

225.02—Detail Requirements.

- (a) **Steel forgings** shall conform to the requirements of ASTM A668, Class D, for use with structural carbon steel and Class F for use with high-strength low-alloy steel.
- (b) **Steel shafting** shall conform to the requirements of ASTM A108, Grades 1016 through 1030.

SECTION 226—STRUCTURAL STEEL**226.01—Description.**

These specifications cover steel structural shapes furnished to specific dimensions and associated hardware and fasteners.

226.02—Detail Requirements.

- (a) **Bridge Structural Steel:** Structural steel for bridge shall conform to the requirements of ASTM A709 for the grade specified, except that stud shear connectors shall conform to (e) herein. Steel for tensile flanges and webs of plate girders, rolled beams, cover and splice plates, and any other components designated as main load carrying components subject to tensile stress shall conform to the supplemental requirements of ASTM A709 for the Charpy V-Notch tests for Zone Two.

Fracture critical bridge steel members designated on the plans shall conform to the requirements of the AASHTO Guide Specifications for Fracture Critical Non-Redundant Steel Bridge members.

One copy of the mill analysis for bridge steel shall be submitted to the Engineer.

- (b) **Other Structural Steel:** Unless otherwise specified, steel for other structural members including H-piles shall conform to the requirements of ASTM A709 Grade 36. One copy of the mill analysis shall accompany steel piles shipped to the project site. Three copies of the mill analysis for structural steel members shall be submitted to the Engineer.
- (c) **Anchor Bolts:**
 - 1. Anchor bolts for general use shall conform to the requirements of AASHTO M314, Grade 36. Nuts shall conform to the requirements of ASTM A563, and washers shall conform to the requirements of ASTM F844. Threads shall be coarse series.

2. High strength anchor bolts shall conform to the requirements of AASHTO M314, Grade 55 with supplemental requirements of S1. Nuts and washers shall conform to the requirements of (h) herein.
 3. Galvanization of steel anchor bolts, nuts, and washers shall be in accordance with the requirements of ASTM A153.
 4. Anchor bolts for railings shall conform to the requirements of (c)1. herein and shall be hot dipped galvanized
- (d) **Stud shear connectors** shall conform to the requirements of AWS D1.1 *Structural Welding Code* or AWS D1.5 *Bridge Welding Code* as applicable. Stud shear connectors that conform to these requirements and are on the Department's approved list may be used without further testing.
- (e) **Steel for Structural Supports for Light Poles and Traffic Control Devices:** Steel shall be suitable for the design requirements and conform to the following:

Characteristic	Value
Min. yield strength	36,000 psi
Min. tensile strength	58,000 psi
Min. elongation (in 8 inches)	18%
Min. elongation (in 2 inches)	20%
Carbon equivalent (as determined by AWS D1.1/D1.5)	Max. 0.45%

Charpy V notch values of 25 foot pounds at 10 degrees F may be substituted for elongation requirements. ASTM A500 tubing shall have charpy values of 25 foot pounds at 10 degrees F.

ASTM A709 Grade 50W steel shall not be used unless specified.

- (f) **Steel for Timber Connectors:** Steel shall conform to the requirements of ASTM A711, AISI No. 1015.
- (g) **Bolts, Nuts, and Washers:** Bolts shall conform to the requirements of ASTM A307 except where high-strength or other special types of bolts are required. Nuts for A307 bolts shall conform to the requirements of ASTM A563, and washers shall conform to the requirements of ASTM F844. Lock washers shall conform to the requirements of ANSI B18.21.1.
- (h) **High-Strength Bolts, Nuts, Washers, and Direct Tension Indicators:** These items shall conform to the following ASTM specifications:

High-Strength Bolts	Nuts for use with High-Strength Bolts, Heavy Hex	Washers (Hardened)	Direct Tension Indicators
A325, Type 1	A563, Grade DH A194, Grade 2H	F436	F959
A325, Type 3	A563, Grade DH3	F436	F959
A325, Galvanized	A563, Grade DH	F436	F959
A490, Types 1 or 2	A563, Grade DH A194, Grade 2H	F436	F9599
A490, Type 3	A563, Grade DH3	F436	F959

