

Designation: A881/A881M - 16a

Standard Specification for Steel Wire, Indented, Low-Relaxation for Prestressed Concrete¹

This standard is issued under the fixed designation A881/A881M; 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 indented, low-relaxation steel wire for use in prestressed concrete.

1.2 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.

2. Referenced Documents

- 2.1 ASTM Standards:²
- A370 Test Methods and Definitions for Mechanical Testing of Steel Products
- A421/A421M Specification for Stress-Relieved Steel Wire for Prestressed Concrete
- A700 Guide for Packaging, Marking, and Loading Methods for Steel Products for Shipment
- 2.2 U.S. Military Standard:³
- MIL-STD-129 Marking for Shipment and Storage
- 2.3 U.S. 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 *indented steel wire, n*—indented, cold-drawn, low-relaxation wire, the wire surface having indentations that reduce longitudinal movement of the wire while also providing consistent prestress transfer length.

3.1.2 *low-relaxation wire, n*—straightened wire that receives a suitable continuous thermo-mechanical treatment as the last operation to produce the properties listed.

4. Ordering Information

4.1 Orders for indented low-relaxation steel wire for prestressed concrete shall include the following necessary information:

- 4.1.1 Quantity (weight [mass]),
- 4.1.2 Required minimum tensile strength (6.2),
- 4.1.3 Nominal diameter (6.1),
- 4.1.4 Packaging, and
- 4.1.5 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 Indentation geometry (7.2, 7.3),
- 4.2.2 Indentation sidewall angle (7.3, 7.4),

4.2.3 Welding of rod prior to cold drawing permissible (9.3),

- 4.2.4 Outside inspection (11.1),
- 4.2.5 Special packaging (14.1, 14.2), and
- 4.2.6 Other special requirements, if any.

5. Materials and Manufacture

5.1 The steel shall be made by any commercially accepted steelmaking process.

5.2 The base metal shall be carbon steel of such quality that when drawn to wire, indented, and then thermo-mechanically treated, shall have the properties and characteristics prescribed in this specification.

6. Mechanical Property Requirements

6.1 *General*—Indented wire shall be supplied in coils, packs, or spools to the specified mechanical properties in Table 1. It shall be permissible to furnish diameters of wire not specifically itemized in this specification, provided that the strength is defined and they conform otherwise to the requirements of this specification.

6.2 *Tensile Strength*—The minimum tensile strength of the indented wire shall conform to the requirements of Table 1. Other values of tensile strength and nominal diameters can be

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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://dodssp.daps.dla.mil.

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Nor Diar	Nominal Tensile Diameter Strength		nsile ength	Nominal Area ^A		Nominal Weight [Mass], lb/1000 ft [g/m]	
in.	[mm]	lbf	[kN]	in. ²	[mm ²]		
0.198	[5.03]	7230	[32.2]	0.0308	[19.86]	104.8 [155.9]	
0.198	[5.03]	7700	[34.3]	0.0308	[19.86]	104.8 [155.9]	
0.2094	[5.32]	9000	[39.1]	0.0344	[22.23]	117.1 [174.5]	

 $^{\rm A}$ The nominal cross-sectional area is based on the nominal diameter. The actual average area in in.² [mm²] may be calculated by dividing the weight [mass] per linear in. [mm] of the specimen in lb [kg] by 0.2836 (weight of 1 in.³ of steel) [7.850 \times 10⁻⁶ kg/mm³ (mass of 1 mm³ of steel)]. The amount of variation is dependent on the shape and character of the indentations.

specified if shown by test that the strength exceeds that specified. The tension test shall be made in accordance with Test Methods A370.

6.3 *Load at 1 % Extension*—The load at 1 % extension shall be at least 90 % of the minimum specified tensile strength when tested in accordance with Test Methods A370.

6.4 *Elongation*—The percent elongation after fracture on a 10-in. [250-mm] gage length shall be 3.0 % minimum.

