SECTION 718 - STEEL FASTENERS

718.01 Standard Fasteners. Standard bolts shall conform to ASTM A 307.

Anchor bolts shall conform to ASTM A 193; anchor bolt nuts to AASHTO M 292. Anchor bolts, including nuts and washers, shall be hot-dip zinc coated.

The Contractor shall submit certified test results of bolts and nuts in accordance with the requirements of this subsection. Certifications shall be submitted before installing bolts.

718.02 High-Strength Bolts And Studs. Bolts and studs shall conform to AASHTO *LRFD Bridge Design Specifications*, Subsection 6.4.3.1. Bolts designated as high-strength bolts shall be AASHTO M 164 structural bolts, steel, heat-treated, 120 or 105 kips per square inch (ksi) minimum tensile strength, Type 1. Bolts 1/2 inch to 1 inch in diameter shall have minimum tensile strength of 120 ksi. Bolts 1-1/8 inches to 1-1/2 inches in diameter shall have minimum tensile strength of 105 ksi. Anchor bolts 1-3/4 inches to 3 inches in diameter and designated as high-strength studs shall conform to ASTM A 449, Type 1. Bolts and studs shall be hot-dip zinc coated. AASHTO M 253 bolts shall not be hot-dip zinc coated.

Bolts shall conform to requirements for heavy hexagon structural bolts in ANSI B18.2, and dimensions in Table 718.02-1 – Bolt and Nut Dimensions.

TABLE 718.02-1 - BOLT AND NUT DIMENSIONS (INCHES)					
NominalBoltSize, D	Bolt Dimension			Nut Dimension	
	Heavy Hexagon Structural Bolts			Heavy Semi-Finished Hexagon Nuts	
	Width Across Flats, F	Height, H	Thread Length, T	Width Across Flats, W	Height, H
1/2	7/8	5/16	1	7/8	31/64
5/8	1-1/16	25/64	1-1/4	1-1/16	39/64
3/4	1-1/4	15/32	1-3/8	1-1/4	47/64
7/8	1-7/16	35/64	1-1/2	1-7/16	55/64
1	1-5/8	39/64	1-3/4	1-5/8	63/64
1-1/8	1-13/16	11/16	2	1-13/16	1-7/64
1-1/4	2	25/32	2	2	1-7/32
1-3/8	2-3/16	27/32	2-1/4	2-3/16	1-11/32
1-1/2	2-3/8	15/16	2-1/4	2-3/8	1-15/32

Rockwell C hardness of bolts shall be 24 minimum and 32 maximum, after heat-treating and before zinc coating.

718.03 Nuts. Nuts shall conform to AASHTO M 291. Nuts shall be hot-dip zinc coated.

Nuts shall be Grade DH or 2H for use with AASHTO M 164, Type 1, bolts. Nut shall be marked on one face with grade symbol DH or 2H, as appropriate. Grade marking shall be impressed on bearing surface of nut.

Nuts shall conform to requirements for heavy semi-finished nuts in ANSI B18.2, and dimensions shown in Table 718.02-1 - Bolt and Nut Dimensions (Inches). Bearing surface of nut under bolt head shall not be less than dimensions shown in Table 718.02-1 – Bolt and Nut Dimensions.

Nuts shall be tapped oversize after hot-dip zinc coating. Overtapping shall be as necessary for threading of nut onto bolt when both are zinc coated. Overtapping shall conform to mechanical property and rotational capacity test requirements in AASHTO M 291. Overtapping threads of nuts shall not exceed the allowances in Paragraph 7.4 and Table 5 of AASHTO M 291.

Zinc-coated nuts shall be lubricated with lubricant containing visible dye.

718.04 Washers. Washers shall be hardened steel washers conforming to AASHTO M 293.

Hardened steel washers shall have flat and smooth surfaces and nominal dimensions conforming to Table 718.04-1 – Washer Dimensions (Inches).

