



Designation: A706/A706M – 22

Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement¹

This standard is issued under the fixed designation A706/A706M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

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

1. Scope*

1.1 *General*—This specification covers deformed and plain low-alloy steel bars in cut lengths and coils for concrete reinforcement intended for applications where restrictive mechanical properties and chemical composition are required for compatibility with controlled tensile property applications or to enhance weldability. The standard sizes and dimensions of deformed bars and their number designations are given in [Table 1](#).

1.2 *Grade*—Bars are of two minimum yield strength levels: namely, 60 000 psi [420 MPa] and 80 000 psi [550 MPa], designated as Grade 60 [420] and Grade 80 [550], respectively.

1.3 Plain bars, in sizes up to and including 2½ in. [63.5 mm] in diameter in coils or cut lengths, when ordered, shall be furnished under this specification. For ductility properties (elongation and bending), test provisions of the nearest smaller nominal diameter deformed bar size shall apply. Requirements providing for deformations and marking shall not be applicable.

1.4 *Controlled Tensile Properties*—This specification limits tensile properties ([Table 2](#)) to provide the desired yield/tensile properties for controlled tensile property applications.

1.5 *Welding*—This specification limits chemical composition ([6.2](#)) and carbon equivalent ([6.4](#)) to enhance the weldability of the material. When this steel is to be welded, a welding procedure suitable for the chemical composition and intended use or service should be used. The use of the latest edition of AWS D1.4/D1.4M is recommended. The AWS D1.4/D1.4M Welding Code describes the proper selection of the filler metals, preheat/interpass temperatures, as well as, performance and procedure qualification requirements.

1.6 Requirements for alternate bar sizes are presented in [Annex A1](#). The requirements in [Annex A1](#) only apply when specified by the purchaser (see [4.2.5](#)).

1.7 The text of this specification references notes and footnotes that provide explanatory material. These notes and footnotes, excluding those in tables, shall not be considered as requirements of this specification.

1.8 This specification is applicable for orders in either inch-pound units (Specification A706) or in SI units [Specification A706M].

1.9 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 this specification.

1.10 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.11 *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:²

[A6/A6M](#) Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling

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

[A510/A510M](#) Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel, and Alloy Steel

¹ This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.05 on Steel Reinforcement.

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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.

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

TABLE 1 Deformed Bar Designation Numbers, Nominal Weights [Masses], Nominal Dimensions, and Deformation Requirements

Bar Designation No.	Nominal Weight, lb/ft [Nominal Mass, kg/m]	Nominal Dimensions ⁴			Deformation Requirements, in. [mm]		
		Diameter, in. [mm]	Cross-Sectional Area, in. ² [mm ²]	Perimeter, in. [mm]	Maximum Average Spacing	Minimum Average Height	Maximum Gap (Chord of 12.5 % of Nominal Perimeter)
3 [10]	0.376 [0.560]	0.375 [9.5]	0.11 [71]	1.178 [29.9]	0.262 [6.7]	0.015 [0.38]	0.143 [3.6]
4 [13]	0.668 [0.994]	0.500 [12.7]	0.20 [129]	1.571 [39.9]	0.350 [8.9]	0.020 [0.51]	0.191 [4.9]
5 [16]	1.043 [1.552]	0.625 [15.9]	0.31 [199]	1.963 [49.9]	0.437 [11.1]	0.028 [0.71]	0.239 [6.1]
6 [19]	1.502 [2.235]	0.750 [19.1]	0.44 [284]	2.356 [59.8]	0.525 [13.3]	0.038 [0.97]	0.286 [7.3]
7 [22]	2.044 [3.042]	0.875 [22.2]	0.60 [387]	2.749 [69.8]	0.612 [15.5]	0.044 [1.12]	0.334 [8.5]
8 [25]	2.670 [3.973]	1.000 [25.4]	0.79 [510]	3.142 [79.8]	0.700 [17.8]	0.050 [1.27]	0.383 [9.7]
9 [29]	3.400 [5.060]	1.128 [28.7]	1.00 [645]	3.544 [90.0]	0.790 [20.1]	0.056 [1.42]	0.431 [10.9]
10 [32]	4.303 [6.404]	1.270 [32.3]	1.27 [819]	3.990 [101.3]	0.889 [22.6]	0.064 [1.63]	0.487 [12.4]
11 [36]	5.313 [7.907]	1.410 [35.8]	1.56 [1006]	4.430 [112.5]	0.987 [25.1]	0.071 [1.80]	0.540 [13.7]
14 [43]	7.65 [11.38]	1.693 [43.0]	2.25 [1452]	5.32 [135.1]	1.185 [30.1]	0.085 [2.16]	0.648 [16.5]
18 [57]	13.60 [20.24]	2.257 [57.3]	4.00 [2581]	7.09 [180.1]	1.58 [40.1]	0.102 [2.59]	0.864 [21.9]

⁴ The nominal dimensions of a deformed bar are equivalent to those of a plain round bar having the same weight [mass] per foot [metre] as the deformed bar.

