

Designation: A996/A996M – 16

Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement¹

This standard is issued under the fixed designation A996/A996M; 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 rail-steel and axle-steel bars for concrete reinforcement. Three types of product are included, designated with a "rail symbol," and an "R" for bars made of rail-steel and with an "A" for bars made of axle-steel. The standard sizes and dimensions of deformed bars and their number designations are given in Table 1. All sizes and grades of all types may not be readily available; manufacturers should be consulted to verify availability.

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

1.3 Type "rail symbol" and Type R are of two minimum yield strength levels, namely 50 000 psi [350 MPa] and 60 000 psi [420 MPa] designated as Grade 50 [350] and Grade 60 [420], respectively. Type A is of two minimum yield levels, namely 40 000 psi [280 MPa] and 60 000 psi [420 MPa] designated as Grade 40 [280] and Grade 60 [420], respectively.

1.4 The weldability of the steel is not a requirement of this specification.

1.5 This specification is applicable for orders in either inch-pound units (Specification A996) or SI units (Specification A996M).

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 must be used independently of the other. Combining values from the two systems may result in nonconformance with the specification.

1.7 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:²
- A370 Test Methods and Definitions for Mechanical Testing of Steel Products
- A700 Guide 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
- E290 Test Methods for Bend Testing of Material for Ductility
- 2.2 Military Standard:³
- MIL-STD-129 Marking for Shipment and Storage
- 2.3 Federal Standard:³
- 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 transverse 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 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 *rib*, *n*—longitudinal protrusion on a deformed bar.

4. Ordering Information

4.1 Orders for rail-steel or axle-steel reinforcing bars under this specification shall contain the following information:

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.

³ Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, http://www.dodssp.daps.mil.

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

	Nominal	Nominal Dimensions ^A			Deformation Requirements, in. [mm]		
Bar Designation No. ^{<i>B</i>}	Weight, lb/ft [Nominal Mass, kg/m]	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]

^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. ^B 9 [29] – 11 [36] axle-steel bars only.

4.1.1 Quantity (weight) [mass],

4.1.2 Type "rail symbol" or Type R for rail steel, or Type A for axle steel,

4.1.3 Bar designation number (size),

4.1.4 Grade (see Table 2),

4.1.5 Requirements for inspection (16.1),

4.1.6 Packaging (see Section 20), and

4.1.7 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 Carbon range for each lot of bars (6.2), and

4.2.2 Other special requirements, if any.

5. Materials and Manufacture

5.1 The bars shall be rolled from standard section Tee rails or from carbon steel axles for railway cars and locomotives. No other materials, such as those known by the terms "rerolled, rail-steel equivalent, and rail-steel quality" shall be substituted.

6. Carbon Determination

6.1 The chemical analysis of the material, as described below, shall be determined in accordance with Test Methods, Practices, and Terminology A751. For axle-steel product, the manufacturer shall make a determination for the carbon content of each axle received for manufacture into reinforcing bars. Based on these carbon determinations, all steel axles shall be

TABLE 2 Tensile	Requirements
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	Grade 40 [280]	Grade 50 [350]		Grade 60 [420]	
Tensile strength, min, psi [MPa]	70 000 [500]	80 000 [550]		90 000 [620]	
Yield strength, min, psi [MPa]	40 000 [280]	50 000 [350]		60 000 [420]	
		Rail		Rail	
Туре	Α	Symbol	А	Symbol	
		and R		and R	
Elongation in 8 in. [20	00				
mm], min, %					
Bar Designation no.					
3 [10]	11	6	8	6	
4, 5, 6 [13, 16, 19]	12	7	8	6	
7 [22]	11	6	8	5	
8 [25]	10	5	7	4.5	
9, 10, 11 [29, 32, 3	6]		7		

stocked for subsequent rolling in separated lots by carbon range. The ranges of carbon shall be determined by the manufacturer as those best suited to meet the mechanical requirements.

6.2 When requested by the purchaser, the manufacturer shall report the carbon range for each lot of bars furnished.

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 from those on the opposite side. Where the line of deformations is over 70° , 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 the 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. Furthermore, the summation of gaps shall not exceed 25 % of the nominal permeter 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 on 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 1) tested that typical deformation height, gap, or spacing does 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 and 14.1, the term "lot" shall mean all the bars of one bar number 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 gage of the tensile 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 A370.

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.

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

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.

TABLE 3	Bend	Test	Req	uirements
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	Pin Diameter for Bend Test ^A			
Bar Designation Nos.	Type Rail Symbol	Type R	Type A	
3, 4, 5 [10, 13, 16]	6 <i>d^B</i>	3½ d	3½ d	
6, 7, 8 [19, 22, 25]	6 <i>d</i>	5 <i>d</i>	5 <i>d</i>	
9, 10, 11 [29, 32, 36]			7 <i>d</i>	

^A Test bends 180°.

 B d = nominal diameter of specimen.

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

10.3 It shall be permissible to use other methods of bend testing 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, retest 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.

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, dimensions, cross-sectional area, and tensile properties of a hand wire brushed test are not less than 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, slivers, cooling or casting cracks, and mill or guide marks.

