

**972.1 REQUIREMENTS**

These specifications shall apply to all high strength bolts and anchor bolts.

**972.2 SPECIFIC REQUIREMENTS****A. General:**

All bolts, nuts, and washers shall have the manufacturer marking on them. The supplier shall provide the symbol and address of each bolt, nut, and washer manufacturer.

The supplier and contractor shall maintain the identification and integrity of fasteners supplied under either the "Production Lot" or "Shipping Lot" method. All certificates, test reports and shipping containers shall be identified with the appropriate lot identification number. The Contractor shall indicate how he plans to maintain the integrity of the lots through installation.

The suppliers certification shall provide a corresponding lot number, which appears on the shipping package and on the certification. The certificate shall provide all test results and shall indicate when and where all testing was done, including the rotational capacity tests and the zinc coating thickness.

Nuts for mechanically galvanized fasteners shall be overtapped to the minimum amount required for fastener assembly.

Mechanically galvanized nuts shall be lubricated with a lubricant containing a visible dye.

The test data referred to in 11.1 of ASTM A563 and 13.2 and 13.3 of A194 shall be furnished.

**B. High Strength Bolts:**

Bolts shall conform to ASTM A325 and shall be mechanically galvanized, unless otherwise specified.

The maximum hardness for AASHTO M164 (ASTM A325) bolts shall be 33Rc. The maximum tensile strength shall be 150 ksi (1030 MPa) for bolts 1 inch (25 mm) or less in diameter and 120 ksi (825 MPa) for larger bolts.

High-strength bolts for structural steel joints including suitable nuts and plain hardened washers shall conform to either AASHTO M164 (ASTM A325) or AASHTO M253 (ASTM A490). When M164 Type 3 bolts are specified, they along with suitable nuts and washers, shall have an atmospheric corrosion resistance approximately two times that of carbon steel with copper.

Bolts and nuts manufactured to AASHTO M164 (ASTM A325) are identified by proper marking as specified on the top of the bolt heads and on one face of the nuts for three different types.

Bolts manufactured to AASHTO M253 (ASTM A490) are identified by marking on the top of the

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head with the symbol A490 and the nuts shall be marked on one face with the legend "2H" or "DH".

Bolt and nut dimensions shall conform to the dimensions shown in Table 1 and to the requirements for Heavy Hexagon Structural Bolts and for Heavy Semi-Finished Hexagon Nuts given in ANSI Standard B18.2.1 and B18.2.2 respectively.

**TABLE 1**

Nominal Bolt Size	Bolt Dimensions In Inches Heavy Hexagon Structural Bolts		Thread Length	Nut Dimensions In Inches Heavy Semi-finished Hexagon Nuts	
	Width Across Flats	Height		Width Across Flats	Height
D	F	H	T	W	H
½	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

Circular washers shall be flat and smooth and their nominal dimensions shall conform to the dimensions given in Table 2, except that for lock pin and collar fasteners, flat washers need not be used, unless slotted or oversized holes are specified.

TABLE 2

WASHER DIMENSIONS<sup>a</sup>

Bolt Size D	Circular Washers		Thickness Side		Square or Rectangular Beveled Washers for American Standard Beams and Channels		
	Nominal Outside Diameter <sup>b</sup>	Nominal Diameter of Hole	Min.	Max.	Min Mean Dimen.	Taper in Thickness	Slope of Thickness
1/2	1-1/16	17/32	.097	.177	1-3/4	5/16	1:6
5/8	1-5/16	21/32	.122	.177	1-3/4	5/16	1:6
3/4	1-15/32	13/16	.122	.177	1-3/4	5/16	1:6
7/8	1-3/4	15/16	.136	.177	1-3/4	5/16	1:6
1	2	1-1/16	.136	.177	1-3/4	5/16	1:6
1-1/8	2-1/4	1-1/4	.136	.177	2-1/4	5/16	1:6
1-1/4	2-1/2	1-3/8	.136	.177	2-1/4	5/16	1:6
1-3/8	2-3/4	1-1/2	.136	.177	2-1/4	5/16	1:6
1-1/2	3	1-5/8	.136	.177 <sup>c</sup>	2-1/4	5/16	1:6
1-3/4	3-3/8	1-7/8	.178 <sup>c</sup>	.28 <sup>c</sup>	---	---	---
2	3-3/4	2-1/8	.178	.28	---	---	---
Over 2							
to 4 Inclusive	2D-1/2	D+1/8	.24 <sup>d</sup>	.34 <sup>d</sup>	---	---	---

