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American Association State Highway and Transportation Officials Standard AASHTO No.: M 253

Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength[1]

This standard is issued under the fixed designation A490; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope*

1.1 This specification covers two types of quenched and tempered, alloy steel, heavy hex structural bolts having a tensile strength of 150 to 173 ksi.

1.2 These bolts are intended for use in structural connections. These connections are covered under the requirements of the Specification for Structural Joints Using Specification A325 or A490M bolts, approved by the Research Council on Structural Connections; endorsed by the American Institute of Steel Construction and by the Industrial Fastener Institute.[2]

1.3 The bolts are furnished in sizes ½ to 1½ in., inclusive. They are designated by type denoting chemical composition as follows:

Type	Description
Type 1	Medium carbon alloy steel
Type 2	Withdrawn in 2002
Type 3	Weathering steel

1.4 This specification provides that heavy hex structural bolts shall be furnished unless other dimensional requirements are specified on the purchase order.

1.5 Terms used in this specification are defined in Terminology F1789 unless otherwise defined herein.

1.6 For metric bolts, see Specification A490MMA490M Classes 10.9 and 10.9.3

1.7 The values stated in inch-pound units are to be regarded as standard. No other units of measurement are included in this standard.

1.8 The following safety hazards caveat pertains only to the Test Methods portion, Section 12 of this specification: *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[3]

A194/A194M Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
A325 Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
A354 Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners
A490M Specification for High-Strength Steel Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints (Metric)
A563 Specification for Carbon and Alloy Steel Nuts
A751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products
D3951 Practice for Commercial Packaging
E384 Test Method for Microindentation Hardness of Materials
E709 Guide for Magnetic Particle Testing
E1444 Practice for Magnetic Particle Testing
F436 Specification for Hardened Steel Washers

[1] This specification is under the jurisdiction of ASTM Committee F16 on Fasteners and is the direct responsibility of Subcommittee F16.02 on Steel Bolts, Nuts, Rivets and Washers.

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[2] Available from American Institute of Steel Construction (AISC), One E. Wacker Dr., Suite 700, Chicago, IL 60601-2001, http://www.aisc.org.

[3] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

***A Summary of Changes section appears at the end of this standard.**

F606 Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, Direct Tension Indicators, and Rivets
F788/F788M Specification for Surface Discontinuities of Bolts, Screws, and Studs, Inch and Metric Series
F959 Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners
F1136 Specification for Zinc/Aluminum Corrosion Protective Coatings for Fasteners
F1136M Specification for Zinc/Aluminum Corrosion Protective Coatings for Fasteners (Metric)
F1470 Practice for Fastener Sampling for Specified Mechanical Properties and Performance Inspection
F1789 Terminology for F16 Mechanical Fasteners
F2328 Test Method for Determining Decarburization and Carburization in Hardened and Tempered Threaded Steel Bolts, Screws and Studs
G101 Guide for Estimating the Atmospheric Corrosion Resistance of Low-Alloy Steels

2.2 *ASME Standards:*[4]
B1.1 Unified Screw Threads
B18.2.6 Fasteners for Use in Structural Applications
B18.24 Part Identification Number (PIN) Code System Standard for B18 Fastener Products

2.3 ~~*SAE Standard:*~~
~~SAE J121Decarburization in Hardened and Tempered Threaded Fasteners~~
~~2.4~~ *IFI Standard:*[5]
IFI 144 Test Evaluation Procedures for Coating Qualification Intended for Use on High-Strength Bolts

3. Ordering Information

3.1 Orders for heavy hex structural bolts under this specification shall include the following:
3.1.1 Quantity (number of pieces of bolts and accessories);
3.1.2 Size, including nominal bolt diameter, thread pitch, and bolt length. The thread length shall not be changed;
3.1.3 Name of product: heavy hex structural bolts, or other such bolts as specified;
3.1.4 Type of bolt (Type 1 or 3). When type is not specified, either Type 1 or Type 3 shall be furnished at the supplier's option;
3.1.5 ASTM designation and year of issue,
3.1.6 Other components such as nuts, washers, and washer-type direct tension indicators, if required;
3.1.7 Test Reports, if required (see Section 15); and
3.1.8 Protective coating per Specification F1136, Grade 3, if required. See 4.3.
3.1.9 Special requirements.
3.1.10 For establishment of a part identifying system, see ASME B18.24.

