~~Designation:A490M–04a$^{\varepsilon 1}$~~ Designation: A 490M – 08

Standard Specification for High-Strength Steel Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints (Metric)[1]

This standard is issued under the fixed designation A 490M; 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.

~~ε[1] NOTE—Sections 2.2 and 4.1.9 were editorially revised in October 2006.~~

1. Scope*

1.1 This specification covers two types of quenched and tempered alloy steel, metric heavy hex structural bolts having a tensile strength of 1040 to 1210 MPa.

1.2 These bolts are intended for use in structural connections comparable to those covered under the requirements of the Specification for Structural Joints Using ASTM A 325 and A 490 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 nominal bolt diameters M12 to M36, 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Type 2	Withdrawn in 2002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 is applicable to metric heavy hex structural bolts and alternate designs as established by the Research Council in its publication, Specification for Structural Joints Using ASTM A 325 and A 490 bolts.

1.5 For inch-pound bolts, see Specification A 490.

~~1.6~~

1.6 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.7 The following safety hazards caveat pertains only to the Test Methods portion, Section 13, 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]

A 325 Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
A 490 Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength
A 490M Specification for High-Strength Steel Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints (Metric)
A 563M Specification for Carbon and Alloy Steel Nuts (Metric)
A 751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products
D 3951 Practice for Commercial Packaging
E 384 Test Method for Microindentation Hardness of Materials
E 709 Guide for Magnetic Particle Testing
E 1444 Practice for Magnetic Particle Testing
F 436M Specification for Hardened Steel Washers (Metric)

[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.

Current edition approved ~~Aug.~~Dec. 1, ~~2004.~~2008. Published ~~August 2004.~~January 2009. Originally approved in 1982. Last previous edition approved in 2004 as A 490M – 04a$^{\varepsilon 1}$.

[2] Available from American Institute of Steel Construction (AISC), One E. Wacker Dr., Suite ~~3100,~~700, Chicago, IL 60601-2001, http://www.aisc.org..

[3] For referenced ASTM standards, visit the ASTM webbiest, 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 webbiest.

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

TABLE 1 Chemical Requirements for Type 1 Bolts

Element	Heat Analysis, %	Product Analysis, %
Carbon		
For sizes through M30	0.30–0.48	0.28–0.50
For size M36	0.35–0.53	0.33–0.55
Phosphorus, max	0.040	0.045
Sulfur, max	0.040	0.045
Alloying Elements	→ See 6.1 ←	

TABLE 2 Chemical Requirements for Type 3 Bolts

Element	Heat Analysis, %	Product Analysis, %
Carbon		
Sizes M20 and smaller	0.20–0.53	0.19–0.55
Sizes larger than M20.	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

F 568M Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners (Metric)
F 606M Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, and Rivets (Metric)
F 788/F 788M Specification for Surface Discontinuities of Bolts, Screws, and Studs, Inch and Metric Series
F 959M Specification for Compressible-Washer-Type Direct Tension Indicators for Use With Structural Fasteners (Metric)
F 1470 Practice for Fastener Sampling for Specified Mechanical Properties and Performance Inspection
F 1789 Terminology for F16 Mechanical Fasteners
G 101 Guide for Estimating the Atmospheric Corrosion Resistance of Low-Alloy Steels

2.2 *ASME Standards:*[4]
B1.13M Metric Screw Threads
B18.2.3.7M Metric Heavy Hex Structural Bolts
B18.24 Part Identifying Number (PIN) Code System Standard for B18 Fastener Products
2.3 *ISO Standards:*[4]
7412 Hexagon Bolts for High Strength Structural Bolting With Large Width Across Flats (Short Thread Length)–Product Grade C–Property Classes 8.8 and 10.9
2.4 *SAE Standards*[5]*:*
J121 Decarburization in Hardened and Tempered Threaded Fasteners

3. Terminology

3.1 Terms used in this specification are defined in Terminology F 1789, unless otherwise defined herein.

4. Ordering Information

4.1 Orders for bolts under this specification shall include the following (see Note 1):
4.1.1 Quantity (number of pieces of bolts and accessories);
4.1.2 Size, including nominal bolt diameter, thread pitch, and bolt length;
4.1.3 Name of product: metric heavy hex structural bolts;
4.1.4 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;
4.1.5 ASTM designation and year of issue;
4.1.6 Other components such as nuts, washers, and washer-type direct tension indicators, if required;
4.1.7 Certification, if required (see Section 16); and
4.1.8 Special requirements, if required.

[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.

4.1.9For4.1.9 For establishment of a part identifying system, see ASME B18.24.

NOTE 1—A typical ordering description follows: 1000 pieces M24 × 3 × 100 mm long, heavy hex structural bolt, Type 1, *ASTM A 490 M– 03;* each with two hardened washers, ASTM F 436M, Type 1; and one heavy hex nut, ASTM A 563M, Grade DH.

