



## Designation: F541 – 12 (Reapproved 2020)

# Standard Specification for Alloy Steel Eyebolts<sup>1</sup>

This standard is issued under the fixed designation F541; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

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

## 1. Scope\*

1.1 This specification covers forged, quenched and tempered, alloy steel threaded eyebolts with improved toughness properties and intended primarily for low temperature applications. The eyebolts are chemically and metallurgically constituted to produce a low transition temperature to minimize brittle failure. Maximum thread size is 2.500 in. (63.50 mm).

1.2 The eyebolts are furnished in two types, as follows:

1.2.1 *Type 1*—Straight Shank Eyebolt.

1.2.2 *Type 2*—Shoulder Eyebolt.

1.3 The values stated in inch-pound units are to be regarded as the standard. The values in parentheses are for information only.

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

## 2. Referenced Documents

2.1 *ASTM Standards:*<sup>2</sup>

[A370 Test Methods and Definitions for Mechanical Testing of Steel Products](#)

[A574 Specification for Alloy Steel Socket-Head Cap Screws](#)

[A751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products](#)

[E10 Test Method for Brinell Hardness of Metallic Materials](#)

[E18 Test Methods for Rockwell Hardness of Metallic Materials](#)

[E112 Test Methods for Determining Average Grain Size](#)

[E340 Practice for Macroetching Metals and Alloys](#)

<sup>1</sup> 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 Dec. 1, 2020. Published December 2020. Originally approved in 1977. Last previous edition approved in 2012 as F541 – 12. DOI: 10.1520/F0541-12R20.

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[E709 Guide for Magnetic Particle Testing](#)

[F606/F606M Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, Direct Tension Indicators, and Rivets](#)

[F1470 Practice for Fastener Sampling for Specified Mechanical Properties and Performance Inspection](#)

2.2 *ASME Standards:*<sup>3</sup>

[B1.1 Unified Screw Threads](#)

[B18.15 Forged Eyebolts](#)

[B18.24 Part Identifying Number \(PIN\) Code System Standard for B18 Fastener Products](#)

## 3. Ordering Information

3.1 Orders for eyebolts under this specification shall include the following information to adequately describe the part:

3.1.1 ASTM specification number and date of issue,

3.1.2 Name of part (alloy steel eyebolts),

3.1.3 Regular or shoulder pattern (8.1),

3.1.4 Size (nominal diameter and threads),

3.1.5 Number of pieces,

3.1.6 Certification or test reports (if required) (14.1),

3.1.7 Additional requirements (if required), and

3.1.8 Supplementary requirements (if required).

3.1.9 For establishment of a part identifying system, see ASME B18.24.

## 4. Materials and Manufacture

4.1 *Melting Process*—The steel shall be made to a fine-grain practice using a melting process yielding a product conforming to the requirements of this specification.

4.2 *Forging*—Eyebolts shall be forged without welds.

4.3 *Heat Treatment*—The eyebolts shall be quenched and tempered in accordance with proper practice to yield a product conforming to the requirements of this specification.

4.4 *Machining*—The eyebolt shall be machined prior to or after heat treatment at the manufacturer's option.

<sup>3</sup> Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Two Park Ave., New York, NY 10016-5990, <http://www.asme.org>.

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

## 5. Chemical Composition

5.1 *Limits*—The eyebolts shall be manufactured from steels having a heat analysis conforming to the requirements in **Table 1**.

### 5.2 Product Analysis:

5.2.1 The purchaser reserves the right to conduct product analyses on the finished eyebolts or request the manufacturer to conduct product analyses tests. The composition thus determined shall conform to the requirements specified in **Table 1** subject to the product analysis tolerances.

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

## 6. Metallurgical Requirements

### 6.1 Grain Size:

6.1.1 *Requirements*—The finished eyebolts shall have an apparent heat-treated grain size of Test Methods **E112** No. 5 or finer.

6.1.2 *Specimen*—Grain size shall be rated on specimens taken from the eyebolt after final heat treatment.

6.1.3 *Test Method*—Grain size on the finished eyebolt shall be determined in accordance with Test Methods **E112**.

