Designation: A490M – 09

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 A490M; 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, 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 A325 and A490 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Type 2	Withdrawn in 2002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 A325 and A490 bolts.

1.5 For inch-pound bolts, see Specification A490.

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]

A325 Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

A490 Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength

A563M Specification for Carbon and Alloy Steel Nuts (Metric)

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

F436M Specification for Hardened Steel Washers (Metric)

F568M Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners (Metric)

F606M Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, and Rivets (Metric)

F788/F788M Specification for Surface Discontinuities of Bolts, Screws, and Studs, Inch and Metric Series

F959M Specification for Compressible-Washer-Type Direct Tension Indicators for Use With Structural Fasteners (Metric)

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

G101 Guide for Estimating the Atmospheric Corrosion Resistance of Low-Alloy Steels

[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.**

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

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

2.5 *IFI Standard* [6]*:*

IFI 144 Test Evaluation Procedures for Coating Qualification Intended for Use on High-Strength Structural Bolts

3. Terminology

3.1 Terms used in this specification are defined in Terminology F1789, 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 Protective Coating per Specification F1136M, Grade 3, if required. See 5.3.

4.1.9 Special requirements, if required.

4.1.10 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 A490 M– 03;* each with two hardened washers, ASTM F436M, Type 1; and one heavy hex nut, ASTM A563M, Grade DH.

4.2 *Recommended Nuts*

4.2.1 Nuts conforming to the requirements of Specification A563M 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)	A563M—10S, 10S3, plain (uncoated)
1, coated in accordance with F1136M, Grade 3	A563M—10S, 10S3 coated in accordance with F1136M, Grade 5
3, weathering steel	A563M—10S3, weathering steel

4.3 *Recommended Washers*

4.3.1 Washers conforming to Specification F436M 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 F1136M, Grade 3	coated in accordance with F1136M, Grade 3
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 F959M, 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.

[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.

[6] Available form Industrial Fastener Institute (IFI), 6363 Oak tree Boulevard, Independence. OH 44131, www.industrial-fasteners.org.

5.3 *Protective Coatings*:

5.3.1 When a protective coating is required and specified, the bolts shall be coated with Zinc/Aluminum Corrosion Protective Coatings in accordance with F1136M Grade 3, which has been qualified in accordance with IFI 144[7].

5.3.2 No other metallic coatings are permitted unless authorized by Committee F16. Future consideration of any coating will be based on a review of test results submitted to Committee F16 in accordance with the requirements of IFI 144.

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 G101 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 A751.

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.

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.

8.2 *Requirements*:

8.2.1 *Carburization*—The bolts shall show no evidence of a carburized surface when evaluated in accordance with the hardness methods established in SAE J121.

8.2.2 *Decarburization*—Hardness value differences shall not exceed the requirements set forth for decarburization in SAE J121 for Class 2/3H materials.

8.3 *Procedure*—Testing for carburization/decarburization shall be performed in accordance with the microhardness (referee) methods established in SAE J121.

9. Dimensions

9.1 *Head and Body*:

9.1.1 The bolts shall conform to the dimensions for heavy hex structural bolts specified in ASME B18.2.3.7M for nominal bolt diameter M16 to M36 inclusive and ISO 7412 for size M12.

9.2 *Threads*:

9.2.1 Threads shall Metric Coarse Thread Series as specified in ASME B1.13M, and shall have Grade 6g tolerance.

9.2.2 The thread length shall not be changed from that specified for heavy hex structural bolts in ASME B18.2.3.7M and ISO 7412 in 9.1.1. Bolts requiring thread lengths other than those required by this specification shall be ordered under Specification F568M, Class 10.9 and 10.9.3.

10. Workmanship

10.1 The allowable limits, inspection, and evaluation of the surface discontinuities, quench cracks, forging cracks, head

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

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.