Designation: A 910/A 910M – 05

Standard Specification for Uncoated, Weldless, 2- and 3-Wire Steel Strand for Prestressed Concrete[1]

This standard is issued under the fixed designation A 910/A 910M; 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 two types and two grades of 2- and 3-wire, uncoated steel strand for use in pretensioned and posttensioned prestressed concrete construction. The two types of strand are low-relaxation and stress-relieved (normal-relaxation). Low-relaxation shall be regarded as the standard type. Stress-relieved (normal-relaxation) strand will not be furnished unless specifically ordered, or by arrangement between purchaser and supplier. The two grades are 1725 (250) and 1860 (270). Grades 250 and 270 have minimum tensile strengths of 1725 MPa (250 ksi) and 1860 MPa (270 ksi) respectively, based on the nominal area of the strand.

1.2 The values stated in either inch-pound units or SI units are to be regarded as the standard. Within the text, the inch-pound units are shown in parentheses. 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:* [2]

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products

E 328 Test Methods for Stress Relaxation Tests for Materials and Structures

2.2 *U.S. Military Standards:*

MIL-STD-129 Marking for Shipment and Storage[3]

MIL-STD-163 Steel Mill Products Preparation for Shipment and Storage[3]

2.3 *Federal Standard:*

Fed. Std. No. 123 Marking for Shipments (Civil Agencies)[3]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *strand*, *n*—all strands shall be comprised of either two wires or three wires helically wound around each other; they shall have a uniform pitch of not less than 12 nor more than 16 times the nominal diameter of the strand.

3.1.2 *Discussion*—The direction of lay may be either right or left hand; however, strands of different lays shall not be spliced together.

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 (meters [feet]),

4.1.2 Diameter of strand (Section 7),

4.1.3 Number of wires (2 or 3),

4.1.4 Grade of strand (see 1.1 and Table 1 and Table 2),

4.1.5 Type of strand (see 1.1 and Table 2),

4.1.6 Packaging (Section 14),

4.1.7 ASTM designation and year of issue, and

4.1.8 Special requirements, if any.

NOTE 1—A typical ordering description is as follows: 100 000 m (325 000 ft) of 6.2 mm (0.244 in.) diameter, three wire, Grade 1860 MPa (270 ksi), low-relaxation strand in 10 000 m (32 500 ft) reelless packs conforming to ASTM A 910/A 910M–XX.

5. Materials and Manufacture

5.1 *Base Metal*—The base metal shall be carbon steel of such quality that when drawn to wire, fabricated into strand and then thermally treated, it shall have the properties and characteristics prescribed in this specification.

5.2 *Wire*—The wire from which the strand is to be fabricated shall be round and have a dry-drawn finish.

NOTE 2—This product is a composite of two or three wires and is produced to mechanical properties only, of which the chemical composition of all wires or any individual wire is not pertinent to this application, and heat identity is not necessarily maintained. It is possible that wire

[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, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

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

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TABLE 1 Breaking Strength Requirements

