



Standard Specification for Headed Steel Bars for Concrete Reinforcement¹

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 (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This specification covers deformed steel reinforcing bars in cut lengths, with a head attached to one or both ends, for concrete reinforcement. Heads are forge-formed, machined from bar stock, or cut from plate. Attachment can be accomplished through:

1.1.1 Welding;

1.1.2 Integrally hot forging of a head from the reinforcing bar end;

1.1.3 Internal threads in the head mating to threads on the bar end;

1.1.4 Cold-swaging an externally threaded coupling sleeve onto the reinforcing bar;

1.1.5 Cold-extruding an external coupling sleeve onto the reinforcing bar;

1.1.6 Cold-swaging an external coupling sleeve or headed sleeve onto the reinforcing bar;

1.1.7 Attaching a coupling sleeve to the end of the reinforcing bar by means of the means of a ferrous-filler medium; or

1.1.8 Separate threaded nut to secure the head to the bar.

NOTE 1—The requirements of this specification are only applicable to headed bars where the attachment of the head is accomplished by one of the methods listed in 1.1.

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 4.2.3).

1.3 This specification is applicable for orders in either inch-pound units as Specification A970 or SI units as Specification A970M.

1.4 The values stated in either inch-pound units or SI units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. 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 specification.

1.5 *This specification 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:*²

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

[A615/A615M Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement](#)

[A700 Guide for Packaging, Marking, and Loading Methods for Steel Products for Shipment](#)

[A706/A706M Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement](#)

2.2 *AWS Standards:*³

[AWS C6.1 Recommended Practices for Friction Welding](#)

[AWS D1.4/D1.4M Structural Welding Code - Reinforcing Steel](#)

2.3 *U.S. Military Standard:*⁴

[MIL-STD-129 Marking for Shipment and Storage](#)

2.4 *U.S. Federal Standard:*⁴

[Fed. Std. No. 123 Marking for Shipment \(Civil Agencies\)](#)

2.5 *ACI Standard:*⁵

[ACI 318 Building Code Requirements for Structural Concrete](#)

3. Terminology

3.1 *Definitions of Terms Specific to This Specification:*

² 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.

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

⁴ 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>.

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

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3.1.1 *cold-extruded coupling sleeve headed bar, n*—steel reinforcing bar that has the head(s) attached by means of a coupling sleeve that is axially cold-extruded onto the bar end(s).

3.1.1.1 *Discussion*—Similar to cold-swaged threaded coupling sleeve headed bar. This extruded coupling sleeve consists of an axially extruded sleeve portion that engages the deformed reinforcing bar and a pre-threaded integral stud with external threads, which match threads internal to the head(s). The head is screwed onto the mating threads on the extruded coupling sleeve. The threads may be parallel or tapered.

3.1.2 *cold-swaged external sleeve headed bar, n*—steel reinforcing bar that has the head(s) attached by means of a coupling sleeve that is cold-swaged onto the bar end(s).

3.1.2.1 *Discussion*—Similar to cold-swaged threaded coupling sleeve headed bar. This sleeve is a combination of a tubular sleeve portion extending in front of the head, and an integral one-piece head immediately adjacent to the cold-swaged sleeve. The sleeve and head assembly is attached to the deformed reinforcing bar by cold-swaging the tubular sleeve portion to the bar with multiple crimps from a hydraulic swaging tool and die, up to the face of the head section.

3.1.3 *cold-swaged headed sleeve headed bar, n*—steel reinforcing bar that has the head(s) attached by means of a sleeve that is cold-swaged onto the bar end(s).

3.1.3.1 *Discussion*—Similar to cold-swaged external coupling sleeve headed bar. This sleeve is a one-piece unit with an integral cold-swaged head. The head assembly is attached to the deformed reinforcing bar by cold-swaging the tubular sleeve to the bar with a hydraulic swaging tool and die.

3.1.4 *cold-swaged threaded coupling sleeve headed bar, n*—steel reinforcing bar that has the head(s) attached by means of a coupling sleeve that is cold-swaged onto the bar end(s).

