Designation: ~~A881/A881M – 16a~~ A881/A881M – 23

Standard Specification for Steel Wire, Indented, Low-Relaxation for Prestressed Concrete[1]

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 text of this specification contains notes or footnotes, or both, that provide explanatory material. Such notes and footnotes do not contain any mandatory information.

1.3 This specification is applicable for orders in either inch-pound units (as Specification A881) or in SI units (as Specification A881M).

1.4 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.

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

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
A1096/A1096M Test Method for Evaluating Bond of Individual Steel Wire, Indented or Plain, for Concrete Reinforcement

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)

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[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://dodssp.daps.dla.mil.

***A Summary of Changes section appears at the end of this standard**

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 *lot, n*—all of the coils, packs, or spools of wire of the same nominal wire diameter contained in an individual shipping release or shipping order.

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

TABLE 1 ~~Tensile Strength Requirements~~

Nominal Diameter		Tensile ~~Strength~~		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]~~

TABLE 1 Mechanical Properties

Nominal Diameter		Minimum Tensile Force		Nominal Area[A]		Nominal Weight [Mass],	Bend Requirements Mandrel Size,		Elongation Requirements	Tensile Strength[B]		Yield Strength[B]	
in.	[mm]	lbf	[kN]	in.^{2}	[mm^2]	lb/1000 ft [g/m]	in.	[mm]	% minimum	ksi	MPa	ksi	MPa
0.198	[5.03]	7230	[32.2]	0.0308	[19.9]	104.8 [155.9]	1.19	[30.2]	3.0	235	1620	211	1460
0.198	[5.03]	7700	[34.3]	0.0308	[19.9]	104.8 [155.9]	1.19	[30.2]	3.0	250	1720	225	1550
0.207	[5.25]	8800	[39.1]	0.0336	[21.65]	114.3 [170.3]	1.24	[31.5]	3.0	260	1790	234	1610
0.209	[5.31]	9000	[40.0]	0.0343	[22.1]	116.7 [173.7]	1.25	[31.9]	3.0	262	1800	236	1620

[A] The nominal cross-sectional area is based on the nominal diameter. The actual average area in in.^{2} [mm^2] 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 × 10^{-6} kg/mm^3 (mass of 1 mm^3 of steel)]. The amount of variation is dependent on the shape and character of the indentations.

[B] Values included for reference only.

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~~10 in. [250 mm] gauge length shall be 3.0 % minimum.

6.5 *Bend Test*—A ~~90 degree~~ 90° 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.~~ 10 s and 30 s. 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 that is visible to a person with normal or corrected vision has 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~~ 1000 h when tested at an initial load of 80 % of minimum tensile ~~strength.~~ strength, or 2.5 % after 1000 h when tested at an initial load of 70 % of minimum tensile strength.