TABLE 718.04-1 - WASHER DIMENSIONS (Inches)							
Circular Washers			Square or Rectangle Beveled Washers for American Standard Beams and Channels				
Bolt Size D	Nominal Outside Diameter[A]	Nominal Diameter of Hole	Thickness		Minimum Side Dimension	Mean Thick-ness	Slope Thick-ness
			Min.	Max.			
1/2	1-1/16	17/32	0.097	0.177	1-3/4	5/16	1:6
5/8	1-5/16	11/16	0.122	0.177	1-3/4	5/16	1:6
3/4	1-15/32	13/16	0.122	0.177	1-3/4	5/16	1:6
7/8	1-3/4	15/16	0.136	0.177	1-3/4	5/16	1:6
1	2	1-1/8	0.136	0.177	1-3/4	5/16	1:6
1-1/8	2-1/4	1-1/4	0.136	0.177	2-1/4	5/16	1:6
1-1/4	2-1/2	1-3/8	0.136	0.177	2-1/4	5/16	1:6
1-3/8	2-3/4	1-1/2	0.136	0.177	2-1/4	5/16	1:6
1-1/2	3	1-5/8	0.136	0.177	2-1/4	5/16	1:6
1-3/4	3-3/8	1-7/8	0.178[B]	0.28[B]	---	---	---
2	3-3/4	2-1/8	0.178[B]	0.28[B]	---	---	---
Over 2 to 4 Incl.	2D - 1/2	D + 1/8	0.24[C]	0.34[C]	---	---	---

[A] May be exceeded by 1/4 inch
[B] 3/16 inch nominal
[C] 1/4 inch nominal

Washers for AASHTO M 164, Type 1, bolts shall be marked with symbol that identifies the manufacturer.

Beveled washers for American Standard beams and channels shall be square or rectangular shape, shall taper in thickness, and shall conform to the dimensions in Table 718.04-1 – Washer Dimensions (Inches).

If necessary, washers shall be clipped on one side to a point not closer than 7/8 of bolt diameter from center of washer.

718.05 Testing.

(A) Bolts.

(1) Proof load tests in accordance with ASTM F 606, Method 1, are required. Minimum frequency of tests shall be in accordance with AASHTO M 164, Paragraph 10.2.4.

(2) Wedge tension tests on full-size bolts in accordance with ASTM F 606, Paragraph 3.5, are required. Bolts shall be tested after zinc coating. Minimum frequency of tests shall be in accordance with AASHTO M 164, Paragraph 10.2.4.

(3) Thickness of zinc coating shall be measured on wrench flats or top of bolt head.

(B) Nuts.

(1) Proof load tests in accordance with ASTM F 606, Paragraph 4.2, are required. Minimum frequency of tests shall be in accordance with AASHTO M 291, Paragraph 9.3; or AASHTO M 292, Paragraph 7.1.2.1. Nuts shall be tested after zinc coating, overtapping, and application of lubricant containing visible dye.

(2) Thickness of zinc coating shall be measured on wrench flats.

(C) Washers.

(1) Hardness of washers shall be tested after zinc coating. Coating shall be removed before hardness measurements are taken.

(2) Thickness of zinc coating shall be measured.

(D) Bolt, Nut, and Washer Assemblies. Rotational-capacity tests on bolt, nut, and washer assemblies are required. Assemblies shall be tested after zinc coating and before shipping. Washers shall be part of test. Washers may not need to be part of installation procedure.

The following shall apply:

(1) Rotational-capacity test shall be done in accordance with AASHTO M 164, except as modified by this subsection.

(2) Each production lot combination of bolt, nut, and washer shall be tested as an assembly. Where washers are not required for installation, washers do not have to be included in lot identification.

(3) Rotational-capacity lot number shall be assigned to each combination of lots tested.

(4) Minimum frequency of testing shall be two assemblies per rotational-capacity lot.

(5) Bolt, nut, and washer shall be assembled on Skidmore-Wilhelm Calibrator or accepted equivalent device. The above requirement supersedes the requirement for the Contractor to test in steel joint as specified in AASHTO M 164. Bolts that are assembled too short in Skidmore-Wilhelm Calibrator shall be tested as specified in Subsection 718.05(D)(9).

(6) Minimum rotation from snug-tight condition (10 percent of specified proof load) shall be as follows:

(a) 240 degrees (2/3 turn) for bolt lengths up to and including 4 diameters.

(b) 360 degrees (one full turn) for bolt lengths over 4 diameters but not exceeding 8 diameters.

(c) 480 degrees (1-1/3 turn) for bolt lengths over 8 diameters.

The requirements indicated above supersede values specified in AASHTO M 164.

(7) Turn-test tension reached at the above rotation shall be equal to or greater than 1.15 times the required installation tension. Installation tension and turn-test tension shall be as shown in Table 718.05-3 – Installation Tension and Turn - Test Tension.