3.1.4.1 *Discussion*—The coupling sleeve assembly is attached to the deformed reinforcing bar by cold-swaging the tubular sleeve portion to the bar with multiple crimps from a hydraulic swaging tool and die, up to the face of the pre-threaded section. This coupling sleeve is pre-threaded with external threads, which match threads internal to the head(s). The head is screwed onto the mating threads on the coupling sleeve. The threads may be parallel or tapered.

3.1.5 *ferrous-filler coupling sleeve headed bar, n*—steel reinforcing bar that has the head(s) attached by means of a coupling sleeve mechanically attached to the bar via an interlock of ferrous-filler material and the bar deformations.

3.1.5.1 *Discussion*—The ferrous-filler material is cast into the coupling sleeve. A variation includes a separate internally threaded nut secured to the threaded bar end or attached via welding a plate to the end of a prepared coupling sleeve.

3.1.6 *forged headed bar, n*—steel reinforcing bar that has the head(s) integrally forged.

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

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

3.1.9 *threaded headed bar, n*—steel reinforcing bar that has the head(s) attached using tapered or straight threads internal to the head or by a separate internally threaded nut securing the head to the threaded bar end.

3.1.10 *welded headed bar, n*—steel reinforcing bar that has the head(s) welded.

4. Ordering Information

4.1 Orders for headed steel bars for concrete reinforcement under this specification shall contain following information:

- 4.1.1 Quantity;
- 4.1.2 Type of product: welded, forged, cold-swaged, cold-extruded, ferrous metal-filled sleeved, or threaded headed bars;
- 4.1.3 Reinforcing bar specification and year of issue;
- 4.1.4 Bar size designation;
- 4.1.5 Deformed reinforcing bars;
- 4.1.6 Head geometry, including thickness, diameter or height and width of the head;
- 4.1.7 Number of heads per bar length;
- 4.1.8 Length of bar assembly; and
- 4.1.9 ASTM designation and year of issue.

4.2 The purchaser shall have the option to specify additional requirements, including, but not limited to, the following:

- 4.2.1 Packaging (15.1, 15.2);
- 4.2.2 Bend testing of welded headed bars in sizes No. 11, 14, and 18 [36, 43, and 57] (6.4.1);
- 4.2.3 Optional requirements of Annex A1, if applicable;
- 4.2.4 Optional copy of material test report (6.1, 13.2); and
- 4.2.5 Other special requirements, if any.

5. Material and Manufacture

5.1 *Reinforcing Bars*—For welded headed bars, the reinforcing bars shall conform to Specification A706/A706M. For forged non-welded 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 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, diameter, or 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.

NOTE 2—Alternate head dimensions resulting in a net bearing area less than four times the nominal cross-sectional 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).

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—Some methods of attachment, as defined in Section 3 of this specification, do not meet the requirements on obstructions as prescribed

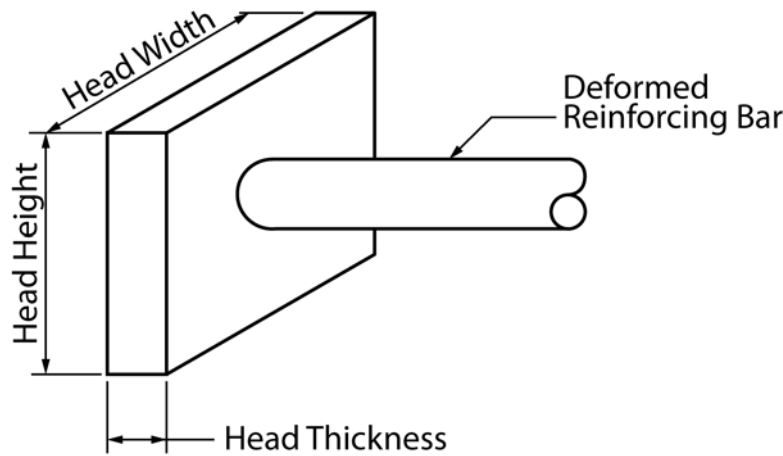


FIG. 1 Headed Reinforcing Bar

in [Annex A1](#). The requirements for head dimensions, limitations to reinforcing bar deformation interruptions and the size of obstruction allowances provided in [Annex A1](#) are mandated by certain consensus building codes and design standards, for example, "Building Code Requirements for Structural Concrete (ACI 318)." Heads with obstructions that do not conform to [Annex A1](#) may not be permitted for use by certain building codes and design standards, such as 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.

