Designation: A 970/A 970M – 07

Standard Specification for Headed Steel Bars for Concrete Reinforcement[1]

This standard is issued under the fixed designation A 970/A 970M; 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 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 A 970M or inch-pound units shown in the text in brackets [Specification A 970].

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 *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:* [2]

A 36/A 36M Specification for Carbon Structural Steel

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products

A 572/A 572M Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel

A 615/A 615M Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

A 700 Practices for Packaging, Marking, and Loading Methods for Steel Products for Shipment

A 706/A 706M Specification for Low-Alloy Steel Deformed and Plain 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)

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 *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 *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:

[1] 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. Published October 2007. Originally approved in 1997. Last previous edition approved in 2006 as A 970/A 970M–06.

[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.

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

Copyright © ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States.

Copyright ASTM International
Provided by IHS under license with ASTM
No reproduction or networking permitted without license from IHS
Not for Resale

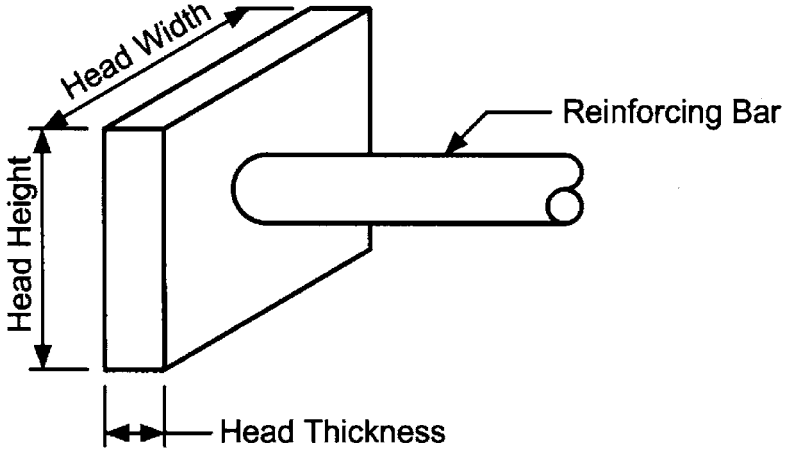

FIG. 1 Headed Reinforcing Bar

4.1.1 Quantity,
4.1.2 Name of product: welded, forged, or threaded headed bars for the reinforcement of concrete,
4.1.3 Reinforcing bar specification and year of issue,
4.1.4 Bar size,
4.1.5 Deformed or plain bars,
4.1.6 Head geometry, including thickness, height, width, and cross-sectional area,
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.

5. Material and Manufacture

5.1 *Reinforcing Bars*—For welded headed bars, the reinforcing bars shall conform to Specification A 706/A 706M. For forged headed bars or threaded headed bars, the reinforcing bars shall conform to Specification A 615/A 615M or A 706/A 706M, 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, 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 *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 *Forging*—For integrally forged headed bars, the heads shall be produced by deforming the bar ends in a hot-forging process.

5.6 *Threading*:

5.6.1 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 counternut. Thread specifications and standards shall be selected by the manufacturer unless otherwise agreed with the purchaser.

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

5.6.3 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 A 370. 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*:

Copyright ASTM International
Provided by IHS under license with ASTM
No reproduction or networking permitted without license from IHS
Not for Resale

TABLE 1 Bend Test Requirements

Bar Designation	Mandrel Diameter
10, 13 and 16 [3, 4 and 5]	3d[A]
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

[A] d = nominal diameter of bar

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 2—Reference Specifications A 615/A 615M and A 706/A 706M 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 3—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.

