



## Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement<sup>1</sup>

This standard is issued under the fixed designation A615/A615M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

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

### 1. Scope\*

1.1 This specification covers deformed and plain carbon-steel bars in cut lengths and coils for concrete reinforcement. Steel bars containing alloy additions, such as with the Association for Iron and Steel Technology and the Society of Automotive Engineers series of alloy steels, are permitted if the resulting product meets all the other requirements of this specification. The standard sizes and dimensions of deformed bars and their number designations are given in **Table 1**.

1.2 Bars are of five minimum yield strength levels: namely, 40 000 psi [280 MPa], 60 000 psi [420 MPa], 75 000 psi [520 MPa], 80 000 psi [550 MPa], and 100 000 psi [690 MPa], designated as Grade 40 [280], Grade 60 [420], Grade 75 [520], Grade 80 [550], and Grade 100 [690], respectively.

NOTE 1—Grade 100 [690] reinforcing bars were introduced in this specification in 2015. In contrast to the lower grades, which have ratios of specified tensile strength to specified yield strength that range from 1.31 to 1.5, Grade 100 [690] reinforcing bars have a ratio of specified tensile strength to specified yield strength of 1.15. Designers should be aware that there will, therefore, be a lower margin of safety and reduced warning of failure following yielding when Grade 100 [690] bars are used in structural members where strength is governed by the tensile strength of the reinforcement, primarily in beams and slabs. If this is of concern, the purchaser has the option of specifying a minimum ratio of tensile strength to actual yield strength. Consensus design codes and specifications such as “Building Code Requirements for Structural Concrete (ACI 318)” may not recognize Grade 100 [690] reinforcing bars: therefore the 125 % of specified yield strength requirements in tension and compression are not applicable. Mechanical and welded splices should meet a minimum specified tensile strength of 115 000 psi [790 MPa].

NOTE 2—Designers need to be aware that design standards do not recognize the use of the No. 20 [64] bar, the largest bar included in this specification. Structural members reinforced with No. 20 [64] bars may require approval of the building official or other appropriate authority and require special detailing to ensure adequate performance at service and factored loads.

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 in Grade 40 [280], Grade 60 [420], Grade 75 [520], Grade 80 [550], and Grade 100 [690]. 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.

NOTE 3—Welding of the material in this specification should be approached with caution since no specific provisions have been included to enhance its weldability. 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 and preheat/interpass temperatures, as well as performance and procedure qualification requirements.

1.4 Requirements for alternate bar sizes are presented in **Annex A1**. The requirements in **Annex A1** only apply when specified by the purchaser (see **4.2.34.2.4**).

1.5 The text of this specification references notes and footnotes which provide explanatory material. These notes and footnotes (excluding those in tables) shall not be considered as requirements of the specification.

1.6 This specification is applicable for orders in either inch-pound units (as Specification A615) or in SI units (as Specification A615M).

1.7 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.

<sup>1</sup> 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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\*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 <sup>A</sup>			Deformation Requirements, in. [mm]		
		Diameter, in. [mm]	Cross-Sectional Area, in. <sup>2</sup> [mm <sup>2</sup> ]	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]
20 [64] <sup>B</sup>	16.69 [24.84]	2.500 [63.5]	4.91 [3167]	7.85 [199.5]	1.75 [44.5]	0.113 [2.86]	0.957 [24.3]

<sup>A</sup> 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.

<sup>B</sup> Refer to **Note 2**.

1.8 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 specification 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>

**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

**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

**A751** Test Methods, Practices, and Terminology 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 ACI Standard:<sup>3</sup>

**ACI 318** Building Code Requirements for Structural Concrete

### 2.3 AWS Standard:<sup>4</sup>

**AWS D1.4/D1.4M** Structural Welding Code—Reinforcing Steel

### 2.4 U.S. Military Standard:<sup>5</sup>

**MIL-STD-129** Marking for Shipment and Storage

### 2.5 U.S. Federal Standard:<sup>5</sup>

**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 construction.

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

<sup>3</sup> Available from American Concrete Institute (ACI), P.O. Box 9094, Farmington Hills, MI 48333-9094, <http://www.concrete.org>.

<sup>4</sup> Available from American Welding Society (AWS), 8669 NW 36 Street, #130, Miami, FL 33166-6672, <http://www.aws.org>.

<sup>5</sup> 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 protrusions that inhibit longitudinal movement of the bar relative to the concrete surrounding the bar in such construction. The 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 carbon-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, ~~and~~

4.1.7 Require bars in each bundle to be supplied from a single heat (19.1).

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

4.2.1 Special package marking requirements (20.2),

4.2.2 Require bars in each bundle to be supplied from a single heat (19.1),

4.2.3 Other special requirements, if any, and

4.2.4 Optional requirements of **Annex A1**.

#### 5. Material and Manufacture

5.1 The bars shall be rolled 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 of steel 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, and sulfur shall be determined. The phosphorus content thus determined shall not exceed 0.06 %.

6.2 A product check, for phosphorus, made by the purchaser shall not exceed that specified in **6.1** by more than 25 %.

#### 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 alternately reverse 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 deformations 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 seven tenths 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 ten 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 (**Note 4**) 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 4—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 or halt of the gauge of the tensile testing machine, where the steel tested has a sharp-knead or well-defined yield point.

9.2.2 Where the steel tested 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 5.)

NOTE 5—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 6.)

NOTE 6—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 testing, 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 the 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 3/8 in. [9.5 mm] in diameter, use Specification A510/A510M. For larger plain bars up to and including 2 1/2 in. [63.5 mm] in diameter, use Specification A6/A6M.

**TABLE 2 Tensile Requirements**

	Grade 40 [280] <sup>A</sup>	Grade 60 [420]	Grade 75 [520]	Grade 80 [550]	Grade 100 [690]
Tensile strength, min, psi [MPa]	60 000 [420]	90 000 [620]	100 000 [690]	105 000 [725]	115 000 [790]
Yield strength, min, psi [MPa]	40 000 [280]	60 000 [420]	75 000 [520]	80 000 [550]	100 000 [690]
Elongation in 8 in. [200 mm], min, %					
Bar Designation No.					
3 [10]	11	9	7	7	7
4, 5 [13, 16]	12	9	7	7	7
6 [19]	12	9	7	7	7
7, 8 [22, 25]	...	8	7	7	7
9, 10, 11 [29, 32, 36]	...	7	6	6	6
14, 18, 20 [43, 57, 64]	...	7	6	6	6

<sup>A</sup> Grade 40 [280] bars are furnished only in sizes 3 through 6 [10 through 19].