TABLE 2 Tensile Requirements

	Grade 60 [420]	Grade 80 [550]
Tensile strength, min, psi [MPa]	80 000 [550] ⁴	100 000 [690] ⁴
Yield strength, min, psi [MPa]	60 000 [420]	80 000 [550]
Yield strength, max, psi [MPa]	78 000 [540]	98 000 [675]
Elongation in 8 in. [200 mm], min, %		
Bar Designation Nos.		
3, 4, 5, 6 [10, 13, 16, 19]	14	12
7, 8, 9, 10, 11 [22, 25, 29, 32, 36]	12	12
14, 18 [43, 57]	10	10

⁴ Tensile strength shall not be less than 1.25 times the actual yield strength.

[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](#)

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

[E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications](#)

[E290 Test Methods for Bend Testing of Material for Ductility](#)

2.2 *AWS Standard*.³

[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 of Terms Specific to This Specification:*

3.1.1 *deformations, n*—transverse protrusions on a deformed bar.

3.1.2 *deformed bar, n*—steel bar with protrusions; a bar that is intended for use as reinforcement in reinforced concrete and related construction.

³ Available from American Welding Society (AWS), 8669 NW 36 Street, #130, Miami, FL 33166-6672, <http://www.aws.org>.

⁴ Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, <http://www.dodssp.daps.mil>.

3.1.2.1 *Discussion*—The surface of the bar is provided with lugs or protrusions that inhibit longitudinal movement of the bar relative to the concrete surrounding the bar in such construction. The lugs or protrusions conform to the provisions of this specification.

3.1.3 *plain bar, n*—steel bar without protrusions.

3.1.4 *rib, n*—longitudinal protrusion on a deformed bar.

4. Ordering Information

4.1 Orders for low-alloy steel bars for concrete reinforcement under this specification shall contain the following information:

4.1.1 Quantity (weight) [mass],

4.1.2 Deformed or plain,

4.1.3 Bar designation number (size) of deformed bars, or nominal diameter (size) of plain bars,

4.1.4 Cut lengths or coils,

4.1.5 Grade, and

4.1.6 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 Requirements for inspection (17.1),

4.2.2 Special package marking requirements (20.2),

4.2.3 Require bars in each bundle to be supplied from a single heat (16.1),

4.2.4 Other special requirements, if any, and

4.2.5 Optional requirements of [Annex A1](#), if applicable.

5. Material and Manufacture

5.1 The bars shall be processed from properly identified heats of mold-cast or strand-cast steel. The steel shall be made by any commercially accepted process.

6. Chemical Composition

6.1 The chemical analysis of each heat shall be determined in accordance with Test Methods, Practices, and Terminology [A751](#). The manufacturer shall make the analysis on test samples taken preferably during the pouring of the heat. The percentages of carbon, manganese, phosphorus, sulfur, silicon, copper, nickel, chromium, molybdenum, and vanadium shall be determined.

6.2 The chemical composition as shown by heat analysis shall be limited by the following:

Element	max, %
Carbon	0.30
Manganese	1.50
Phosphorus	0.035
Sulfur	0.045
Silicon	0.50

6.3 Choice and use of alloying elements, combined with carbon, phosphorus, and sulfur to produce the mechanical properties prescribed in **Table 2** and **Table 3**, shall be made by the manufacturer. Elements commonly used include manganese, silicon, copper, nickel, chromium, molybdenum, vanadium, columbium, titanium, and zirconium.