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

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.

5.7.2 The out-of-roundness in the as-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 of the assembly.

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](#). The 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 10 in. [250 mm] 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 4—Reference the requirements of Specifications [A615/A615M](#) and [A706/A706M](#) for minimum reinforcing bar tensile properties. Class A has been introduced for applications that 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. 3 to 10 [10 to 32] shall be subject to bend testing. Bend testing of welded headed bars in sizes No. 11, 14, and 18 [36, 43, and 57] shall be subject to agreement between the purchaser and manufacturer.

NOTE 5—Serious safety issues may be involved in performing bend tests on welded headed bars in sizes No. 11, 14, and 18 [36, 43, and 57]. 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

TABLE 1 Bend Test Requirements

Bar Designation No.	Mandrel Diameter
3, 4, and 5 [10, 13, and 16]	3d ^A
6, 7, and 8 [19, 22, and 25]	4d
9, 10, and 11 [29, 32, and 36]	6d
14 and 18 [43 and 57]	8d

^A d = nominal diameter of bar

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 deformed 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 deformed 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 for welded headed bars and two tensile tests for all headed bars. The tests shall be repeated for each combination of head and bar material specification, grade or type, or head attachment method.

NOTE 6—The bend test is used to ensure that no weak points existed in the weld at the head-to-bar connection. Other head-to-bar connections are not subject to this test due to the mechanical nature of those head-to-bar connections.

7.1.2 *Production Sampling and Testing of Headed Bars*—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 of headed bar. A minimum of two specimens shall be sampled and tested for each production shift or period. One test of a headed bar at the start and one test at the end of each 8-h production period or less than 8-h production period or at random intervals during the production period shall be conducted. Sampling shall be conducted at the location where the head is permanently attached to the reinforcing bar in its final form, unless otherwise agreed to by the purchaser and the manufacturer at the time of purchase.

NOTE 7—Headed bars as defined in this specification can be produced from single or multiple components. It is the intent of this specification to require production sampling at the location where final assembly occurs.

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 headed bar assemblies 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 head attachment method prior to continuing production.

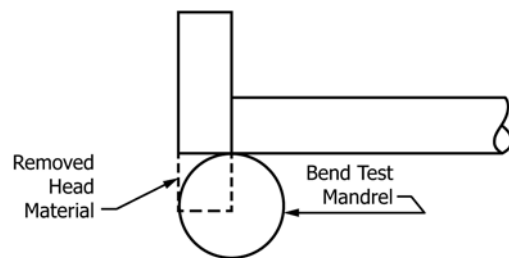


FIG. 2 Bend Test Specimen Mandrel Configuration

7.1.2.2 *Test Specimen Length*—The test specimen length shall be sufficient to accommodate a minimum of 8 in. [200 mm] of free bar length between the grips of the tensile testing machine holding the reinforcing bar and the bearing face of the head. Lot traceability shall be maintained for the specimen.

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 headed 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 headed bars, if thread dimensions are found not to meet the manufacturer's practices for the threads, 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 meet 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.

9. Inspection

9.1 The inspector representing the purchaser shall have free entry while work on the contract of the purchaser is being performed to the parts of the manufacturer's facilities that

concern manufacture of the material ordered. The manufacturer shall afford the inspector reasonable access to the facilities to satisfy the inspector that the materials and procedures are in accordance with this specification. Inspection at the place of manufacture shall be conducted so as not to interfere unnecessarily with the operation of the manufacturer's facilities.