13. Test Specimens

13.1 All mechanical tests shall be conducted in accordance with Test Methods and Definitions A370. In case of any conflict between the requirements in this specification and the requirements of Test Methods and Definitions A370, the requirements in this specification shall prevail

13.2 Tension test specimens shall be the full section of bar as rolled. Unit stress determinations for yield and tensile strength shall be based on the nominal bar area.

13.2.1 Tension test specimens shall be long enough to provide for an 8-in. [200-mm] gage length, a distance of at least two bar diameters between each gage mark and the grips.

Note 2—It is recommended that sufficient additional length of the test specimen be provided to fill the grips completely, leaving some excess length protruding beyond each grip. The grips should be shimmed so that no more than $\frac{1}{2}$ in. [13 mm] of a grip protrudes from the head of the tensile testing machine.

13.2.2 *Gage Marks*—The 8-in. [200-mm] gage length shall be marked on the specimen using a preset 8-in. [200-mm] punch or, alternately, may be punch marked every 2 in. [50 mm] along the 8-in. [200-mm] gage length, on one of the longitudinal ribs, if present, or in the clear spaces between

transverse deformations. Punch marks shall not be placed on a transverse deformation.

Note 3—Light punch marks are desirable because deep marks severely indent the bar and may affect the results.

13.3 Bend-test specimens shall be the full section of the bar as rolled.

14. Number of Tests

14.1 For all bar sizes, one tension test, one bend test, and one set of dimensional property tests including bar weight [mass] and spacing, height, and gap of deformations shall be made from each lot (Note 1) of 10 tons [9 mg], or fraction thereof.

15. Retests

15.1 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 strength, or within two percentage points 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.

15.2 If a bend test fails for reasons other than mechanical reasons or flaws in the specimen as described in 15.4.2 and 15.4.3, 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 $60^{\circ}F$ [$16^{\circ}C$].

15.3 If a weight [mass] test fails for reasons other than flaws in the specimen as described in 15.4.3, a retest shall be permitted on two random specimens from the same lot. Both retest specimens shall meet the requirements of this specification.

15.4 If the original test or any of the random retests fails because of any reasons listed in 15.4.1, 15.4.2, or 15.4.3, the test shall be considered an invalid test:

15.4.1 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 4—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.

15.4.2 Mechanical reasons such as failure of testing equipment or improper specimen preparation,

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

15.5 The original results from sections 15.4.1, 15.4.2, or 15.4.3 shall be discarded and the test shall be repeated on a new specimen from the same lot.

16. Inspection

16.1 Inspection of the reinforcing bars shall be agreed upon between the purchaser and the manufacturer as part of the purchase order or contract.

17. Rejection

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

18. Test Reports

18.1 The following information shall be reported on a per lot basis. It shall be permissible to report additional items as requested or desired.

18.1.1 Carbon level—Type A only.

18.1.2 Tensile properties.

18.1.3 Bend test results.

18.2 A Material Test Report, Certificate of Inspection, or similar document printed from or used in electronic form from an electronic data interchange (EDI) transmission shall be regarded as having the same validity as a counterpart printed in the certifier's facility. The content of the EDI transmitted document must meet the requirements of the invoked ASTM standard(s) and conform to any EDI agreement between the purchaser and the supplier. Notwithstanding the absence of a signature, the organization submitting the EDI transmission is responsible for the content of the report.

NOTE 5—The industry definition invoked here is: EDI is the computer to computer exchange of business information in a standard format such as ANSI ASC X12.

19. Marking

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

19.2 Each manufacturer shall identify the symbols of his marking system.

19.3 All bars produced to this specification 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.

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

19.3.2 *Size Designation*—Arabic number corresponding to Bar Designation Number in Table 1.

19.3.3 *Type of Steel*—Rail symbol, letter R or letter A indicating that the bar was produced from rail or axle steel.

19.3.4 *Minimum Yield Designation*—For Grade 60 [420] bars, either the number 60 [4] or a single continuous line through at least five spaces offset from the center of the bar (No marking designation for Grade 50 [350] or Grade 40 [280] bars).

19.3.5 It shall be permissible to substitute bars having sizes and grades in SI units for bars ordered to the corresponding sizes and grades in inch-pound units.

20. Packaging and Package Marking

20.1 Packaging, marking, and loading for shipment shall be in accordance with Practices A700.

20.2 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

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the contract or order, shall be in accordance with MIL-STD-129 for military agencies and with Fed. Std. No. 123 for civil agencies.

21. Keywords

21.1 concrete reinforcement; deformations (protrusions); steel bars

SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this standard since the last issue (A996/A996M - 15) that may impact the use of this standard. (Approved Jan. 15, 2016.)

(1) Revised Sections 4 and 16.

Committee A01 has identified the location of selected changes to this standard since the last issue (A996/A996M - 14a) that may impact the use of this standard. (Approved July 1, 2015.)

(1) Revised 3.1, 3.1.1, and 3.1.2.1.	(4) Revised Section 13.
(2) Revised Section 18.	(5) Revised Section 4.
(3) Revised 2.1 and Section 10.	

Committee A01 has identified the location of selected changes to this standard since the last issue (A996/A996M - 14) that may impact the use of this standard. (Approved Oct. 1, 2014.)

(1) Added information for axle-steel bars, Type A, bar sizes Nos. 9, 10, and 11 [29, 32, and 36] to Tables 1-3.

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