6.4 The heat analysis shall be such as to provide a carbon equivalent (C.E.) not exceeding 0.55 % as calculated by the following formula:

$$C.E. = \% C + \frac{\% Mn}{6} + \frac{\% Cu}{40} + \frac{\% Ni}{20} + \frac{\% Cr}{10} - \frac{\% Mo}{50} - \frac{\% V}{10} \quad (1)$$

6.5 *Product (Check) Verification Analysis*—A product check analysis made by the purchaser shall not exceed the following percentages:

Element	max, %
Carbon	0.33 %
Manganese	1.56 %
Phosphorus	0.043 %
Sulfur	0.053 %
Silicon	0.55 %

7. Requirements for Deformations

7.1 Deformations shall be spaced along the bar at substantially uniform distances. The deformations on opposite sides of the bar shall be similar in size, shape, and pattern.

7.2 The deformations shall be placed with respect to the axis of the bar so that the included angle is not less than 45°. Where the line of deformations forms an included angle with the axis of the bar from 45 to 70°, inclusive, the deformations shall reverse alternately in direction on each side, or those on one side shall be reversed in direction from those on the opposite side. Where the line of deformation is over 70°, a reversal in direction shall not be required.

7.3 The average spacing or distance between deformations on each side of the bar shall not exceed $\frac{7}{10}$ of the nominal diameter of the bar.

7.4 The overall length of deformations shall be such that the gap (measured as a chord) between the ends of the deformations shall not exceed 12.5 % of the nominal perimeter of the bar. Where the ends terminate in a rib, the width of the rib shall

be considered as the gap between these ends. The summation of the gaps shall not exceed 25 % of the nominal perimeter of the bar. The nominal perimeter of the bar shall be 3.1416 times the nominal diameter.

7.5 The spacing, height, and gap of deformations shall conform to the requirements prescribed in **Table 1**.

8. Measurements of Deformations

8.1 The average spacing of deformations shall be determined by measuring the length of a minimum of 10 spaces and dividing that length by the number of spaces included in the measurement. The measurement shall begin from a point on a deformation at the beginning of the first space to a corresponding point on a deformation after the last included space. Spacing measurements shall not be made over a bar area containing bar marking symbols involving letters or numbers.

8.2 The average height of deformations shall be determined from measurements made on not less than two typical deformations. Determinations shall be based on three measurements per deformation, one at the center of the overall length and the other two at the quarter points of the overall length.

8.3 Insufficient height, insufficient circumferential coverage, or excessive spacing of deformations shall not constitute cause for rejection unless it has been clearly established by determinations on each lot (see **Note 1**) tested that typical deformation height, gap, or spacing do not conform to the minimum requirements prescribed in **Section 7**. No rejection shall be made on the basis of measurements if fewer than ten adjacent deformations on each side of the bar are measured.

NOTE 1—As used within the intent of **8.3**, the term “lot” shall mean all the bars of one bar size and pattern of deformations contained in an individual shipping release or shipping order.

9. Tensile Requirements

9.1 The material, as represented by the test specimens, shall conform to the requirements for tensile properties prescribed in **Table 2**.

9.2 The yield point or yield strength shall be determined by one of the following methods:

9.2.1 The yield point shall be determined by the drop of the beam or halt in the gauge of the tensile testing machine, where the steel tested has a sharp-kneed or well-defined yield point.

9.2.2 Where the steel does not have a well-defined yield point, the yield strength shall be determined by the offset method (0.2 % offset) as described in **Test Methods and Definitions A370**.

9.3 When material is furnished in coils, the test specimen shall be taken from the coil and straightened prior to placing it in the jaws of the tensile testing machine. (See **Note 2**.)

NOTE 2—Straighten the test specimen to avoid formation of local sharp bends and to minimize cold work. Insufficient straightening prior to attaching the extensometer can result in lower-than-actual yield strength readings.

9.3.1 Test specimens taken from post-fabricated material shall not be used to determine conformance to this specification. (See **Note 3**.)

TABLE 3 Bend Test Requirements

Bar Designation No.	Pin Diameter for 180° Bend Tests	
	Grade 60 [420]	Grade 80 [550]
3, 4, 5 [10, 13, 16]	3d ^A	3½ d ^A
6, 7, 8 [19, 22, 25]	4d	5d
9, 10, 11 [29, 32, 36]	6d	7d
14, 18 [43, 57]	8d	9d

^A d = nominal diameter of specimen.

NOTE 3—Multiple bending distortion from mechanical straightening and fabricating machines can lead to excessive cold work, resulting in higher yield strengths, lower elongation values, and a loss of deformation height.

9.4 The percentage of elongation shall be as prescribed in [Table 2](#).

10. Bending Requirements

10.1 The bend test specimen shall withstand being bent around a pin without cracking on the outside radius of the bent portion. The requirements for degree of bending and sizes of pins are prescribed in [Table 3](#). When material is furnished in coils, the test specimen shall be straightened prior to placing it in the bend tester.