9.2 For Government Procurement Only—Except as otherwise specified in the contract, the manufacturer shall be responsible for the performance of inspection and test requirements specified herein, unless otherwise agreed by the purchaser at the time of purchase, and shall use the purchaser's own or other suitable facilities for the performance of the inspection and test requirements specified herein.

10. Rejection

10.1 The purchaser shall have the right to perform any of the inspections and tests as set forth in this specification as deemed necessary. Unless otherwise specified, any rejection based on tests made in accordance with this specification shall be reported to the manufacturer within five working days from the receipt of samples by the purchaser.

10.2 Material that does not meet the requirements of this specification subsequent to its acceptance at the manufacturer's facilities shall be subject to rejection, and the manufacturer shall be promptly notified.

11. Rehearing

11.1 Samples tested in accordance with this specification that represent rejected material shall be preserved for two weeks from the date rejection is reported to the manufacturer. In case of dissatisfaction with the results of the test, the manufacturer shall make claim for a rehearing within that time.

12. Documentation

12.1 A manufacturer's product certificate shall accompany headed bars when they are shipped from the manufacturer's facilities.

13. Test Reports

13.1 For welded headed bars, a test report shall be furnished by the manufacturer containing on a per heat basis the chemical analysis of the bar and of the head material, including all elements represented in the carbon equivalent formula of Specification **A706/A706M**, in addition to phosphorus and sulfur.

13.2 A test report shall be required of the manufacturer for the production of headed bar assemblies as described in

Section **6**, including the failure mode. A copy of the test report shall be provided to the purchaser upon request.

13.3 A material test report, certificate of inspection, or similar document printed from or used in electronic form from an electronic data interchange (EDI) transmission shall be regarded as having the same validity as a counterpart printed in the certifier's facility. The content of the EDI transmitted document shall meet the requirements of the invoked ASTM standard(s) and conform to any existing EDI agreement between the purchaser and the manufacturer. Notwithstanding the absence of a signature, the organization submitting the EDI transmission is responsible for the content of the report.

NOTE 8—The industry definition as invoked here is: EDI is the computer-to-computer exchange of business information in a standard format such as ANSI ASC X12.

14. Marking

14.1 Each manufacturer shall identify the symbols of their marking system.

14.2 All headed bars manufactured under this specification shall be identified by a distinguishing set of marks legibly stamped onto the flat outer side of the head, away from the bar, to denote the following:

14.2.1 Point of Origin—Letter(s) or symbol(s) established as the manufacturer's designation.

14.2.2 Type of Headed Reinforcing Bar—Letter *T* indicating that the headed bar was manufactured to this specification.

15. Packaging

15.1 When specified in the purchase order, packaging shall be in accordance with the procedures in Practices **A700**.

15.2 For Government Procurement Only—When specified in the contract or order and for direct procurement by or direct shipment to the U.S. government, marking for shipment, in addition to requirements specified in the contract or order, shall be in accordance with MIL-STD-129 for military agencies and Fed. Std. No. 123 for civil agencies.

16. Keywords

16.1 carbon-steel reinforcing bars; cold-extruded threaded headed reinforcing bars; cold-swaged coupling sleeve headed reinforcing bars; cold-swaged external sleeve headed reinforcing bars; cold-swaged headed sleeve reinforcing bars; concrete reinforcement; deformations (protrusions); ferrous-filled headed reinforcing bars; headed reinforcement; headed reinforcing bars; integrally-forged headed reinforcing bars; low-alloy steel reinforcing bars; threaded headed reinforcing bars; welded headed reinforcing bars



ANNEX

(Mandatory Information)

A1. REQUIREMENTS FOR CLASS HA HEAD DIMENSIONS

INTRODUCTION

The following requirements shall apply only when specified in the purchase order or contract. When specified, this **Annex A1** replaces **5.3**, **6.3.1.1**, and **14.2.2** with the following.