a-Dimensions in inches

b-May be exceeded by 1/4 inch

c-3/16 inch nominal

d-1/4 inch nominal

Bolt and nut dimensions shall conform to the dimensions shown in Table 1 and to the requirements for Heavy Hexagon Structural Bolts and for Heavy Semi-Finished Hexagon Nuts given in ANSI Standard B18.2.1 and B18.2.2 respectively.

TABLE 1 (METRIC)

Bolt Dimensions (mm) - Heavy Hex Structural Bolts						Nut Dimensions (mm)		
Nominal Bolt Size	Width across flats	Height		Thread Length		Width across flats	Thickness	
		H		T			W	Max
D	F	Max	Min	Bolt length =100	Bolt length >100			
M16	27	10.75	9.25	31	38	27	17.1	16.4
M20	34	13.40	11.60	36	43	34	20.7	19.4
M22	36	14.90	13.10	38	45	36	23.6	22.3
M24	41	15.90	14.10	41	48	41	24.2	22.9
M27	46	17.90	16.10	44	51	46	27.6	26.3
M30	50	19.75	17.65	49	56	50	30.7	29.1
M36	60	23.55	21.45	56	63	60	36.6	35.0

Circular washers shall be flat and smooth and their nominal dimensions shall conform to the dimensions given in Table 2, except that for lock pin and collar fasteners, flat washers need not be used, unless slotted or oversized holes are specified.

TABLE 2 (METRIC)

Circular Washers							Square or Rectangular Beveled Washers				
Bolt Size	Nominal Outside Diameter		Nominal Diameter of Hole		Thickness Side		Min. Mean Dimension		Mean Thickness		Slope of Thickness
	max	min	max	min	max	min	max	min	max	min	
M16	34	32.4	18.4	18	0.8	0.4	45.0	43.0	8.5	7.5	1:6
M20	42	40.4	22.5	22	0.8	0.4	45.0	43.0	8.5	7.5	1:6
M22	44	42.4	24.5	24	0.8	0.4	45.0	43.0	8.5	7.5	1:6
M24	50	48.4	26.5	26	0.8	0.4	45.0	43.0	8.5	7.5	1:6
M27	56	54.1	30.5	30	0.8	0.4	58.0	56.0	8.5	7.5	1:6
M30	60	58.1	33.6	33	0.8	0.4	58.0	56.0	8.5	7.5	1:6
M36	72	70.1	39.6	39	0.8	0.4	58.0	56.0	8.5	7.5	1:6

Bolt and nut dimensions shall conform to the dimensions shown in Table 1 and to the requirements for Heavy Hexagon Structural Bolts and for Heavy Semi-Finished Hexagon Nuts given in ANSI Standard B18.2.1 and B18.2.2 respectively.

Beveled washers for American Standard Beams and Channels or other sloping faces shall be required and shall be square or rectangular, shall taper in thickness and shall conform to the dimensions given in Table 2.

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

Other fasteners or fastener assemblies which meet the materials, manufacturing and chemical composition requirements of AASHTO M164 (ASTM A325) or AASHTO M253 (ASTM A490) and which meet the mechanical property requirements of the same specification in full-size tests and which have body diameter and bearing areas under the head and nut, or their diameter and bearing areas under the head and nut, or their equivalent, not less than those provided by a bolt and nut of the same nominal dimensions prescribed in the previous paragraph, may be used. Such alternate fasteners may differ in other dimensions from those of the specified bolts and nuts. Their installation procedure may differ from those specified in Section 410.3 G.6.d. and their inspection may differ from that specified in Section 410.3 G.6.f. When a different installation procedure or inspection is used, it shall be detailed in a supplemental specification, prepared by the Contractor, applying to the alternate fastener and that specification must be approved by the Engineer.