10.2 The bend test shall be made on specimens of sufficient length to ensure free bending and with apparatus that provides:

10.2.1 Continuous and uniform application of force throughout the duration of the bending operation,

10.2.2 Unrestricted movement of the specimen at points of contact with the apparatus and bending around a pin free to rotate,

10.2.3 Close wrapping of the specimen around the pin during the bending operation.

10.3 It shall be permissible to use other methods of bend testing as described in Test Methods [E290](#), such as placing a specimen across two round bearings free to rotate and applying the bending force with a fixed rounded-tip mandrel conforming to the specified bend radius, allowing the bar to pass through with sufficient clearance. When failures occur under other methods of bend resistance, retests shall be permitted under the bend-test method prescribed in [10.2](#).

11. Permissible Variation in Weight [Mass]

11.1 Deformed reinforcing bars shall be evaluated on the basis of nominal weight [mass]. The weight [mass] determined using the measured weight [mass] of the test specimen and rounding in accordance with Practice [E29](#), shall be at least 94 % of the applicable weight [mass] per unit length prescribed in [Table 1](#). In no case shall overweight [excess mass] of any deformed bar be cause for rejection.

11.2 Weight [mass] variation for plain bars shall be computed on the basis of permissible variation in diameter. For plain bars smaller than $\frac{3}{8}$ in. [9.5 mm] in diameter, use Specification [A510/A510M](#). For larger plain bars up to and including $2\frac{1}{2}$ in. [63.5 mm] in diameter, use Specification [A6/A6M](#).

12. Finish

12.1 The bars shall be free of detrimental surface imperfections.

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

12.3 Surface imperfections or flaws other than those specified in [12.2](#) shall be considered detrimental when specimens

containing such imperfections fail to conform to either tensile or bending requirements. Examples include, but are not limited to, laps, seams, scabs, slivers, cooling or casting cracks, and mill or guide marks.

NOTE 4—Deformed reinforcing bars intended for epoxy coating applications should have surfaces with a minimum of sharp edges to achieve proper coverage. Particular attention should be given to bar marks and deformations where coating difficulties are prone to occur.

NOTE 5—Deformed reinforcing bars destined to be mechanically-spliced or butt-spliced by welding may require a certain degree of roundness in order for the splices to adequately achieve strength requirements.

13. Number of Tests

13.1 One tension test and one bend test shall be made of each bar size rolled from each heat.

13.2 One set of dimensional property tests including bar weight [mass] and spacing, height, and gap of deformations shall be made of each bar size rolled from each heat.

14. Retests

14.1 If the results of an original tension test specimen fail to meet the specified minimum requirements and are within 2000 psi [14 MPa] of the required tensile strength, within 1000 psi [7 MPa] of the required yield strength, or within two percentage units of the required elongation, a retest shall be permitted on two random specimens for each original tension test specimen failure from the lot. Both retest specimens shall meet the requirements of this specification.

14.2 If a bend test fails for reasons other than mechanical reasons or flaws in the specimen as described in [14.4.2](#) and [14.4.3](#), a retest shall be permitted on two random specimens from the same lot. Both retest specimens shall meet the requirements of this specification. The retest shall be performed on test specimens that are at air temperature but not less than 60°F [16°C].

14.3 If a weight [mass] test fails for reasons other than flaws in the specimen as described in [14.4.3](#), a retest shall be permitted on two random specimens from the same lot. Both retest specimens shall meet the requirements of this specification.

14.4 If the original test or any of the random retests fails because of any reasons listed in [14.4.1](#), [14.4.2](#), or [14.4.3](#), the test shall be considered an invalid test:

14.4.1 The elongation property of any tension test specimen is less than that specified, and any part of the fracture is outside the middle half of the gage length, as indicated by scribe marks on the specimen before testing;

NOTE 6—Marking specimens with multiple scribe or punch marks can reduce the occurrence of fracture outside or near these marks and the need for declaring the test invalid.

14.4.2 Mechanical reasons such as failure of testing equipment or improper specimen preparation; and

14.4.3 Flaws are detected in a test specimen, either before or during the performance of the test.

14.5 The original results from [14.4.1](#), [14.4.2](#), or [14.4.3](#) shall be discarded and the test shall be repeated on a new specimen from the same lot.