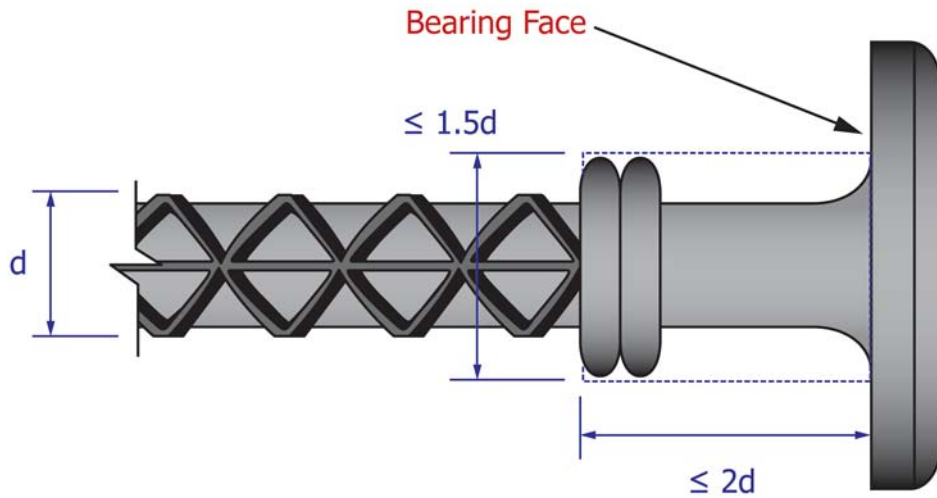


FIG. A1.1 Maximum Dimensions of Obstruction or Interruptions of Bar Deformations and Non-Planar Features of the Bearing Surface

A1.1 Replacement Requirements for **5.3**

A1.1.1 Head dimensions for headed bars conforming to Class HA shall be provided by the purchaser in the purchase order.

A1.1.1.1 Head dimensions shall define the head geometry including thickness, diameter or height and width of the head (**Fig. 1**).

A1.1.1.2 Class HA head dimensions shall comply with **A1.1.1.3** through **A1.1.1.5**.

A1.1.1.3 The net bearing area of the head shall not be less than four times the nominal cross-sectional area of the bar. The net bearing area of bars meeting the requirements of this annex is the gross area of the head minus the area of the deformed reinforcing bar.

A1.1.1.4 The bearing face shall consist of a single, nominally flat surface that lies in a plane perpendicular to the longitudinal axis of the bar.

A1.1.1.5 Obstructions or interruptions of the bar deformations and non-planar features on the bearing face of the head shall not extend more than two nominal bar diameters from the bearing face and shall not have a diameter greater than 1.5 nominal bar diameters (**Fig. A1.1**). Such obstructions shall not be considered to detract from the net bearing area of the head. Obstructions exceeding any of these limits are not permitted.

A1.2 Replacement Requirements for **6.3.1.1**

A1.2.1 *Class HA*—Develop the minimum specified tensile strength of the reinforcing bar.

A1.3 Replacement Requirements for **14.2.2**

A1.3.1 *Type of Headed Reinforcing Bar*—Letter *H* indicating that the headed bar was manufactured in accordance with this **Annex A1**.

**APPENDIXES****(Nonmandatory Information)****X1. SPECIFICATION PHILOSOPHY FOR HEADED REINFORCING BARS**

X1.1 The requirements for headed reinforcing bars are based on the application method to attach a head to one or both ends of a standard reinforcing bar. To achieve consistent performance of the attached head by welding, the bar material is limited to Specification **A706/A706M** so as to require a bar with a controlled chemical composition to be used. The ferrous-filler material attachment method process and coupling sleeve is a mechanical method of attachment.

X1.2 In the case of forged headed bars, the head(s) is produced by integrally hot forging the head from the bar. The chemical composition requirements of the bar for a forging operation are such that low-alloy steel or carbon steels can be used. Thus, integrally forged headed bars are allowed to use either Specifications **A615/A615M** or **A706/A706M** bar material.