NOTE 1—A typical ordering description follows: 1000 pieces 1–8 in. dia × 4 in. long heavy hex structural bolt, Type 1, ~~*ASTM A490–02;*~~ ASTM A490M – 02; each with two hardened washers, ASTM F436 Type 1; and one heavy hex nut, ASTM A563 Grade DH.

3.2 *Recommended Nuts*:
3.2.1 Nuts conforming to the requirements of Specification A563 are the recommended nuts for use with Specification A490M heavy hex structural bolts. The nuts shall be of the class and have a surface finish for each type of bolt as follows:

Bolt Type and Finish	Nut Class and Finish
1, plain (uncoated)	A563—DH, DH3 plain (uncoated)
1, coated in accordance with Specification F1136, Grade 3	A563—coated in accordance with Specification F1136, Grade 5.
3, weathering steel	A563—DH3, weathering steel

3.2.2 Alternatively, nuts conforming to Specification A194/A194M Gr. 2H plain (uncoated) are considered a suitable substitute for use with Specification A490M Type 1 heavy hex structural bolts.

3.3 *Recommended Washers*—Washers conforming to Specification F436 are the recommended washers for use with Specification A490M heavy hex structural bolts. The washers shall have a surface finish for each type of bolt as follows:

Bolt Type and Finish	Washer Finish
1, plain (uncoated)	plain (uncoated)
1, coated in accordance with F1136, Grade 3	plain, coated in accordance with F1136, Grade 3

[4] Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990, http://www.asme.org.
~~[5] Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, http://www.sae.org.~~
[5] Available from Industrial Fastener Institute, (IFI), 6363 Oak Tree Boulevard, Independence, OH 44131. http://www.industrial-fasteners.org.

3, weathering steel weathering steel

3.4 *Other Accessories*—When compressible washer type direct tension indicators are specified to be used with these bolts, they shall conform to Specification F959 Type 490.

4. Materials and Manufacture

4.1 *Heat Treatment*—Type 1 and Type 3 bolts shall be heat treated by quenching in oil from the austenitic temperature and then tempered by reheating to a temperature of not less than 800°F.

4.2 *Threading*—The threads shall be cut or rolled.

4.3 *Protective Coatings*:

4.3.1 When a protective coating is required and specified, the bolts shall be coated with Zinc/Aluminum Corrosion Protective Coatings in accordance with Specification F1136, Grade 3. This coating has been qualified based on the findings of an investigation founded on IFI 144. [6]

4.3.2 No other metallic coatings are permitted unless authorized by Committee F16. Future consideration of any coating will be based on results of testing performed in accordance with the procedures in IFI 144, and submitted to Committee F16 for review (See note 2).

NOTE 2—For more detail see the H. E. Townsend Report "Effects of Zinc Coatings on Stress Corrosion Cracking and Hydrogen Embrittlement of Low Alloy Steel," published in Metallurgical Transactions, Vol. 6, April 1975.

5. Chemical Composition

5.1 Type 1 bolts shall be alloy steel conforming to the chemical composition specified in Table 1. The steel shall contain sufficient alloying elements to qualify it as an alloy steel (see Note 3).

NOTE 3—Steel is considered to be alloy by the American Iron and Steel Institute when the maximum of the range given for the content of alloying elements exceeds one or more of the following limits: manganese, 1.65 %; silicon, 0.60 %; copper, 0.60 %; or in which a definite range or a definite minimum quantity of any of the following elements is specified or required within the limits of the recognized field of constructional alloy steels: aluminum, chromium up to 3.99 %, cobalt, columbium, molybdenum, nickel, titanium, tungsten, vanadium, zirconium, or any other alloying elements added to obtain a desired alloying effect.

5.2 Type 3 bolts shall be weathering steel conforming to the chemical composition requirements in Table 2. See Guide G101 for methods of estimating the atmospheric corrosion resistance of low alloy steel.

5.3 Product analyses made on finished bolts representing each lot shall conform to the product analysis requirements specified in Tables 1 and 2, as applicable.

5.4 Heats of steel to which bismuth, selenium, tellurium, or lead has been intentionally added shall not be used for bolts furnished to this specification. Compliance with this requirement shall be based on certification that steels having these elements intentionally added were not used.

5.5 Chemical analyses shall be performed in accordance with Test Methods, Practices, and Terminology A751.

6. Mechanical Properties

6.1 *Hardness*—The bolts shall conform to the hardness specified in Table 3.