### C. Anchor Bolts:

Bolts conforming to ASTM A307, A449, and F1554 are allowed to be used for anchor bolts. Other materials may be submitted for approval providing the following information is submitted:

1. The allowable stresses that are to be used for design based on the proposed material.
2. Minimum average Charpy V-Notch impact values for 15 ft-lb at  $-20$  degrees F (20.3 N-m at  $-29$  degrees C) in accordance with ASTM A370.
3. Ultimate wedge tensile strength in accordance with ASTM A370.
4. Yield strength reports in accordance with ASTM A370.

Anchor bolts shall be either threaded full length or equipped with a satisfactory mechanical end anchorage. Details for any mechanical end anchorage shall be included in the shop plans submittal for prior approval. Swaged anchor bolts and anchor bolts with hooked end anchorage are not allowed.

The anchor bolt threads shall be three inches (75 mm) plus the projection. At least three inches (75 mm) of threads shall be below the top of the concrete. Rolled UNC threads are required for all bolts.

Nuts shall conform to ASTM A194, 2H or ASTM A563, DH. All nuts are to be heavy hex.

Washers shall conform to ASTM F436 or ASTM F959.

Bolts, Nuts, and Washers shall be galvanized in accordance with ASTM A153 or B695, Class 50. The minimum length of galvanizing shall be the bolt projection plus three inches (75 mm).

### D. Bolt Testing: Bolt testing shall conform to the following:

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When bolts conforming to ASTM A325, A449, A307, F1554 or others are designated for use in the plans and/or shop drawings, a Certified Mill Test Report for each type designated shall be submitted for approval to the Certification Engineer a minimum of 14 days prior to incorporating these bolts into the work. Certified Mill Test Reports for nuts, washers, direct tension indicators, and other required hardware shall be included.

The Certified Mill Test Reports for the bolts shall include test results, tested in accordance with the applicable ASTM Specifications, for the following:

<b>Test</b>	<b>A325</b>	<b>A449</b>	<b>A307</b>	<b>F1554</b>	<b>Others</b>
Chemical Analysis	X	X	X	X	X
Hardness Test	X	X	X		X
* Tensile Strength (By Wedge Test Method)	X	X	X	X	X
** Proof Load Test	X	X	X	X	X
*** Rotational Capacity Test	X				
**** Charpy V-Notch				X	X

\* Certified Mill Test Report shall state that Wedge Test Method was used. For ASTM A307 and A449 bolts, the Wedge Test Method is required only for square and hexagon head bolts. The Wedge Test Method is not required for ASTM F1554 bolts. See appropriate specifications.

\*\* Proof Load Test and/or Yield Test as allowed or specified by the applicable ASTM Specification.

\*\*\* Rotational Capacity Test required for Zinc Coated (Galvanized) bolts only. This test shall be conducted using the actual nuts that are used on the project.

\*\*\*\* Anchor bolts conforming to ASTM F1554 Grade 36 (205) and 55 (380) shall satisfy Supplemental Requirement S4. Anchor bolts conforming to ASTM F1554 Grade 105 (725) shall satisfy Supplemental Requirement S5.

Note: The requirements set forth in this table are to alert the Contractor to the requirements for testing and certification as specified in the applicable ASTM Specifications and are not intended to alter the requirements of the ASTM Specifications

Proof load tests on bolts (ASTM F606 Method 1) are required. Wedge testing of full size bolts is required in accordance with AASHTO M164 (ASTM A325). Galvanized bolts shall be wedge tested after galvanizing. Proof load tests (AASHTO M291) are required for the nuts and shall be performed after galvanizing, overtapping, and lubricating.