



# Standard Specification for Deformed and Plain, Low-carbon, Chromium, Steel Bars for Concrete Reinforcement<sup>1</sup>

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 ( $\epsilon$ ) 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.<sup>2</sup>

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.

<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.

Current edition approved Sept. 1, 2011. Published October 2011. Originally approved in 2004. Last previous edition approved in 2009 as A1035/A1035M – 09. DOI: 10.1520/A1035\_A1035M-11.

<sup>2</sup> 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,<sup>1</sup> which you may attend.

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

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.

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>3</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 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)

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

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

MIL-STD-129 Marking for Shipment and Storage

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

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

<sup>3</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>4</sup> 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.

**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]

<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.

**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	—

## 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, % <sup>A</sup>
Carbon	0.15 %
Chromium	8.0 to 10.9 %
Manganese	1.5 %
Nitrogen	0.05 %
Phosphorus	0.035 %
Sulfur	0.045 %
Silicon	0.50 %

<sup>A</sup> 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

## 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.

## 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.



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 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. Weight [mass] variation for plain rounds shall be computed on the basis of permissible variation in diameter. For plain bars smaller than  $\frac{3}{8}$  in. [9.5 mm], use **Specifications A510** and **A510M**. For larger bars up to and including 2.25 in. [57.2 mm], 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 oxidation shall not be cause for rejection, provided the mass, dimensions, cross-sectional area, and tensile properties of a 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

**TABLE 3 Bend Test Requirements**

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

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

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



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 bars intended to be mechanically spliced or 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. If, however, material from one heat differs by three or more size designation numbers, one tension and one bend test shall be made from both the highest and lowest designation number of the deformed bars rolled.

### **14. Retests**

14.1 If any tensile property of any tension test specimen is less than that specified, and any part of the fracture is outside the middle third of the gage length, as indicated by scribe scratches marked on the specimen before testing, a retest shall be allowed.

14.2 If the results of an original tension 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 point, or within two percentage units of the required elongation, a retest shall be permitted on two random specimens for each original tension specimen failure from the lot. Both retest specimens shall meet the requirements of this specification.

14.3 If a bend test fails for reasons other than mechanical reasons or flaws in the specimen as described in 14.5 and 14.6, 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].

14.4 If a weight [mass] test fails for reasons other than flaws in the specimen as described in 14.6, a retest shall be permitted on two random specimens from the same lot. Both retest specimens shall meet the requirements of this specification.

14.5 If any test specimen fails because of mechanical reasons such as failure of testing equipment or improper specimen preparation, a replacement specimen shall be permitted.

14.6 If flaws are detected in a test specimen, either before or during the performance of the test, a replacement specimen shall be permitted from the same heat and bar size as the original.

### **15. Specimen Preparation**

15.1 All mechanical tests shall be conducted in accordance with Test Methods and Definitions A370 including Annex A9.

15.2 Tension test specimens shall be the full section of the bar as rolled. The unit stress determination shall be based on the nominal bar area.

15.3 The bend-test specimens shall be the full section of the bar as rolled.

### **16. Test Reports**

16.1 When specified in the purchase order, the following information shall be reported on a per heat basis. Report additional items as requested or desired.

16.1.1 Chemical analysis including percentages of carbon, chromium, manganese, nitrogen, phosphorus, silicon, and sulfur.

16.1.2 Tensile properties.

16.1.3 Bend test results.

### **17. Inspection**

17.1 The inspector representing the purchaser shall have free entry at all times while work on the contract of the purchaser is being performed to all parts of the manufacturer's works that concern the manufacture of the material ordered. The manufacturer shall afford the inspector all reasonable facilities to satisfy him that the material is being furnished in accordance with this specification. All tests (except product analysis) and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

17.2 *For Government Procurement Only*—Except as otherwise specified in the contract, the contractor is responsible for the performance of all inspection and test requirements specified herein. The contractor shall be permitted to use his own or any other suitable facilities for the performance of the inspection and test requirements specified herein, unless disapproved by the purchaser at the time of purchase. The purchaser shall have the right to perform any inspections and tests at the same frequency as set forth in this specification, where such inspections are deemed necessary to ensure that material conforms to prescribed requirements.

### **18. Rejection**

18.1 Unless otherwise specified, any rejection based on tests made in accordance with 6.2 shall be reported to the manufacturer within five working days from the receipt of samples by the purchaser.

18.2 Material that shows injurious defects subsequent to its acceptance at the manufacturer's works shall be rejected, and the manufacturer shall be notified.

### **19. Rehearing**

19.1 Samples tested in accordance with 6.2 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 tests, the manufacturer shall have the right to make claim for a rehearing within that time.

### **20. Marking**

20.1 When loaded for mill shipment, bars shall be properly separated and tagged with the manufacturer's heat or test identification number.

20.2 Each manufacturer shall identify the symbols of their marking system.

20.3 All bars produced to this specification, except plain round bars which shall be tagged, shall be identified by a





distinguishing set of marks legibly rolled onto the surface of one side of the bar to denote in the following order:

20.3.1 *Point of Origin*—Letter or symbol established as the manufacturer's mill designation.

20.3.2 *Size Designation*—Arabic number corresponding to bar designation number of [Table 1](#).

20.3.3 *Type of Steel*—Letter CS indicating that the bar was produced to this specification.

20.3.4 *Minimum Yield Designation*—For Grade 100 [690] bars, either the number 100 [6] or three continuous longitudinal lines through at least five spaces offset each direction from the center of the bar. For Grade 120 [830] bars, either the number 120 [8] or four continuous longitudinal lines through at least five spaces offset each direction from the center of the bar.

20.3.5 It shall be permissible to substitute: a metric size bar for the corresponding inch-pound size bar.

## 21. Packaging and Package Marking

21.1 Packaging, marking, and loading for shipment shall be in accordance with Practices [A700](#).

21.2 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 with [Fed. Std. No. 123](#) for civil agencies.

## 22. Keywords

22.1 concrete reinforcement; deformations (protrusions); low-carbon, chromium steel bars

## SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this standard since the last issue (A1035/A1035M – 09) that may impact the use of this standard. (Approved Sept. 1, 2011.)

(I) Added Footnote 2.

*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](mailto:service@astm.org) (e-mail); or through the ASTM website ([www.astm.org](http://www.astm.org)). Permission rights to photocopy the standard may also be secured from the ASTM website ([www.astm.org](http://www.astm.org)/COPYRIGHT/).*