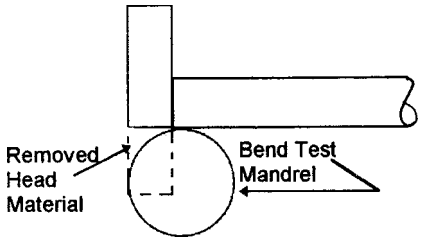

FIG. 2 Bend Test Specimen Mandrel Configuration

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

Copyright ASTM International
Provided by IHS under license with ASTM
No reproduction or networking permitted without license from IHS
Not for Resale

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 A 706/A 706M, 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 must meet the requirements of the invoked ASTM standard(s) and conform to any existing EDI agreement between the purchaser and the supplier. Notwithstanding the absence of a signature, the organization submitting the EDI transmission is responsible for the content of the report.

NOTE 4—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 produced 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 welded, threaded, or forged headed bar was produced to this specification.

15. Packaging

15.1 When specified in the purchase order, packaging shall be in accordance with the procedures in Practices A 700.

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; concrete reinforcement; deformations (protrusions); headed reinforcement; headed reinforcing bars; integrally-forged headed reinforcing bars; low-alloy steel reinforcing bars; threaded headed reinforcing bars; welded headed reinforcing bars

--`,,```,,,,````-`-`,,`,,`,`,,`---
Copyright ASTM International
Provided by IHS under license with ASTM
No reproduction or networking permitted without license from IHS
Not for Resale

APPENDIXES

(Nonmandatory Information)

X1. SPECIFICATION PHILOSOPHY FOR HEADED REINFORCING BARS

X1.1 The requirements for headed reinforcing bars are based on the application of welding, threading, or forging 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 A 706/A 706M so as to require a bar with a controlled chemical composition to be used.

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 A 615/A 615M or A 706/A 706M 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 counternut. 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 straight threads, additional quality inspection of the reinforcing steel 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 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.

X1.5 Tensile and bend testing of Class B headed bars are required to establish that the head will stay 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.

X1.6 The head shall be dimensioned to be capable of resisting the nominal tensile strength of the reinforcing bar when the welded, threaded, or forged headed reinforcing bar is embedded in the concrete. Nominal head dimensions were previously provided to inform manufacturers of these systems 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 via 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 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 actual 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

Copyright ASTM International
Provided by IHS under license with ASTM
No reproduction or networking permitted without license from IHS
Not for Resale

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, unless otherwise specified by the purchaser.

X3. HEADED REINFORCING BARS IN PRACTICE

X3.1 Test results obtained in Europe and North America show that anchorages can be designed so that the headed bar is immediately anchored by the head alone and that the assembly has essentially no development length required.

X3.2 Designers using these headed bars should be aware that application of prudent structural detailing concepts, including use of transverse reinforcement for confinement, should result in strong, ductile anchorages. Specific recommendations for design using headed reinforcing bars in actual structural members are now under development by various researchers and manufacturers of headed bars. In addition, the Structural Concrete Building Code Committee of the American Concrete Institute is currently working on developing design and detailing provisions for the use of headed bars in concrete structures. These rules will provide designers with appropriate guidance for the design of structures using headed reinforcing bars so that the anchorages remain ductile, even under earthquake loading.

SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this standard since the last issue (A 970/A 970M–06) that may impact the use of this standard.

(*1*) Deleted provisions in Section 1 that are repeated in this specification.
(*2*) Deleted documents from Section 2 that are not cited in this specification.
(*3*) Revised Section 5 to clarify the steels suitable for the various types of headed bars and added provisions (from Section 1) for alternate materials to manufacture headed bars.
(*4*) Deleted former Section 6 on Chemical Composition.
(*5*) Revised Section 6 (formerly Section 7) to require determination of tensile strength only of the headed bar assembly in tensile tests and clarified that bend tests are required only for welded headed bars. Bend testing of the large bar sizes is subject to agreement between purchaser and manufacturer.
(*6*) Revised to distinguish two classes of headed bar assemblies: Class A and Class B.
(*7*) Revised the appendixes to delete outdated information and to reflect revisions made in the body of this specification.

ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.

This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or service@astm.org (e-mail); or through the ASTM website (www.astm.org).

Copyright ASTM International
Provided by IHS under license with ASTM
No reproduction or networking permitted without license from IHS
Not for Resale