1. ASTM A490 bolts, nuts and washers shall be plain (uncoated) and ASTM A325 Type 1 bolts, nuts and washers shall be galvanized. High strength bolts used with unpainted weathering steel shall conform to ASTM A325, Type 3 or when specified, ASTM A490, Type 3.
2. The maximum hardness for ASTM A325 bolts shall be 33R_c. The maximum tensile strength for ASTM A325 bolts shall be 150 kips per square inch for bolts 1 inch or less in diameter and 120 kips per square inch for larger bolts.
3. High-strength fasteners (plain and coated) shall be subjected to a rotational-capacity test similar to the supplementary requirements of ASTM A325 and ASTM A490 and as modified by the following:
 - a. Washers shall be used in the rotational-capacity test even though they may not be specified for use. Each combination of a bolt production lot, a nut production lot and a washer production lot shall be tested as an assembly. A rotational-capacity lot number shall be assigned to each combination of lots tested. When washers are not specified for use, they need not be included in the rotational-capacity lot number. The minimum frequency of testing shall be two assemblies per shipping lot.

Starting with 10 percent of the specified proof load using a Skidmore-Wilhelm Calibrator or equivalent tension-measuring device, the assembly shall withstand the number of turns indicated without breaking:

- (1) Bolt length up to and including 4 diameters: 2/3 turn
- (2) Bolt length over 4 but not exceeding 8 diameters: 1 turn
- (3) Bolt length over 8 but not exceeding 12 diameters: 1 1/3 turn

Bolts too short to test in a Skidmore-Whilhelm Calibrator shall be tested using steel plate(s) without the specified proof load requirement.

- b. During this test, the minimum recorded tension shall be at least 1.15 times the required bolt proof load as specified in ASTM A325 and A490.

1.15 x Proof Load (lb)

Bolt Size (in)	A325	A490
1/2	13,800	19,600
5/8	22,000	31,100
3/4	32,600	46,100
7/8	45,100	63,700
1	59,200	83,600
1 1/8	64,900	105,200
1 1/4	82,400	133,700
1 3/8	98,200	159,300
1 1/2	119,600	193,800

- c. The measured torque to produce the required fastener tension shall not exceed the value obtained by the following equation:

$$\text{Torque} = 0.25 PD$$

Where:

Torque = measured torque (foot-pounds),

P = measured bolt tension (pounds), and

D = nominal diameter (feet).

Max. Torque 1.15 x Proof Load (ft-lb)

Bolt Size (in)	A325	A490
1/2	140	200
5/8	280	400
3/4	500	720
7/8	820	1,160
1	1,230	1,730
1 1/8	1,510	2,460
1 1/4	2,140	3,470
1 3/8	2,800	4,550
1 1/2	3,730	6,040

- d. Bolts shall be proof-load tested in accordance with the requirements of ASTM F606, Method I. Full-size bolts shall be wedge tested in accordance with the requirements of ASTM F606. Nuts

shall be proof-load tested in accordance with the requirements of ASTM F606. Galvanized bolts shall be wedge tested after galvanizing. Galvanized nuts shall be proof-load tested in accordance with the requirements of ASTM F606 only when overlapping, galvanizing, and lubricating operations are completed.

- e. Galvanized bolts, nuts and washers shall be hot dipped galvanized by the hot dipped method in accordance with the requirements of ASTM A153. If the bolts are to be topcoated with paint, mechanically galvanized bolts, nuts and washers in accordance with the requirements of ASTM B695, Class 50 may be used.

When galvanized nuts conforming to ASTM A563 are specified, the amount of over tapping may be less than specified; however, all nuts in each lot shall be over tapped the same amount. Galvanized nuts shall be lubricated in accordance with the requirements of ASTM A563 using a lubricant sufficiently tinted so as to be readily visible.

Galvanized bolts, nuts and washers shall have the galvanization measured for thickness. Measurements for bolts shall be taken on the wrench flats or top of the bolt head. Measurements for nuts shall be taken on the wrench flats.

When galvanized washers are specified, hardness testing shall be performed after galvanizing. The coating shall be removed prior to testing.

- f. All bolts, nuts and washers shall be identified with a marking which identifies the manufacturer of such products. The Contractor shall provide an example of such marking and the certification of each manufacturer for the bolts, nuts and washers supplied. The Contractor shall also provide written documentation of all tests required by ASTM and by specifications herein for bolts, nuts and washers. Documentation shall indicate the results of such tests, the address where the tests were performed and the date of testing. Test results of bolts and nuts shall also indicate the lot number of the product. Bolts, nuts and washers from different rotational-capacity lots shall not be shipped in the same container. In addition, shipping containers shall be marked with the rotational-capacity test lot number of the product supplied.

SECTION 227—STEEL GRID FLOORING

227.01—Description.

These specifications cover plant-fabricated steel for use as a portion of a bridge deck.