

SECTION 970 STEEL STRUCTURES MATERIAL

970.1 GENERAL

These specifications apply to bolted and welded construction.

970.2 STRUCTURAL STEEL

Steel shall be furnished according to the following specifications. Unless otherwise specified, structural carbon steel shall be furnished.

- A. **Carbon Steel:** Structural carbon steel for bolted or welded construction shall conform to, AASHTO M270 (ASTM A709) grade 36 (grade 250).
- B. **Eyebars:** Steel for eyebars shall be of a weldable grade. These grades include structural steel conforming to Structural Steel, AASHTO M270 (ASTM A709) grade 36 (grade 250) or AASHTO M270 (ASTM A709) grade 50W (grade 345W) with supplemental requirement S3 of AASHTO M270 grade 50W (grade 345W) mandatory.
- C. **High-Strength Low-Alloy Structural Steel:** High-strength low-alloy structural steel shall conform to AASHTO M270 (ASTM A709) grade 50 (grade 345) or AASHTO M270 (ASTM A709) grade 50W (grade 345W).
- D. **High-Strength Low-Alloy Structural Steel for Welding:** High-strength low-alloy structural steel for welding shall conform to Grade 50 (grade 345), AASHTO M270 (ASTM A709 with supplementary requirement S3 of AASHTO M270 grade 50 mandatory) or AASHTO M270 (ASTM A709 with supplementary requirement S3 of AASHTO M270 grade 50W (grade 345W) mandatory).
- E. **High-Strength Structural Steel for Bolted Construction:** High-strength structural steel for bolted construction shall conform to AASHTO M270 (ASTM A709) grade 50 (grade 345) or AASHTO M270 (ASTM A709) grade 50W (grade 345W).
- F. **High-Yield-Strength, Quenched and Tempered Alloy Steel Plate:** High-yield-strength, quenched and tempered alloy steel plate shall conform to AASHTO M270 (ASTM A709) grades 100 (grade 690) or 100W (grade 690W).

Quenched and tempered alloy steel structural shapes and seamless mechanical tubing, meeting all of the mechanical and chemical requirements of A709 grades 100/100W (grades 345/345W) steel, except that the specified maximum tensile strength may be 140,000 psi (965 MPa) for structural shapes and 145,000 psi (1,000 MPa) for seamless mechanical tubing, shall be considered as A709 grades 100/100W (grades 345/345W) steel.

- G. **High-Strength 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

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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 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
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

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.

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TABLE 2

WASHER DIMENSIONS^a

Bolt Size D	Circular Washers			Square or Rectangular Beveled Washers for American Standard Beams and Channels		
	Nominal Outside Diameter ^b	Nominal Diameter of Hole	Thickness Side 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 ^c	2-1/4	5/16	1:6
1-3/4	3-3/8	1-7/8	.178 ^c .28 ^c	---	---	---
2	3-3/4	2-1/8	.178 .28	---	---	---
Over 2 to 4 Inclusive	2D-1/2	D+1/8	.24 ^d .34 ^d	---	---	---

a-Dimensions in inches
c-3/16 inch nominal

b-May be exceeded by 1/4 inch
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.

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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

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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 C.7.c. and their inspection may differ from that specified in Section 410.3 C.7.e. 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.

- H. Copper Bearing Steel:** Copper bearing steel shall contain not less than 0.2 percent of copper.
- I. Welded Stud Shear Connectors:** Shear connector studs shall conform to, AASHTO M169 (ASTM A108), cold-drawn bars, grades 1015, 1018 or 1020, either semi or fully-killed. If flux retaining caps are used, the steel for the caps shall be of a low carbon grade suitable for welding and shall comply with, ASTM A109.

Tensile properties as determined by tests of bar stock after drawing or of finished studs shall conform to the following requirements:

Tensile Strength (min.)	60,000 (415 MPa)
Yield Strength* (min.)	50,000 (345 MPa)
Elongation (min.)	20% in 2 inches (20% in 50 mm)
Reduction of area (min.)	50%

* As determined by a 0.2% offset method.

Tensile properties shall be in accordance with 4.23.2 of ANSI/AASHTO/AWS D1.5.

Finished studs shall be of uniform quality and condition, free from injurious laps, fins, seams, cracks, twists, bends or other injurious defects. Finish shall be as produced by cold drawing, cold rolling or machining.

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The manufacturer shall certify that the studs as delivered are in accordance with the material requirements of this section. Certified copies of in-plant quality control test reports shall be furnished upon request.

The Engineer may select, at the Contractor's expense, studs of each type and size used under the contract, as necessary for checking the requirements of this section.

