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## Standard Specification for Headed Steel Bars for Concrete Reinforcement<sup>1</sup>

This standard is issued under the fixed designation A970/A970M; 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.

### 1. Scope\*

1.1 This specification covers deformed and plain steel reinforcing bars in cut lengths, with a head attached to one or both ends, for concrete reinforcement. Attachment can be accomplished through welding, by integrally hot forging of a head from the reinforcing bar end, by internal threads in the head mating to threads on the bar end, or by a separate threaded nut to secure the head to the bar. Heads are forge formed, machined from bar stock, or cut from plate.

NOTE 1—This specification is applicable for headed bars produced with welded, threaded, or forged heads and used for reinforcement of concrete structures. The requirements of this specification are not applicable to headed bars where the attachment of the head is accomplished by alternate means.

~~1.2 This specification is applicable for orders in either SI units as Specification A970M or inch-pound units shown in the text in brackets [Specification A970].~~

~~1.3 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.~~

~~1.4~~

1.2 Limitations on head dimensions and on obstructions and interruptions of bar deformations on the non-planar features on the bearing face of the head are presented in Annex A1. The requirements in Annex A1 only apply when specified by the purchaser (see 4.1.13).

1.3 This specification is applicable for orders in either SI units as Specification A970M or inch-pound units shown in the text in brackets [Specification A970].

1.4 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.5 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:<sup>2</sup>

~~A36/A36M Specification for Carbon Structural Steel~~

A370 Test Methods and Definitions for Mechanical Testing of Steel Products

~~A572/A572M Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel~~

A615/A615M Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

A700 Practices for Packaging, Marking, and Loading Methods for Steel Products for Shipment

A706/A706M Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement

#### 2.2 AWS Standards:<sup>3</sup>

AWS C6.1 Recommended Practices for Friction Welding

AWS D1.4/D1.4M Structural Welding Code - Reinforcing Steel

#### 2.3 U.S. Military Standard:<sup>4</sup>

<sup>1</sup> This specification is under the jurisdiction of ASTM A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of A01.05 on Steel Reinforcement. Current edition approved Oct. 15, 2007-2009. Published October 2007-December 2009. Originally approved in 1997. Last previous edition approved in 2006-2007 as A970/A970M – 067. DOI: 10.1520/A0970\_A0970M-079.

<sup>2</sup> 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.

<sup>3</sup> Available from American Welding Society (AWS), 550 NW LeJeune Rd., Miami, FL 33126, http://www.aws.org.

<sup>4</sup> Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS. Or visit: http://assist.daps.dla.mil/online.

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

MIL-STD-129 Marking for Shipment and Storage

2.4 *U.S. Federal Standard:*<sup>4</sup>

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)

2.5 *ACI Standard:*<sup>5</sup>

ACI 318 Building Code Requirements for Structural Concrete

### 3. Terminology

3.1 *Definitions:*

3.1.1 *forged headed bar*—steel bar used in the reinforcement of concrete that has the head(s) integrally forged to one or both ends.

3.1.2 *head*—round, elliptical, or rectangular shape used to anchor a steel bar in concrete.

~~3.1.3~~

3.1.3 *net bearing area*—gross cross-sectional area of the head minus the nominal cross-sectional area of the deformed reinforcing bar.

3.1.4 *threaded headed bar*—steel bar used in the reinforcement of concrete that has the head(s) attached to one or both ends using tapered or straight threads internal to the head or by a separate internally threaded nut securing the head to the threaded bar end.

~~3.1.4~~

3.1.5 *welded headed bar*—steel bar used in the reinforcement of concrete that has the head(s) welded to one or both ends.