TABLE 718.05-3 - INSTALLATION TENSION AND TURN-TEST TENSION		
Diameter (Inches)	**Required Installation Tension (kips)**	**Turn-Test Tension (kips)**
1/2	12	14
5/8	19	22
3/4	28	32
7/8	39	45
1	51	59
1-1/8	56	64
1-1/4	71	82
1-3/8	85	98
1-1/2	103	118

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

Torque $\leq$ 0.25 PD,

Where: Torque = Measured Torque in Foot-Pounds
P = Measured Bolt Tension in Pounds
D = Bolt Nominal Diameter in Feet

(9) Bolts that are too short to test in a Skidmore-Wilhelm Calibrator can be tested in a steel joint. Tension requirements of Table 718.05-3 - Installation Tension and Turn-Test Tension will not be applicable. Maximum torque requirement in Subsection 718.05(D)(8) shall be calculated using a value for P that is equal to turn-test tension shown in Table 718.05-3 - Installation Tension and Turn-Test Tension.

(E) Reporting.

(1) Test results (including zinc coating thickness) shall be recorded in accordance with the requirements of this subsection and AASHTO specifications, as appropriate.

(2) Location of tests and date of tests shall be reported on appropriate document.

(F) Witnessing. It is not necessary that a professional inspector witness the tests. Certifications of accuracy as to test results from manufacturer or distributor that did the testing will be acceptable.

718.06 Documentation.

(A) Mill Test Report (MTR).

(1) MTRs shall be submitted for mill steel used in manufacturing bolts, nuts, and washers.

(2) Each MTR shall show location of melting and manufacture.

(B) Manufacturer-Certified Test Report (MCTR).

(1) MCTRs shall be submitted for bolts, nuts, and washers.

(2) MCTR shall conform to the reporting requirements in Subsection 718.05(E) - Reporting.

(3) MCTR shall include the following information from manufacturer that performed rotational-capacity test:

(a) Lot number of each item tested.

(b) Rotational-capacity lot number, as required by Subsection 718.05(D)(3).

(c) Test results, as required by Subsection 718.05(E)(1).

(d) Information required by Subsection 718.05(E)(2).

(e) Statement that MCTR for nuts, bolts, and washers complies with the requirements of this Subsection 718.05 - Testing and applicable AASHTO specifications.

(f) Location where components of bolt assembly were manufactured.

(C) Distributor-Certified Test Report (DCTR).

(1) DCTR shall include MCTR for various components of bolt assembly.

(2) Distributor-prepared rotational-capacity tests and reporting of test results in the DCTR are acceptable.

(3) Test results to be included in the DCTR shall conform to the requirements of Subsection 718.05(D) - Bolt, Nut, and Washer Assemblies.

(4) Information to be included in the DCTR shall conform to Subsection 718.05(E)(2).

(5) Rotational-capacity lot number to be included in the DCTR shall be as required by Subsection 718.05(D)(3).

(6) Certification shall be provided in the DCTR that the MCTR conforms to the requirements of Subsection 718.05 - Testing and applicable AASHTO specifications.

718.07 Shipping.

(A) Bolts, nuts, and washers from each rotational-capacity lot shall be shipped in the same container. If there is only one production lot number for each size of nut and washer, nuts and washers may be shipped in separate containers. Each container shall be marked permanently with its rotational-capacity lot number to make identification possible at various stages before installation.

(B) The MTR, MCTR, or DCTR, as appropriate, shall be submitted in accordance with the contract documents.

718.08 Installation. Shop or field installation of high-strength bolts shall conform to AASHTO *Standard Specifications for Highway Bridges*, Division II, Subsection 11.5.6.4, Installation, and as modified by this subsection. Bolts shall be installed in accordance with AASHTO *Standard Specifications for Highway Bridges*, Subsection 11.5.6.4.7, Direct Tension Indicator Installation Method, using zinc-coated indicators. The exception is that anchor bolts for railing posts base plates may also be installed as specified in Subsection 11.5.6.4.4, Turn-of-Nut Installation Method, and Subsection 11.5.6.4.5, Calibrated Wrench Installation Method, of AASHTO *Standard Specifications for Highway Bridges*.

Railing post base plate anchor bolts embedded in epoxy resin shall be installed in accordance with manufacturer's requirements. Nut installations shall begin with all connections brought to snug condition. Either or both final tension and torque shall not exceed the maximum value allowed by manufacturer.

END OF SECTION 718