4.2 *Recommended Nuts*

4.2.1 Nuts conforming to the requirements of Specification A 563M are the recommended nuts for use with Specification A 490M 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)	A 563M—10S, 10S3, plain (uncoated)
3, weathering steel	A 563M—10S3, weathering steel

4.3 *Recommended Washers*

4.3.1 Washers conforming to Specification F 436M are the recommended washers for use with Specification F 490M 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)
3, weathering steel	weathering steel

4.4 *Other Accessories*

4.4.1 When compressible washer type tension indicators are specified to be used with these bolts, they shall conform to Specification F 959M, Type 10.9.

5. Materials and Manufacture

5.1 *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 425°C.

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

5.3 *Protective Coatings*—The bolts shall not be coated[6] by hot-dip zinc coating, mechanical deposition, or electroplating with zinc or other metallic coatings.

6. Chemical Composition

6.1 Type 1 bolts shall be alloy steel conforming to the chemical composition requirements in Table 1. The steel shall contain sufficient alloying elements to qualify it as an alloy steel (see Note 2).

NOTE 2—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.

6.2 Type 3 bolts shall be weathering steel conforming to the chemical composition requirements in Table 2. See Guide G 101 for methods of estimating the atmospheric corrosion resistance of low alloy steel.

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

6.4 Applications of heats of steel to which bismuth, selenium, tellurium, or lead has been intentionally added shall not be permitted for bolts. Compliance with this requirement shall be based on a statement on the steel certificate indicating that these elements were not intentionally added.

6.5 Chemical analyses shall be performed in accordance with Test Methods, Practices, and Terminology A 751.

7. Mechanical Properties

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

7.2 *Tensile Properties*:

7.2.1 Except as permitted in 7.2.2 for long bolts and 7.2.3 for short bolts, nominal bolt diameters M24 and smaller having a length of 2¼ *D* and longer, and nominal bolt diameters larger than M24 having a length of 3*D* and longer shall be wedge tested full size and shall conform to the minimum 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.

7.2.2 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] 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.

TABLE 3 Hardness Requirements for Bolt Sizes M12 to M36 Inclusive

Nominal Bolt Diameter, mm	Length[A]	Brinell		Rockwell C	
		min	max	min	max
M12 to M24, inclusive	Less than 2*D*	311	352	33	39
	2*D* and longer	. . .	352	. . .	39
Over M24 to M36, inclusive	Less than 3*D*	311	352	33	39
	3*D* and longer	. . .	352	. . .	39

[A] Heavy hex structural bolts M24 and smaller and shorter than 2*D* are subject only to minimum and maximum hardness. Heavy hex structural bolts larger than M24 to M36 inclusive and shorter than 3*D* are subject only to minimum and maximum hardness.

TABLE 4 Tensile Load Requirements for Full-Size Bolts

Nominal Bolt Diameter and Thread Pitch, mm	Stress Area,[A] mm^2	Tensile Load,[B] kN		Proof Load,[B] kN	Alternative Proof Load,[B] kN
		min	max	Length Measurement Method	Yield Strength Method
Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
M12 × 1.75	84.3	87.7	103	70	79.2
M16 × 2	157	163	190	130	148
M20 × 2.5	245	255	296	203	230
M22 × 2.5	303	315	366	251	285
M24 × 3	353	367	427	293	332
M27 × 3	459	477	555	381	431
M30 × 3.5	561	583	679	466	527
M36 × 4	817	850	989	678	768

[A] The stress area is calculated as follows:

$$A_s = 0.7854\ [D - (0.9382P)^2$$

where:
A_s = stress area, mm^2
D = nominal bolt size, mm, and
n = thread pitch, mm.

[B] Loads tabulated and loads to be used for tests of full-size bolts larger than 36 mm in diameter are based on the following:

Nominal Bolt Diameter, mm	Column 3	Column 4	Column 5	Column 6
M12 to M36 inclusive	1040 MPa	1210 MPa	830 MPa	940 MPa

TABLE 5 Tensile Strength Requirements for Specimens Machined from Bolts

Nominal Bolt Diameter, mm	Tensile Strength, MPa		Yield Strength (0.2 % offset), min, MPa	Elongation in 50 mm, min, %	Reduction of Area, min, %
	min	max			
M12 to M36, inclusive	1040	1210	940	14	40

7.2.3 Nominal bolt diameters M24 and smaller having a length shorter than 2¼ *D* down to 2*D* inclusive, which 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. Nominal bolt diameters M24 and smaller having a length shorter than 2*D* which cannot be axially tensile tested shall be qualified on the basis of hardness.

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

8. Carburization/Decarburization

8.1 *Definition*—This test is intended to evaluate the presence or absence of carburization and decarburization as determined by the difference in microhardness near the surface and core.