complete structure assembly or progressive structure assembly at the fabricator's option:

(a) Complete structure assembly shall consist of assembling all of the structural steel for the superstructure of the bridge.

(b) Progressive structure assembly shall consist of initially assembling part of two adjacent girder lines simultaneously. Each girder line shall consist of at least three girders. While blocked in position, the diaphragm and girder field splices shall be fitted, and match drilled. At least one shop section shall be added at the advancing end of a girder line and the next girder line started before any section is removed from the rearward end.

All girders shall be oriented upright and blocked simultaneously in the position they will occupy on the bridge's substructure. All holes shall be drilled while the girders are blocked in this position. Marking holes to be drilled after the girders are moved is not allowed.

After the holes are drilled, all splice plates shall be positioned in their respective locations and pinned/bolted to demonstrate that the hole alignment through the multiple plate thicknesses is in accordance with the specifications. The Division's QA inspector shall be notified prior to disassembly to verify splice hole alignment. Verification of splice hole alignment shall not relieve the Contractor of the responsibility for proper fit up of the structural steel.

Quality Control shall measure flatness of the bottom flange at the bearing area. The bottom flange shall conform to the requirements of the Subsection 509.19(j). The Contractor's Quality Control Report shall list each bearing measurement.

Connecting parts assembled in the shop for field connections shall be match-marked, and two copies of a diagram showing each match-marked piece and defining how to use the marking system shall be provided to the Engineer 10 days prior to beginning structural steel erection.

The gap of abutting joints between members in a connection shall not exceed 3/8 of an inch.

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Subsection 509.22 shall include the following:

The QA Inspector will perform Rotational Capacity and Verification Tests in accordance with the procedures outlined in the Report " High-Strength Bolts for Bridges" (Report No. FHWA-SA-91-031 May 1991, revised April 1992) on all lots used for shop connections. Any rotational capacity lot that fails to conform to the requirements shall be rejected. Rotational capacity lots that fail may, at the Contractor's option, be reprocessed and submitted for retest.

Bolt assemblies shall be installed in accordance with the procedures defined in Report No. FHWA-SA-91-031 May 1991, as revised April 1992.

Delete subsection 509.24 (c) and replace with the following:

(c) Paint System. All structural steel, with the exception of weathering (AASHTO M 222), shall be painted with the two coat system defined in Subsection 708.03. Painting shall include a coat of primer on splice plates, faying surfaces of girders and diaphragms, and the interior surfaces of steel box girders. The primer and topcoat shall be applied in the structural steel fabrication shop prior to shipment of the steel to the project site. The primer and topcoat, color as defined in the plans, shall have a dry film thickness of 3.0 mils each. The Volatile Organic Content (VOC) of the paint shall not exceed 2.8 pounds per gallon (340 gm per liter). The QA Inspector shall be provided with a materials data sheet for all paint used on the project.

Paint shall be stored, mixed, strained, and applied in accordance with the manufacturer's application instructions. Quality Control inspections and tests shall be performed in accordance with the listed test. The Quality Control Inspector shall maintain a checklist of the pieces tested. Only deficiencies require measurement records. These records shall be forwarded to the QA Inspector.

The Contractor shall perform the test procedure ASTM D 4285 once every four operating hours to assure the absence of oil and moisture in the compressed air lines used to blast and paint.

The profile of surfaces to be painted shall be tested once every 2000 square feet (185 square meters). The procedure shall conform to ASTM D 4417.

The thinner used shall be that indicated in the Manufacturer's Technical Data Sheet. No material shall be substituted without approval. The maximum volume used in dilution shall not exceed the amount specified in the Technical Data Sheet.

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The dry film thickness shall be measured to the frequency and using the procedure listed in The Structural Steel Paint Council Specification SSPC PA-2, with exception of diaphragms, bearings, and ancillary items. Ten percent of internal diaphragms in box girders, external diaphragms on all bridge girders, and ancillary items shall be spot measured (average to three readings). The Quality Control Inspector shall maintain a checklist of the members tested.

Replace subsection 509.28 with the following:

509.28 Connections Using High Strength Bolts.

(a) Field Connections. Only Heavy Hex Structural Bolts with Compressible-Washer-Type Direct Tension Indicators or Tension Control Bolts conforming to the requirements of Subsection 509.08 shall be used in structural steel connections.

(b) Bolted Parts. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible material. All joint faying surfaces, when assembled, shall be free of scale; dirt; burrs; drilling/cutting lubricants; other foreign material; and other defects that may prevent solid seating of the parts. Contact surfaces within joints shall be free of oil, paint (except primer coat), lacquer, or rust inhibiter.

(c) Rotational Capacity and Verification Tests. The Division will perform Rotational Capacity and Verification Tests in accordance with the procedures outlined in the Report " High-Strength Bolts for Bridges" (Report No. FHWA-SA-91-031 May 1991, revised April 1992) on all lots used for field connections. Any rotational capacity lot that fails to conform to the requirements shall be rejected. Rotational capacity lots that fail may, at the Contractors option, be reprocessed and submitted for retest.

(d) Installation. Bolt assemblies of appropriately assigned lot numbers shall be assembled together when installed in a joint. Fasteners and contact surfaces of splices shall be protected from dirt, moisture, and oil at the project site. Only as many fasteners as are anticipated to be installed and tightened during a work shift shall be taken from protected storage. Fasteners not used shall be returned to protected storage at the end of the shift. Fasteners shall not be cleaned of lubricant that is required to be present in as-delivered condition. Bolt assembly lots which are improperly stored, lack lubrication, or accumulate rust, dirt, or other contaminants

shall be cleaned, relubricated, and submitted for retest as defined in Subsection 509.28(c).

Bolt assemblies shall be installed in and tensioned to the minimum tension specified in the following table:

Bolt Diameter Inch (mm)	Required Minimum Bolt Tension Kips (kN)
1/2 (12.7)	13 (57.8)
5/8 (15.8)	20 (89.0)
3/4 (19.1)	29 (129.0)
7/8 (22.2)	41 (182.4)
1 (25.4)	54 (240.2)

Bolt assemblies shall be installed in accordance with the procedures defined in the Report "High-Strength Bolts for Bridges" (Report No. FHWA-SA-91-031 May 1991, as revised April 1992.

(e) Inspection. The Contractor shall provide an acceptable platform from which the Engineer can inspect the bolt tension and determine whether the work meets the specification requirements. The Engineer will inspect a sufficient number of fasteners to assure that the minimum bolt tension has been attained. All undertensioned bolt assemblies shall be brought into compliance.

(f) Painting of Connections. Structural steel connections in which all bolt assemblies have been satisfactorily tensioned shall be cleaned to remove the lubricant from the exposed portions of the fasteners and any other contaminants. The bolts and splice plates shall then be painted as defined in Subsection 509.24.

(g) Repair of Painted Surfaces. The Contractor shall repaint “touch up”, all areas in which the paint has been damaged. Tie downs and dunnage shall be cushioned to protect painted surfaces during transit. Repainting shall include all damage incurred during transit, handling, erection of structural steel, and forming and casting the deck. Paint shall conform to Subsection 708.03. Repainting will not be measured and paid for separately but shall be included in the work.