### 4. Ordering Information

4.1 It shall be the responsibility of the purchaser to specify all requirements that are necessary for material ordered to this specification. Such requirements shall include but are not limited to the following:

4.1.1 Quantity;

4.1.2 Name of product: welded, forged, or threaded headed bars for the reinforcement of concrete; concrete;

4.1.3 Reinforcing bar specification and year of issue; issue;

4.1.4 Bar size; size;

4.1.5 Deformed or plain bars; bars;

4.1.6 Head geometry, including thickness, height, width, diameter or height and cross-sectional area; width of the head;

4.1.7 Head material specification and year of issue for welded head bars (5.2.1);

4.1.8 Bend testing of welded headed bars in sizes No. 36, 43, and 57 [11, 14, and 18] (6.4.1);

~~4.1.9 Number of heads per bar length;~~

~~4.1.10 Length of bar assembly;~~

~~4.1.11 Packaging; and~~

~~4.1.12 ASTM designation and year of issue. );~~

4.1.9 Number of heads per bar length;

4.1.10 Length of bar assembly;

4.1.11 Packaging;

4.1.12 ASTM designation and year of issue; and

4.1.13 Optional requirements of Annex A1, if applicable.

### 5. Material and Manufacture

5.1 *Reinforcing Bars*—For welded headed bars, the reinforcing bars shall conform to Specification A706/A706M. For forged headed bars or threaded headed bars, the reinforcing bars shall conform to Specification A615/A615M or A706/A706M, as specified by the purchaser.

5.2 *Heads:*

5.2.1 For welded and threaded headed bars, the head material shall be selected by the manufacturer.

5.3 The head dimensions shall be provided by the purchaser in the order. Head dimensions shall define the head geometry including thickness, height, height and width of the head (Fig. 1). ~~Alternate head dimensions supplied by the manufacturer shall be permitted if agreed to in advance by the purchaser. The manufacturer shall furnish documentation to the purchaser, in the form of calculations or test reports, or both, that confirms the suitability of alternate head dimensions for the intended application.~~

5.4) Alternate head dimensions supplied by the manufacturer shall be permitted if agreed to in advance by the purchaser. The manufacturer shall furnish documentation to the purchaser, in the form of calculations or test reports, or both, that confirms the suitability of alternate head dimensions for the intended application.

NOTE 2—Alternate head dimensions resulting in a net bearing area less than four times the area of the deformed reinforcing bar are not suitable for use in construction projects governed by certain consensus building codes and design standards (see 5.4 and Note 3).

<sup>5</sup> Available from American Concrete Institute (ACI), P.O. Box 9094, Farmington Hills, MI 48333-9094, <http://www.concrete.org>.

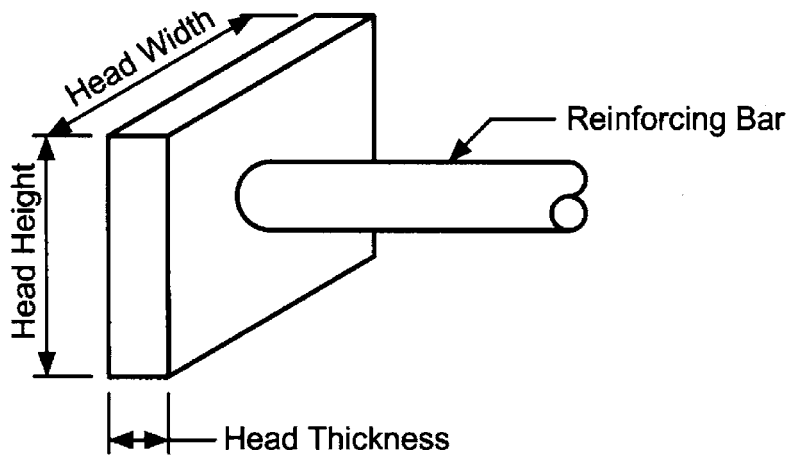


FIG. 1 Headed Reinforcing Bar

5.3.1 Head dimensions shall define the head geometry including thickness, diameter or height and width of the head (Fig. 1).