### 6.2 Macroetch Test:

6.2.1 *Requirement*—When ground and etched, the cross section of the eyebolt shall be free of injurious surface seams, internal cracks, pipe, segregation, and other imperfections detrimental to the intended application.

6.2.2 *Specimen*—Macroetch test specimens shall consist of the full transverse cross section of a finished eyebolt shank.

6.2.3 *Test Method*—Macroetch tests shall be performed in accordance with Test Method **E340**.

### 6.3 Decarburization:

6.3.1 *Requirement*—The depth of decarburization (total + partial), as measured on the eyebolts after heat treatment, shall not exceed the requirements in **Table 2**.

6.3.2 *Specimen*—The test specimens shall consist of the unmachined surface of the heat-treated eyebolts in an area where threads would normally be machined.

6.3.3 *Test Method*—The depth of decarburization shall be determined by metallographic etching. The edge of the specimen shall be suitably prepared to preserve the original surface

**TABLE 1 Chemical Requirements, %**

	Heat Analysis	Permissible Variation on Product Analysis, Over or Under
Carbon, max	0.33	0.02 over
Manganese	0.30 to 1.10	0.04
Phosphorus, max	0.025	0.005 over
Sulfur, max	0.025	0.005 over
Silicon	0.15 to 0.35	0.02
Chromium, max <sup>A</sup>	0.90	0.05 over
Molybdenum <sup>A</sup>	0.10 to 0.60	0.02
Nickel <sup>A</sup>	0.40 to 3.75	0.03

<sup>A</sup> The composition shall contain at least two of the elements shown.

**TABLE 2 Decarburization Limits**

Nominal Size, In.	Depth of Decarburization, Total + Partial, max	
	in.	mm
0.250 to 0.375	0.030	0.762
0.4375 to 0.625	0.040	1.02
0.750 to 1.000	0.050	1.27
1.125 to 1.500	0.060	1.52
1.750 to 2.500	0.070	1.78

and the sample shall then be polished for metallographic examination. The section shall be etched in 4 % nital and the samples examined under a microscope at 100× using an eyepiece graduated in 0.001-in. (0.025-mm) increments. The measured depth of any light etched band shall be taken as the decarburization depth.

6.3.4 When the metallographic etch method of **6.3.3** for decarburization renders results that are inconclusive, then the microhardness traverse method of Specification **A574** shall be employed. The depth of decarburization shall be denoted by that radial depth where the hardness decrease is more than the equivalent of 3 points HRA, when compared to the average microhardness of undecarburized locations beyond this site. The average microhardness of undecarburized locations of the eyebolt shall be determined for depths not exceeding 25 % of its shank diameter.

## 7. Mechanical Properties

### 7.1 Hardness:

7.1.1 *Requirements*—The eyebolts shall have a Brinell Hardness of 197 to 248 (equivalent Rockwell B93 to 101). Hardness tests are subject to confirmation by tensile tests.

7.1.1.1 In case of controversy, acceptance based on tensile requirements shall take precedence over low readings of hardness tests.

7.1.2 *Specimens*—For routine inspection, hardness tests shall be made on a properly prepared surface of the finished eyebolt. For referee purposes tests shall be made on a transverse section through the threads one diameter from the end.

7.1.3 *Test Method*—Hardness tests shall be made in accordance with Test Methods **E10** or **E18**, as applicable.

### 7.2 Tensile Strength:

7.2.1 *Requirement*—Test specimens machined from finished eyebolts shall conform to the tensile properties specified in **Table 3**.

7.2.2 *Specimens*—Eyebolts for tensile tests shall be selected from the eyebolts subjected to the hardness test to represent the high and low end of the hardness test results. The specimens

**TABLE 3 Tensile Requirements**

Tensile strength, min, psi (MPa)	95 000 (660)
Yield strength, min (0.2 % offset), psi (MPa)	70 000 to 100 000 (485 to 690)
Elongation in 2 in. (50 mm), min, %	22
Reduction of area, min, %	55
Brinell hardness <sup>A</sup>	197 to 248
Rockwell B hardness <sup>A</sup>	93 to 101

<sup>A</sup> Hardness tests are subject to confirmation by tension tests.