Designation: A1035/A1035M – 13

StandardSpecification for Deformed and Plain, Low-carbon, Chromium, Steel Bars for Concrete Reinforcement[1]

This standard is issued under the fixed designation A1035/A1035M; 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 low-carbon, chromium, steel bars, deformed and plain for concrete reinforcement in cut lengths and coils. 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 and figures) shall not be considered as requirements of the specification.[2]

1.2 Bars are of two minimum yield strength levels as defined in 9.2: namely, 100 000 psi [690 MPa], and 120 000 [830 MPa] designated as Grade 100 [690] and Grade 120 [830], respectively.

NOTE 1—**Caution:** Designers need to be aware that typical design standards limit the design strength to 80 000 psi [550 MPa], except for prestressing steel and for spiral transverse reinforcement. Members reinforced with bars with yield strengths that are considerably above 80 000 psi [550 MPa] may exhibit behavior that differs from that expected of conventional reinforced concrete members or may require special detailing to ensure adequate performance at service and factored loads.

1.3 Deformed bars shall have a minimum yield strength and other tensile properties in accordance with Table 2. Hot-rolled plain rounds in sizes up to and including 2.25 in. [57.2 mm] in diameter in coils or cut lengths when specified for dowels, spirals, structural ties or bar supports shall be furnished under this specification and shall also meet the tensile properties requirements of Table 2. Ductility properties for plain rounds shall be those of the nearest smaller nominal diameter deformed bar size in Table 2. Requirements covering deformation dimensions and marking are not applicable to plain rounds.

NOTE 2—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.

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 4.1.10).

1.5 This specification is applicable for orders in either inch-pound units (as Specification A1035) or in SI units (as Specification A1035M).

1.6 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.

2. Referenced Documents

2.1 *ASTM Standards:*[3]

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

A510M Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel (Metric) (Withdrawn 2011)[4]

A700 Practices for Packaging, Marking, and Loading Methods for Steel Products for Shipment

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

[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] MMFX Technologies Corporation has several patented materials (US Patents #6,273,968, #6,709,534, #7,118,637, #7,214,278) that meet this specification. Interested parties are invited to submit information regarding the identification of an alternative(s) to this patented item to the ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

[3] 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.

[4] The last approved version of this historical standard is referenced on www.astm.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.	Nominal Weight, lb/ft [Nominal Mass, kg/m]	Nominal Dimensions[A]			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]

[A] 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 Properties Requirements

	Grade 100 [690]	Grade 120 [830]
Tensile strength, min, psi [MPa]	150 000 [1030]	150 000 [1030]
Yield strength (0.2 % offset), min, psi [MPa]	100 000 [690]	120 000 [830]
Stress corresponding to an extension under load of 0.0035 in./in. [0.0035 mm/mm], min, psi [MPa]	80 000 [550]	90 000 [620]
Elongation in 8 in. [200 mm], min, %:		
Bar Designation No.		
3 through 11 [10 through 36]	7	7
14, 18 [43, 57]	6	—

2.2 *U.S. Military Standard:*[5]
MIL-STD-129 Marking for Shipment and Storage
2.3 *U.S. Federal Standard:*[5]
Fed. Std. No. 123 Marking for Shipment (Civil Agencies)

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *deformations, n*—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.

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 *lot, n*—all the bars of one bar size or pattern of deformation contained in an individual shipping release or shipping order.

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

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

[5] 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.

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 material: low-carbon, chromium, 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 21),

4.1.8 ASTM designation and year of issue, and

4.1.9 Certified mill test reports, and

4.1.10 Optional requirements of Annex A1, if applicable.

5. Materials and Manufacture

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

6. Chemical Composition

6.1 The chemical analysis of each heat shall be determined in accordance with Test Methods, Practice, 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, chromium, and nitrogen, shall be determined and reported as required in Section 16.

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

Element	max, %[A]
Carbon	0.15 %
Chromium	8.0 to 10.9 %
Manganese	1.5 %
Nitrogen	0.05 %
Phosphorus	0.035 %
Sulfur	0.045 %
Silicon	0.50 %

[A] Maximum unless range is indicated percentages refer to weight percentages.

7. Requirements for Deformation

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 on opposite sides of the bar shall not exceed 12½ % of the nominal perimeter of the bar. Where the ends terminate in a longitudinal rib, the width of the longitudinal rib shall be considered the gap. Where more than two longitudinal ribs are involved, the total width of all longitudinal ribs shall not exceed 25 % of the nominal perimeter of the bar; furthermore, the summation of 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 Deformation

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 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.

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 strength shall be determined by the offset method (0.2 % offset), described in Test Methods and Definitions A370. In addition, the stress corresponding to a tensile strain of 0.0035 shall be a minimum of 80 000 psi [550 MPa] for Grade 100 and 90 000 psi [620 MPa] for Grade 120.

NOTE 3—The stress-strain curves for bars meeting this specification do not have a well-defined yield point (that is, yield is not characterized by a sharp knee or discontinuity similarly to stainless steel bars). The provisions of 9.2 require that the yield strength (minimum 100 000 psi for Grade 100 [690 MPa] and minimum 120 000 psi for Grade 120 [830 MPa], respectively) be measured by the 0.2 % offset method and that the stress corresponding to a strain of 0.0035 be a minimum of 80 000 psi for Grade 100 and 90 000 psi [620 MPa] for Grade 120. Experimental results for concrete beams reinforced with bars meeting this specification show that the flexural strength of under-reinforced members is conservatively predicted based on the yield strength measured using the 0.2 % offset method. The minimum stress corresponding to a tensile strain of 0.0035 is required to ensure that the specified steel is at least as stiff at lower strains as lower-strength reinforcing bars.

9.3 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 sample shall be straightened prior to placement 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 E29, shall be at least

TABLE 3 Bend Test Requirements

Bar Designation No.	Pin Diameter for Bend Tests[A]
3, 4, 5, [10, 13, 16]	3½ *d*[B]
6, 7, 8 [19, 22, 25]	5*d*
9,10,11 [29, 32, 36]	7*d*
14, 18 [43, 57] (90°)	9*d*

[A] Test bends 180° unless otherwise agreed.
[B] *d* = nominal diameter of specimen.