



**Designation: A 615/A 615M – 08b**

American Association State Highway and  
Transportation Officials Standard  
AASHTO No.: M 31

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

This standard is issued under the fixed designation A 615/A 615M; 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 reappraisal. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reappraisal.

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

## 1. Scope\*

1.1 This specification covers deformed and plain carbon-steel bars for concrete reinforcement in cut lengths and coils. Steel bars containing alloy additions, such as with the American Iron and Steel Institute 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**. 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.

1.2 Bars are of three minimum yield strength levels: namely, 40 000 [280 MPa], 60 000 [420 MPa], and 75 000 psi [520 MPa], designated as Grade 40 [280], Grade 60 [420], and Grade 75 [520], 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 in Grade 40 [280], Grade 60 [420], and Grade 75 [520]. 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 1—Welding of the material in this specification should be approached with caution since no specific provisions have been included to enhance its weldability. When 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 D 1.4/D 1.4M** is recommended. This document describes the proper selection of the filler metals and preheat/interpass temperatures, as well as performance and procedure qualification requirements.

1.4 This specification is applicable for orders in either inch-pound units (as Specification A 615) or in SI units (as Specification A 615M).

<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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1.5 The values stated in either inch-pound units or SI units are to be regarded as standard. Within the text, the SI units are shown in brackets. The values stated in each system are not exact equivalents; therefore, each system must be used independently of the other. Combining values from the two systems may result in nonconformance with the specification.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>2</sup>

**A 6/A 6M** Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling

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

**A 510** Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel

**A 510M** Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel (Metric)

**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

**E 29** Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

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

**AWS D 1.4/D 1.4M** Structural Welding Code—Reinforcing Steel

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

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

**\*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. <sup>A</sup>	Nominal Weight, lb/ft [Nominal Mass, kg/m]	Nominal Dimensions <sup>B</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]

<sup>A</sup> Bar numbers are based on the number of eighths of an inch included in the nominal diameter of the bars [bar numbers approximate the number of millimetres of the nominal diameter of the bar].

<sup>B</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.

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

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

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

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

## 5. Material and Manufacture

5.1 The bars shall be rolled from properly identified heats of mold-cast or strand-cast steel using the electric-furnace, basic-oxygen, or open-hearth process.

## 6. Chemical Composition

6.1 An analysis of each heat of steel shall be made by the manufacturer from test samples taken preferably during the pouring of the heats. 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.

## 3. Terminology

### 3.1 Definitions of Terms Specific to This Standard:

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

3.1.1.1 *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.

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

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

4.1.1 Quantity (weight) [mass],

4.1.2 Name of the material (deformed and plain carbon-steel bars for concrete reinforcement),

4.1.3 Size,

4.1.4 Cut lengths or coils,

4.1.5 Deformed or plain,

4.1.6 Grade,

4.1.7 Packaging (see Section 20),

4.1.8 ASTM designation and year of issue, and

4.1.9 Certified mill test reports (if desired). (See Section 16.)

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

## 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 2) 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 2—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 drop of the beam or halt in the gage of the testing machine.

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 A 370.

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 machine. Straightening of test specimens shall be done carefully to avoid formation of local sharp bends and to minimize cold work. (See Note 3.)

**TABLE 2 Tensile Requirements**

	Grade 40 [280] <sup>A</sup>	Grade 60 [420]	Grade 75 [520]
Tensile strength, min, psi [MPa]	60 000 [420]	90 000 [620]	100 000 [690]
Yield strength, min, psi [MPa]	40 000 [280]	60 000 [420]	75 000 [520]
Elongation in 8 in. [203.2 mm], min, %:			
Bar Designation No.			
3 [10]	11	9	7
4, 5 [13, 16]	12	9	7
6 [19]	12	9	7
7, 8 [22, 25]	...	8	7
9, 10, 11 [29, 32, 36]	...	7	6
14, 18 [43, 57]	...	7	6

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

9.3.1 Test specimens taken from post-fabricated material shall not be used to determine conformance to this specification.

NOTE 3—Insufficient straightening prior to attaching the extensometer can result in lower-than-actual yield strength readings. Multiple bending deformation from mechanical straightening and fabricating machines can lead to excessive cold work, resulting in higher yield strengths, lower elongation values, and a reduction of the 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 which 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 is permissible to use more severe methods of bend testing, such as placing a specimen across two pins free to rotate and applying the bending force with a fixed pin. When failures occur under more severe methods, 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 E 29, 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  $\frac{3}{8}$  in. [9.5 mm] in diameter, use Specification A 510 [Specification A 510M]. For larger bars up to and including  $2\frac{1}{2}$  in. [63.5 mm] in diameter, use Specification A 6/A 6M.

**TABLE 3 Bend Test Requirements**

Bar Designation No.	Pin Diameter for Bend Tests <sup>A</sup>		
	Grade 40 [280]	Grade 60 [420]	Grade 75 [520]
3, 4, 5 [10, 13, 16]	$3\frac{1}{2} d^B$	$3\frac{1}{2} d$	$5d$
6 [19]	$5d$	$5d$	$5d$
7, 8 [22, 25]	...	$5d$	$5d$
9, 10, 11 [29, 32, 36]	...	$7d$	$7d$
14, 18 [43, 57] (90°)	...	$9d$	$9d$

<sup>A</sup> Test bends 180° unless noted otherwise.

<sup>B</sup>  $d$  = nominal diameter of specimen.