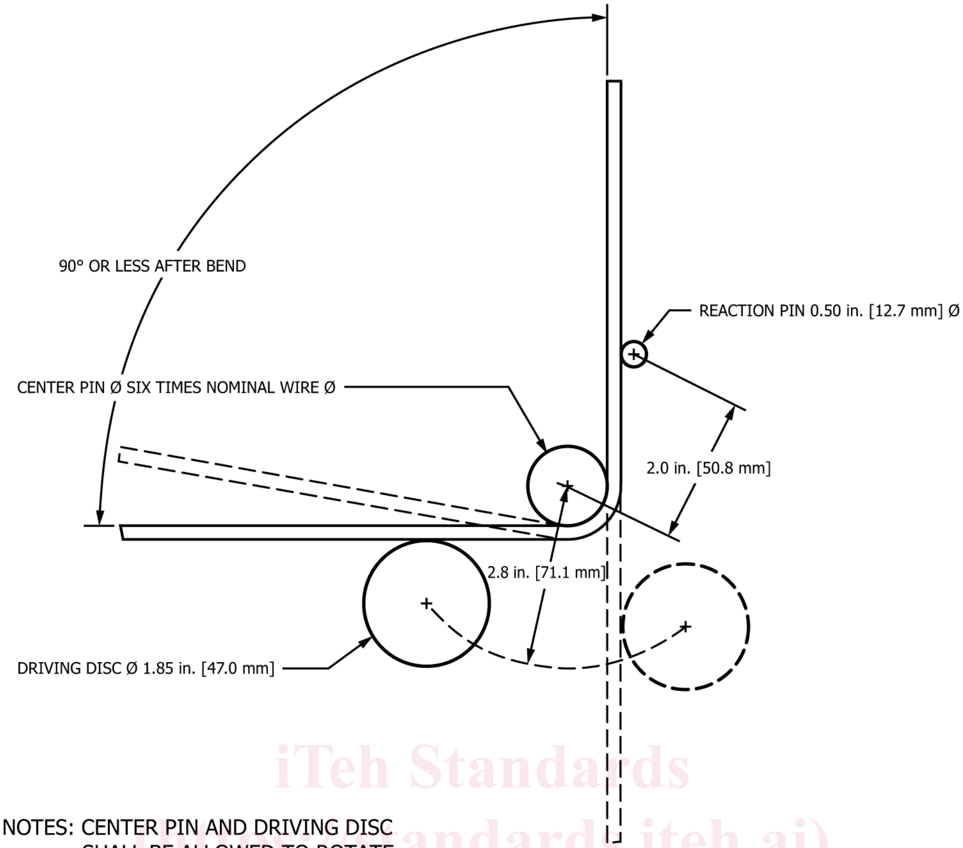
7. Requirements for Indentations

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 ,~~ 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.

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.



NOTES: CENTER PIN AND DRIVING DISC
SHALL BE ALLOWED TO ROTATE
TOLERANCE ON DIMENSIONS SHALL BE +/– 5%

FIG. 1 Bend Test Configuration

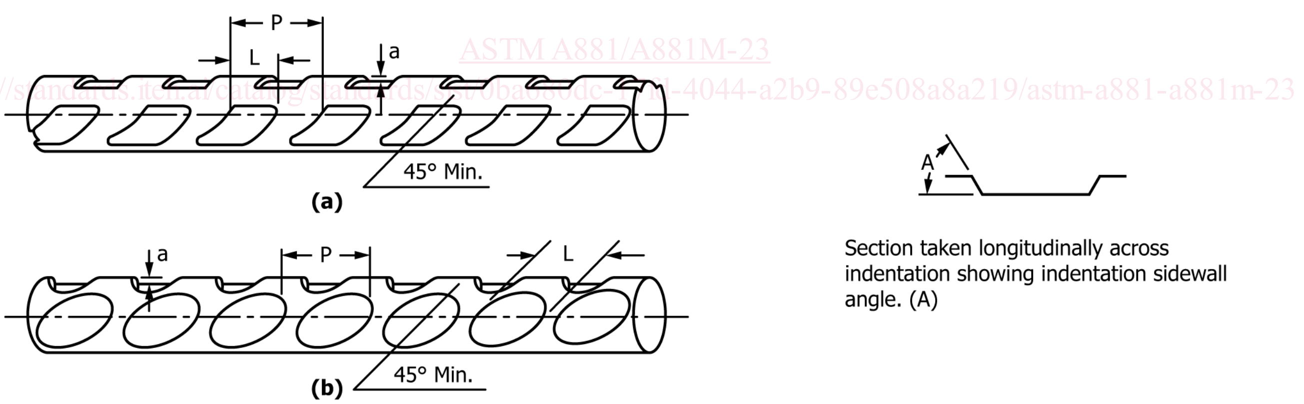


FIG. 2 Acceptable Type of Indented Wire

7.4.1 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.

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

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~~angles. Test Method A1096/A1096M was developed to allow for evaluation of the bond of single prestressing wire and could be utilized.