6.5 *Bend Test*—A 90 degree bend test (see Fig. 1) around a pin six times the nominal diameter of the wire shall be performed once per coil/pack/spool for each row of indentations, with the centerline of the row of indentations located at the outside of the bend. The wire shall be bent at a

uniform rate, with the duration of test to be between 10 and 30 seconds. The bend location along the axis of the wire specimen shall be random and three locations shall be tested along the specimen, for a total of nine bends per test. Each bend shall be inspected after testing to ensure no cracking or fracturing occurred.

6.6 *Relaxation*—Relaxation properties shall be provided at least annually from records of tests on finished wire. Additional relaxation tests shall be conducted if there is a change in raw rod supply or type. Tests to satisfy this requirement shall comply with the conditions of Supplementary Requirement S1 of Specification A421/A421M. The relaxation losses are not to exceed 3.5 % after 1000 hours when tested at an initial load of 80 % of minimum tensile strength.

7. Requirements for Indentations

7.1 *Indentations*—Indentations shall be in three lines spaced uniformly around the wire with one line of indentations inclined in the opposite direction to the other two. The indentations shall be placed in respect to the axis of the wire so that the included angle is not less than 45° , as shown in Fig. 2. Pitch and shape shall be consistent , with not more than 10 % being malformed in any 2 ft [600 mm] length of wire, judged visually. Criteria for what constitutes a malformed indentation shall be mutually agreed upon between manufacturer and purchaser as required.



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Section taken longitudinally across indentation showing indentation sidewall angle. (A)

FIG. 2 Acceptable Type of Indented Wire

7.2 *Type*—Two acceptable types of indented wire are shown in Fig. 2(a) and (b), with dimensions in Table 2.

7.3 *Options*—Other types of indented wire are permitted by agreement, provided the wire is comparable with the accepted types in mechanical properties and bond with concrete.

7.4 Indentation Sidewall Angle—The manufacturer and purchaser shall agree upon minimum and maximum indentation sidewall angles (as shown in Fig. 2). The manufacturer shall demonstrate process controls to meet mutually agreed upon requirements.

Note 1—Shallow indentation sidewall angles can impart excessive radial forces into the concrete. Similarly, angles that are too steep can reduce transfer length to the point of creating excessive bond demand on the concrete. Depth of indentation, concrete properties at release of prestress, and wire surface condition are other factors to take into consideration when determining min/max allowable indentation sidewall angles

8. Permissible Variation in Dimensions

8.1 The diameter as determined by weight [mass] of the indented wire shall not vary from the nominal diameter by more than ± 0.003 in. [± 0.08 mm]. Diameter as determined by weight [mass] shall be calculated using the weight [mass] of any given length of wire and densities provided in footnote of Table 1.

8.2 The indented wire shall not be out-of-round by more than 0.003 in. [0.08 mm]. Measure out-of-round using a depth gauge by placing the wire on a flat surface and checking maximum/minimum diameters at the same cross section. Out-of-round is the difference between maximum and minimum diameters measured.

9. Workmanship, Finish, and Appearance

9.1 The wire shall be free of kinks, tight curls, twists, or sharp bends.

9.2 The wire shall be furnished in firmly tied coils, packs, or spools and packaged in such a way to prevent rubbing or collapse during shipment. Each coil, pack, or spool shall be of one continuous length.

9.3 There shall be no welds or joints in the finished wire, unless the manufacturer and purchaser mutually agree on a welding process done on wire rod prior to any cold drawing that results in wire properties that are consistent with the intended use. Any welds or joints made after the initial drawing process shall be removed.

9.4 *Cast (Curvature)*—The curvature of the wire shall be 3 in. [75 mm] maximum offset on a chord 6 ft [1.8 m] long.

9.5 The wire shall not be oiled or greased and must be essentially free of residual wire-drawing lubricants. Slight rusting, providing it is not sufficient to cause pits visible to a person with normal or corrected vision, shall not be cause for rejection.