X1.3 For headed reinforcing bars with threaded heads, two options exist. The head may be internally threaded so that it directly screws on the threaded bar end. The other option is for the head to have a non-threaded hole so that the head is held on the bar end by a nut and a counter nut. In either case the threads should be carefully cut or rolled so that the engagement of the threads results in a uniform load in the head-to-bar connection. For machine cut or rolled straight threads, additional quality inspection of the reinforcing steel bars will be required to eliminate bars that may be excessively out-of-round. Individual manufacturers will have to establish their own standards for the out-of-roundness that can be tolerated with their particular threading system.

X1.4 For headed reinforcing bars with coupling sleeves attached by means of ferrous-filler material, the head may be attached directly by means of the ferrous filler material, by an externally threaded coupling sleeve and separate internally threaded head, or by a secondary plate externally welded directly to the ferrous-filled coupling sleeve. These methods of attaching the head to the reinforcing bar do not require restrictions on chemical composition of the bar.

X1.5 For cold-swaged coupling sleeve headed reinforcing bars, the coupling sleeve is cold-swaged onto the bar end by means of a hydraulically actuated press. A variation includes a separate internally threaded head that is then assembled onto the coupling sleeve. This method of attaching the head to the reinforcing bar does not require restrictions on the chemical

composition of the bar.

X1.6 Research has shown that the head can provide adequate anchorage of the reinforcing bar in concrete when the anchorage is properly detailed. Designers are cautioned to consult the specific design code as to the use of headed bars to ensure that the detailing rules are employed.

X1.7 Tensile and bend testing of Class B headed bars are required to establish that the head will remain attached to the bar under severe loading and that failure will not occur in the connection region of the specimen. These testing requirements are designed to test both the preproduction headed bars as well as actual production products to verify that Class B head-to-bar connection is as strong as the parent head and bar materials and that the connection has sufficient ductility.

X1.8 The head should be dimensioned to be capable of resisting the nominal tensile strength of the reinforcing bar when the headed reinforcing bar is embedded in the concrete. Nominal head dimensions were previously provided in this specification to inform manufacturers of headed reinforcing bar assemblies as to typical head dimensions. The head dimensions found in editions prior to 2004 of this specification are not included in the current version. The anchorage of the bar by means of the head provides the shortest tensile development length possible and essentially means that the headed bar is immediately anchored. No nominal head dimensions are now provided in the specification making the determination of the head dimensions the responsibility of the designer, purchaser, or manufacturer. Designers should be cognizant that the head sizes must be evaluated to ensure that adequate anchorage is provided, that the steel and concrete stresses are not excessive for the loadings, and that the detailing of the head-to-bar connection is consistent with the intended usage. Nominal head dimensions historically have called for gross head area to be ten times the bar area with the net bearing area of the head to be nine times the bar area. The head dimensions provided in previous editions of this specification were shown by extensive testing to provide headed bars that can resist the nominal tensile strength of the bar without failure of the head or crushing of the concrete under the head. Designers, purchasers, and manufacturers who have no other information regarding head proportioning may refer to these dimensions as a starting point.



X2. TESTING REQUIREMENTS FOR HEADED BARS

X2.1 The production of headed bars that can meet the performance requirements of this specification require a number of tests to be conducted prior to and during production of these assemblies.

X2.2 The requirements of Section 6 state that there are specific tensile property levels that must be achieved by the headed bar assembly. Class A headed steel bars ensure that the specific minimum tensile strength of the reinforcement is developed. Whereas, Class B headed steel bars ensure that the tensile strength of the bar is achieved along with the specified minimum elongation requirements.

X2.3 Bend testing of the completed assemblies of welded headed bars will be required to meet the requirement of this specification since the head-to-bar connection itself must be tested.