5.4 When specified by the purchaser in the purchase order or contract as a class HA headed bar, head dimensions shall meet the requirements of Annex A1.

NOTE 3—The requirements for head dimensions in Annex A1 are mandated by certain consensus building codes and design standards, for example, "Building Code Requirements for Structural Concrete (ACI 318)."

5.5 *Welding*—A welding procedure conforming to AWS D1.4/D1.4M shall be used for all required production welding of the head to the bar, except for friction welding that shall conform to AWS C6.1 in conjunction with the manufacturer's QA/QC procedures.

5.5

5.6 *Forging*—For integrally forged headed bars, the heads shall be produced by deforming the bar ends in a hot-forging process.

5.6

5.7 *Threading*:

5.7.1 Threads on bars shall be either tapered or straight. The head shall either thread onto the bar directly, or it shall be held on the bar end by a nut and counter nut. Thread specifications and standards shall be selected by the manufacturer unless otherwise agreed with the purchaser.

5.7.2 The out-of-roundness in the rolled reinforcing bar shall be evaluated so that the manufacturer's minimum thread dimensions are maintained.

5.7.3 It shall be permissible to hot- or cold-roll, or machine cut, threads into the surface of the bar and heads at the option of the manufacturer.

## 6. Mechanical Test and Performance Requirements

6.1 Headed bars shall be subjected to mechanical tests to verify production method and product quality prior to manufacture. Mechanical testing also shall be performed at intervals during production.

6.2 *Tensile Tests*:

6.2.1 Tensile testing of the headed bar assembly shall be performed in accordance with the requirements described in Test Methods and Definitions A370. Failure mode shall be reported as partial or total fracture of the bar, the head, or the head-to-bar connection.

6.2.2 *Specimen Preparation*—Tensile test specimens shall be the full cross-section of the bar with a head attached to one end of the reinforcing bar. The minimum length of the test specimen shall be the greater of 250 mm [10 in.] or ten times the nominal diameter of the bar. The test specimen shall be placed in the testing machine with the head supported to prevent movement and bending of the head. Provisions shall be made for clearance between the support and any weld or forming material on the reinforcing bar-to-head connection. The opposite bar end of the bar, without a head attached, shall be gripped by the testing machine and loaded to failure.

6.3 *Tensile Requirements*:

6.3.1 *Tensile Properties*—The tensile properties of the test specimen shall conform to one of the following classes:

6.3.1.1 *Class A*—Develop the minimum specified tensile strength of the reinforcing bar.

6.3.1.2 *Class B*—Develop the minimum specified tensile strength and the minimum specified elongation of the reinforcing bar.

NOTE 24—Reference Specifications A615/A615M and A706/A706M requirements for minimum reinforcing bar tensile properties. Class A has been introduced for applications that only require the development of the minimum tensile strength of the reinforcing bar. The Class B criteria requires the head and the head-to-bar connection to meet or exceed the minimum specified tensile strength and the minimum specified elongation requirements of the reinforcing bar. In the previous criteria, the failure of the head or the head-to-bar connection within the attachment region was cause for rejection.

#### 6.4 Bend Test Requirements:

6.4.1 Only welded headed bars in sizes No. 10 to 32 [3 to 10] shall be subject to bend testing. Bend testing of welded headed bars in sizes No. 36, 43, and 57 [11, 14, and 18] shall be subject to agreement between the purchaser and manufacturer.

NOTE 35—Serious safety issues may be involved in performing bend tests on welded headed bars in sizes No. 36, 43, and 57 [11, 14, and 18]. Thus, 6.4 requires such bend testing to be subject to agreement between the purchaser and manufacturer.

6.4.2 *Procedure*—The test specimen shall be bent around a mandrel of suitable diameter to an angle of at least 90° with no observed partial or total fracture of the head, the bar, or the head-to-bar connection.