10. Sampling

10.1 Unless otherwise agreed upon between the manufacturer and the purchaser, test specimens shall be taken from each coil, pack, or spool in a lot (see Note 2) and tested to determine compliance with 6.2 - 6.5 and Sections 7, 8, and 9.

Note 2—The term "lot" means all the coils, packs, or spools of wire of the same nominal wire diameter contained in an individual shipping release or shipping order.

TABLE 2 Dimensions of Indentations

NOTE 1—Indentation sidewall angle shall be measured along the centerline axis of the wire through the center of indentation. Leading and trailing sidewall angles shall be calculated using measured horizontal distances and indentation depths.

Note 2—Depth of indentation shall be the average depth of six or more random indentations measured at maximum depth.

Nominal Wire Diameter,		Depth, a, in. [mm]	Depth, a, in. [mm] Nominal Length, L,		Nominal Pitch, P,	
in.	[mm]		in.	[mm]	in.	[mm]
0.198	[5.03]	0.005 + 0.001, -0.002 [0.13 + 0.02, -0.05]	0.138 ± 0.02	[3.5 ± 0.5]	0.217 ± 0.02	[5.5 ± 0.5]
0.2094	[5.32]	0.0045 ± 0.0014 [0.115 ± 0.035]	0.138 ± 0.02	$[3.5 \pm 0.5]$	0.215 ± 0.011	[5.46 ± 0.29]



11. Inspection

11.1 The purchaser shall state, at the time of order, whether outside inspection is required. If outside inspection is required, the manufacturer shall afford the inspector representing the purchaser all reasonable facilities to satisfy him that the material is being furnished in accordance with this specification. All tests and inspections shall be made at the place of manufacture prior to shipment, unless otherwise agreed upon at the time of purchase, and shall be so conducted without unnecessarily interfering with manufacturing operations.

12. Rejection

12.1 In case a test specimen fails to meet any requirement of this specification, two additional tests shall be made on specimens of wire from the same coil, pack, or spool and if failure occurs in either of these tests, the coil/pack/spool shall be rejected.

12.2 Unless otherwise specified, any rejection based on tests made in accordance with this specification shall be reported to the manufacturer within a reasonable length of time.

13. Certification

13.1 When specified in the purchase order or contract, the manufacturer's certification shall be furnished to the purchaser stating that specimens representing each lot have been manufactured, tested, and inspected in accordance with this specification and the requirements have been met. The certification shall include the specification number, year-date of issue, and revision letter, if any. A report of the test results shall be furnished.

13.2 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 shall meet the requirements of the invoked ASTM standard(s) and conform to any existing EDI agreement between the purchaser and the manufacturer. Notwithstanding the absence of a signature, the organization submitting the EDI transmission is responsible for the content of the report.

Note 3—The industry definition as invoked here is: EDI is the computer-to-computer exchange of business information in a standard format such as ANSI ASC X12.

14. Packaging and Package Marking

14.1 The nominal diameter of the indented wire, ASTM designation A881 [A881M], and name or mark of the manufacturer shall be marked on a tag securely attached to each bundle of wire.

14.2 When specified in the purchase order or contract, and for direct procurement by or direct shipment to the U.S. Government, material shall be preserved, packaged, and packed in accordance with the requirements of Practices A700. Marking for shipment in addition to requirements specified in the purchase order or contract, shall be in accordance with Fed. Std. No. 123 for civil agencies and MIL-STD-129 for military agencies.

15. Keywords

15.1 indented wire; low-relaxation wire; prestressed concrete; steel wire (tendon)

SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this standard since the last issue (A881/A881M - 16) that may impact the use of this standard. (Approved Dec. 1, 2016.)

(1) Revised Section 4.

Committee A01 has identified the location of selected changes to this standard since the last issue (A881/A881M - 15) that may impact the use of this standard. (Approved March 1, 2016.)

(1) Revised the title, 1.1, and Section 3, and 15.1.

(2) Revised throughout for editorial corrections.

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