6.2 *Tensile Properties*:

6.2.1 Except as permitted in 6.2.2 for long bolts and 6.2.3 for short bolts, sizes 1.00 in. and smaller having a length of 2¼ *D* and longer and sizes larger than 1.00 in. having a length of 3*D* and longer shall be wedge tested full size and shall conform to the minimum and maximum wedge tensile load, and proof load or alternative proof load specified in Table 4. The load achieved during proof load testing shall be equal to or greater than the specified proof load.

6.2.2 When the length of the bolt makes full-size testing impractical, machined specimens shall be tested and shall conform to the requirements specified in Table 5. When bolts are tested by both full-size and machined specimen methods, the full-size test shall take precedence.

[6] Available from Industrial Fastener Institute, (IFI), 6363 Oak Tree Boulevard, Independence, OH 44131. http://www.industrial-fasteners.org.

[6] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report F16-1001.

TABLE 1 Chemical Requirements for Type 1 Bolts

Element	Heat Analysis, %	Product Analysis, %
Carbon		
For sizes through 1⅜ in.	0.30–0.48	0.28–0.50
For size 1½ in.	0.35–0.53	0.33–0.55
Phosphorus, max	0.040	0.045
Sulfur, max	0.040	0.045
Alloying Elements	→ See 5.1 ←	

TABLE 2 Chemical Requirements for Type 3 Bolts

Element	Heat Analysis, %	Product Analysis, %
Carbon		
Sizes 0.75 in. and smaller	0.20–0.53	0.19–0.55
Sizes larger than 0.75 in.	0.30–0.53	0.28–0.55
Manganese, min	0.40	0.37
Phosphorus, max	0.035	0.040
Sulfur, max	0.040	0.045
Copper	0.20–0.60	0.17–0.63
Chromium, min	0.45	0.42
Nickel, min	0.20	0.17
or		
Molybdenum, min	0.15	0.14

TABLE 3 Hardness Requirements for Bolts ½ to 1½ in. Nominal Size

Size, in.	Length, in.	Brinell		Rockwell C	
		min	max	min	max
½ to 1, incl.	Less than $2D^A$	311	352	33	39
	$2D^A$ and longer	. . .	352	. . .	39
Over 1 to 1½ , incl.	Less than $3D^A$	311	352	33	39
	$3D^A$ and longer	. . .	352	. . .	39

[A] Heavy hex structural bolts 1 in. and smaller and shorter than 2*D* are subject only to minimum and maximum hardness. Heavy hex structural bolts larger than 1 through 1½ , incl., in diameter and shorter than 3*D* are subject only to minimum and maximum hardness.

TABLE 4 Tensile Load Requirements for Full-Size Bolts

Bolt Size, Threads per Inch, and Series Designation	Stress Area,[A] $in.^2$	Tensile Load,[B] lbf		Proof Load,[B] lbf	Alternative Proof Load,[B] lbf
		min	max	Length Measurement Method	Yield Strength Method
Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
½-13 UNC	0.142	21 300	24 600	17 050	18 500
⅝-11 UNC	0.226	33 900	39 100	27 100	29 400
¾-10 UNC	0.334	50 100	57 800	40 100	43 400
⅞-9 UNC	0.462	69 300	79 950	55 450	60 100
1-8 UNC	0.606	90 900	104 850	72 700	78 800
1⅛-7 UNC	0.763	114 450	132 000	91 550	99 200
1¼-7 UNC	0.969	145 350	167 650	116 300	126 000
1⅜-6 UNC	1.155	173 250	199 850	138 600	150 200
1½-6 UNC	1.405	210 750	243 100	168 600	182 600

[A] The stress area is calculated as follows:

$$A_s = 0.7854\ [D - (0.9743/n)]^2$$

where:
A_s = stress area, $in.^2$
D = nominal bolt size, and
n = threads per inch.

[B] Loads tabulated and loads to be used for tests of full-size bolts larger than 1½ in. in diameter are based on the following:

Bolt Size	Column 3	Column 4	Column 5	Column 6
½ to 1½ in., incl	150 000 psi	173 000 psi	120 000 psi	130 000 psi

6.2.3 Sizes 1.00 in. and smaller having a length shorter than 2¼ *D* down to 2*D*, inclusive, that cannot be wedge tensile tested shall be axially tension tested full size and shall conform to the minimum tensile load and proof load or alternate proof load specified in Table 4. Sizes 1.00 in. and smaller having a length shorter than 2*D* that cannot be axially tensile tested shall be qualified on the basis of hardness.

6.2.4 For bolts on which hardness and tension tests are performed, acceptance based on tensile requirements shall take precedence in the event of low hardness readings.