6.4.3 *Bend Test Mandrel*—The mandrel shall be placed so as to directly bend the welded region. The required mandrel dimensions for bend testing are prescribed in Table 1. The centerline of the bend test mandrel shall be placed at the intersection of the reinforcing bar and the weld, as shown in Fig. 2.

6.4.4 *Specimen Preparation*—Bend test specimens shall be the full cross-section of the bar with a head attached to one end of the reinforcing bar. Where the welded head interferes with placement of the bend test mandrel, sufficient head material and any excess material associated with the welding process shall be removed along one edge of the reinforcing bar to provide a flat surface on the specimen for the bend mandrel. This preparation shall ensure that the contact point of the bend mandrel is directly at the base of the reinforcing bar diameter as shown in Fig. 2.

### 7. Frequency of Testing

#### 7.1 Number of Tests:

7.1.1 *Pre-Production*—Prior to production, a testing program shall be undertaken that includes two bend tests and two tensile tests for welded headed bars, and two tensile tests for forged or threaded headed bars. The tests shall be repeated for each combination of head and bar material specification, grade or type, and welding, threading, or forging process.

7.1.2 *Production*—It shall be permissible to use either the tensile test prescribed in 6.3, or the bend test prescribed in 6.4 to verify the production method and product quality. A minimum of two tests shall be conducted during the production shift or period. One test at the start and one test at the end of each 8-h shift or less than 8-h production period or at random intervals during the production period shall be conducted.

7.1.2.1 In the event different heats of head or bar material, or both, within the same material specification are used to produce welded, threaded, or forged headed bars during a production run, a minimum of two tensile tests in accordance with 6.3 or two bend tests in accordance with 6.4 shall be conducted to verify the production method, product quality, and welding, forging, or threading quality or weldability of the heats of materials prior to continuing production.

#### 7.2 Retests:

7.2.1 *Pre-Production*—Any identified procedural or performance deficiencies shall be corrected and pre-production testing repeated until the tensile and bend test results meet the performance requirements of this specification.

7.2.2 *Production*—For welded headed bars, when partial or total fracture(s) of the bend or tensile test specimens occur(s) in the weld, the production lot shall be rejected and a retest shall be conducted as shown in 7.2.2.1 or 7.2.2.3. During production tests of welded, forged, or threaded bars, if any tensile test specimen fails to not meet the requirements for tensile properties in 6.3.1, the production lot shall be retested as shown in 7.2.2.1. For threaded components used to assemble the threaded headed bars, if thread dimensions are found not to meet the manufacturer’s specifications for the thread, the production lot shall be rejected.

7.2.2.1 If the result of a tension test fails to meet the requirements for tensile properties in 6.3.1, then a retest shall be allowed. Two specimens taken at random from the production lot shall be tested during a retest. Both specimens shall pass the tension test requirements of Section 6, or the production lot shall be rejected.

7.2.2.2 If any test specimen fails because of mechanical reasons, such as failure of the testing equipment or from flaws caused by specimen preparation, shipment, or other damage unrelated to manufacturing or testing, it shall be discarded and another specimen from the same production lot substituted.

7.2.2.3 If a bend test fails for reasons other than mechanical reasons or flaws in the specimen, as described in 7.2.2.2, a retest shall be permitted on two random specimens from the same production lot. If the results of both test specimens meet the specified requirements, the lot shall be accepted.

### 8. Finish

8.1 Rust, surface irregularities, or mill scale shall not be cause for rejection, provided the dimensions, cross-sectional area, and tensile properties of a hand wire brushed specimen are not less than the requirements of this specification.

**TABLE 1 Bend Test Requirements**

Bar Designation	Mandrel Diameter
10, 13 and 16 [3, 4, and 5]	3d <sup>A</sup>
19, 22 and 25 [6, 7, and 8]	4d
29, 32 and 36 [9, 10, and 11]	6d
43 and 57 [14 and 18]	8d

<sup>A</sup> d = nominal diameter of bar