- J. Unfilled Tubular Steel Piles:** Unfilled Tubular Steel Piles shall conform to ASTM A252, Grade 2, with chemical requirements meeting ASTM A53, Grade B.

970.3 STEEL FORGINGS AND STEEL SHAFTING

- A. Steel Forgings:** Steel forgings shall conform to, AASHTO M102 (ASTM A668), Classes C, D, F, or G.
- B. Cold Finished Carbon Steel Shafting:** Cold finished carbon steel shafting shall conform to, AASHTO M169 (ASTM A108). Grade 1016-1030, inclusive, shall be furnished.

970.4 STEEL CASTINGS

- A. Steel Castings for Highway Bridges:** Steel castings for use in highway bridge components shall conform to , AASHTO M192 (ASTM A486) or AASHTO M103 (ASTM A27). Class 70 (485) or Grade 70-36 (485-250) of steel, respectively, shall be used.
- B. Chromium Alloy-Steel Castings:** Chromium alloy-steel castings shall conform to, AASHTO M163 (ASTM A743). Grade CA 15 shall be furnished.

970.5 IRON CASTINGS

Iron castings shall be gray iron conforming to, AASHTO M105 (ASTM A48), Class No. 35 (250).

Iron castings shall be true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blow holes and other defects in positions affecting their strength and value for the service intended. Castings shall be boldly filleted at angles and the arises shall be sharp and perfect.

Castings must be sandblasted or otherwise effectively cleaned of scale and sand so as to present a smooth, clean and uniform surface.

970.6 DUCTILE IRON CASTINGS

Ductile iron castings shall conform to, ASTM A536, Grade 60-40-18. In addition to the specified test coupons, test specimens from parts integral with the castings, such as risers, shall be tested for castings weighing more than 1,000 pounds (450 kg) to determine that the required quality is obtained in the castings in the finished condition.

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Iron castings shall be true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blow holes and other defects in positions affecting their strength and value for the service intended. Castings shall be boldly filleted at angles and the arises shall be sharp and perfect.

Castings must be sandblasted or otherwise effectively cleaned of scale and sand so as to present a smooth, clean and uniform surface.

970.7 MALLEABLE CASTINGS

Malleable castings shall conform to, ASTM A47. Grade No. 35018 (24018) shall be furnished.

Malleable castings shall be true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blow holes and other defects in positions affecting their strength and value for the service intended. The castings shall be boldly filleted at angles and the arises shall be sharp and perfect.

Castings must be sandblasted or otherwise effectively cleaned of scale and sand so as to present a smooth, clean and uniform surface.

970.8 BRONZE CASTINGS AND COPPER-ALLOY PLATES

- A. **Bronze Castings:** Bronze castings shall conform to, AASHTO M107 (ASTM B22) Alloy 911.
- B. **Copper-Alloy Plates:** Copper-alloy plates shall conform to, AASHTO M108 (ASTM B100) alloy 510 or 511.

970.9 SHEET LEAD

Sheet lead shall conform to, ASTM B29.

970.10 SHEET ZINC

Sheet zinc shall conform to Type II of ASTM B69.

970.11 GALVANIZING

When specified, ferrous metal products shall be galvanized in accordance with, AASHTO M111 (ASTM A123).

970.12 PREFORMED FABRIC PADS

The preformed fabric pads shall be composed of multiple layers of eight-ounce (225 grams) cotton duck impregnated and bound with high-quality natural rubber or of equivalent and equally suitable materials compressed into resilient pads of uniform thickness. The number of

plies shall be such as to produce the specified thickness, after compression and vulcanizing. The finished pads shall withstand compression loads perpendicular to the plane of the laminations of not less than 10,000 pounds per square inch (70 MPa) without reduction in thickness or extrusion.

970.13 BRONZE OR COPPER-ALLOY BEARING AND EXPANSION PLATES

The sliding surfaces of these plates shall be finished in the direction of the motion to ANSI B46.1 No. 125. This surface shall be bored on a geometric pattern of recesses and be lubricated with a material suitable for long-life service of the sliding face. The lubricated area shall comprise approximately 25 percent of the bearing face to provide coefficient of friction not to exceed 10 percent for loads of 600 to 1,000 psi (4 to 7 MPa). The edges of the plate shall be chamfered 1/8 inch (3 mm)

- A. Bronze Bearing and Expansion Plates:** Bronze bearing and expansion plates shall conform to, AASHTO M107 (ASTM B22) Alloy 911.
- B. Rolled Copper-Alloy Bearings and Expansion Plates:** Rolled copper-alloy bearing and expansion plates shall conform to, AASHTO M108 (ASTM B100), Alloy No. 510 or No. 511.