X2.4 Metallurgical and hardness tests are strongly recommended for diagnostic purposes prior to production of headed bars, and especially those with welded or forged heads. One metallographic examination and hardness survey should be carried out on a section of the head and welded or forged zone. This examination and survey should be used for diagnostic purposes in the event that later production testing reveals unacceptable tension or bend test performance. The test specimen for hardness testing should be obtained by cutting a headed bar in half along the longitudinal axis of the bar to expose two symmetric sections consisting of the head, the

welded or forged zone, and a minimum two bar diameter length of bar beyond the head-to-bar interface. This type of diagnostic examination should be conducted prior to continuous production for each combination of bar and head materials that will be produced. The information obtained can be essential in eliminating problems with strength or ductility of the welded or forged head-to-bar connection, or both.

X2.5 When automated equipment performs welding operations for welded headed bars, it is recommended that all such equipment be fitted with an effective in-process monitoring system to record essential production parameters that describe the process of welding of the head onto the reinforcing bar. The important parameters to record include force, temperature, revolutions, or other elements of the production process. The data on this in-process monitoring should be recorded and preserved by the manufacturer for a minimum of one year after manufacture of the welded headed bars.

X2.6 The manufacturer should maintain a complete record and traceability of production and materials used in the production of headed bars. The records to be maintained include, but are not limited to, certificates for bar and head materials, date and number of components produced, and test and inspection records. The information should be traceable to specific production runs. Such documentation and records should be preserved at the manufacturer's facilities for a minimum of one year after manufacture of the headed bars.

X3. HEADED REINFORCING BARS IN PRACTICE

X3.1 The ACI 318 Building Code, which is cited in this specification (2.5), contains requirements for headed deformed reinforcing bars. Provisions for the design and detailing of headed deformed anchorages are provided in the Code. The Code requires headed deformed reinforcing bars to conform to Specification A970/A970M including Annex A1, Requirements for Class HA Head Dimensions. Preparation of Annex A1 was coordinated with the ACI Committee 318 Building Code Committee. Annex A1 includes criteria regarding a minimum net bearing area of the head (A1.1.1.3); the geometry of the bearing face of the head in relation to the longitudinal axis of the bar (A1.1.1.4); and a limitation on obstructions or interruptions of the bar deformations in close proximity to the bearing face of the head and non-planar features on the bearing face of the head (A1.1.1.5 and Fig. A1.1). The Code's rationale for limiting headed bars to types meeting the criteria for HA heads in Annex A1 is that headed bars with significant obstructions or interruptions of the bar deformations were not evaluated in the tests used to formulate the Code's provisions for design and detailing of headed bar anchorages. Also included in the Code is a provision for headed bars that are not anchored in accordance with the Code's design and detailing provisions and do not meet the limitation for Class HA heads

regarding obstructions or interruptions of the bar deformations—such headed bars may be used if tests demonstrate the ability of the headed bar assemblies to develop or anchor the desired force in the bar.

X3.2 The ACI 318 Building Code has specific language and limitations concerning obstructions in the reinforcing bar deformations immediately in front of the head. Annex A1 was added to A970/A970M to address specific issues noted by ACI 318 Subcommittee B as related to the standard's use with ACI 318. Commentary Section 12.6 in ACI 318 states "the limitation on obstructions and interruptions of the deformations is included in Code Section 3.5.9 because there is a wide variety of methods to attach heads to bars, some of which involve obstructions or interruptions of the deformations that extend more than $2d_b$ from the bearing face of the head. These systems were not evaluated in the tests used to formulate the provisions in Code Section 12.6.2, which were limited to systems that meet the criteria in Code Section 3.5.9." Some of the types of headed bars added to this specification after the 2009 version may have obstructions or interruptions in deformations exceeding the requirements of ACI 318 and thus not comply with the design requirements. Those types of headed bars explicitly



satisfying the geometrical requirements in A970/A970M – 09 provided in ACI 318, Sections 3.5.9 and 12.6. and **Annex A1**, comply with the minimum requirements

SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this standard since the last issue (A970/A970M – 15) that may impact the use of this standard. (Approved March 1, 2016.)

(1) Revised Section **4**.

Committee A01 has identified the location of selected changes to this standard since the last issue (A970/A970M – 13a) that may impact the use of this standard. (Approved March 1, 2015.)

(1) Added **7.1.2.2**.

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