Description and Diameter of Strand				Breaking Strength of Strand		Steel Area of Strand		Weight of Strand	
in.		mm							
Description	Nominal Diameter	Description	Nominal Diameter	lbf	kN	in.^{2}	mm^2	lbs/1000 ft	kg/1000 m
GRADE 250 (1725 MPa)									
2 × 0.114	0.228	2 × 2.90	5.8	5000	22.2	0.020	13.2	69.9	104.0
3 × 0.089	0.189	3 × 2.25	4.8	4750	21.1	0.019	12.0	63.3	94.2
3 × 0.095	0.205	3 × 2.40	5.2	5250	23.4	0.021	13.6	71.9	107.0
3 × 0.114	0.244	3 × 2.90	6.2	7750	34.5	0.031	19.8	104.0	155.0
3 × 0.118	0.256	3 × 3.00	6.5	8250	36.7	0.033	21.3	112.0	167.0
3 × 0.138	0.295	3 × 3.50	7.5	11 250	50.0	0.045	29.0	153.0	228.0
3 × 0.158	0.340	3 × 4.00	8.6	14 500	64.5	0.058	37.4	200.6	298.4
GRADE 270 (1860 MPa)									
2 × 0.114	0.228	2 × 2.90	5.8	5400	24.0	0.020	13.2	69.9	104.0
3 × 0.089	0.189	3 × 2.25	4.8	5130	22.8	0.019	12.0	63.3	94.2
3 × 0.095	0.205	3 × 2.40	5.2	5670	25.2	0.021	13.6	71.9	107.0
3 × 0.114	0.244	3 × 2.90	6.2	8370	37.2	0.031	19.8	104.0	155.0
3 × 0.118	0.256	3 × 3.00	6.5	8910	39.6	0.033	21.3	112.0	167.0
3 × 0.138	0.295	3 × 3.50	7.5	12 150	54.0	0.045	29.0	153.0	228.0
3 × 0.158	0.340	3 × 4.00	8.6	15 660	69.7	0.058	37.4	200.6	298.4

TABLE 2 Yield Strength Requirements

Description and Diameter of Strand				Initial Load		Minimum Load at 1 % Extension			
in.		mm				Stress-Relieved (Normal Relaxation)		Low Relaxation	
Description	Nominal Diameter	Description	Nominal Diameter	lbf	kN	lbf	kN	lbf	kN
GRADE 250 (1725 MPa)									
2 × 0.114	0.228	2 × 2.90	5.8	500	2.2	4250	18.9	4500	20.0
3 × 0.089	0.189	3 × 2.25	4.8	475	2.1	4038	18.0	4275	19.0
3 × 0.095	0.205	3 × 2.40	5.2	525	2.3	4463	20.0	4725	21.0
3 × 0.114	0.244	3 × 2.90	6.2	775	3.5	6588	29.3	6975	31.0
3 × 0.118	0.256	3 × 3.00	6.5	825	3.7	7013	32.2	7425	33.0
3 × 0.138	0.295	3 × 3.50	7.5	1250	5.0	9563	42.5	10 125	45.0
3 × 0.158	0.340	3 × 4.00	8.5	1450	6.5	12 325	54.8	13 050	11.7
GRADE 270 (1860 MPa)									
2 × 0.114	0.228	2 × 2.90	5.8	540	2.4	4590	20.4	4860	21.6
3 × 0.089	0.189	3 × 2.25	4.8	513	2.3	4360	19.4	4617	20.5
3 × 0.095	0.205	3 × 2.40	5.2	567	2.5	4820	21.4	5103	22.7
3 × 0.114	0.244	3 × 2.90	6.2	837	3.7	7115	31.6	7533	33.5
3 × 0.118	0.256	3 × 3.00	6.5	891	4.0	7574	33.7	8019	36.0
3 × 0.138	0.295	3 × 3.50	7.5	125	5.4	10 328	45.9	10 125	45.0
3 × 0.158	0.340	3 × 4.00	8.6	566	7.0	13 311	59.2	14 094	62.7

from more than one heat may be used in the manufacture of a reel or pack. Traceability is based on pack identity as maintained and reported by the manufacturer.

5.3 *Treatment*—After stranding, low-relaxation strand shall be subjected to a continuous thermo-mechanical treatment to produce the prescribed mechanical properties. For stress-relieved (normal-relaxation) strand, only thermal treatment is necessary. Temper colors that result from the stress-relieving operation are considered normal for the finished appearance of this strand.

6. Mechanical Properties

6.1 Methods of testing for mechanical properties are in Annex A7 of Test Methods and Definitions A 370. Low-relaxation strand shall also be tested as prescribed in Methods E 328.

6.2 *Breaking Strength*—The breaking strength of the finished strand shall conform to the requirements prescribed in Table 1.

6.3 *Yield Strength*—Yield strength in kN (lbs) shall be measured at 1 % extension under load. The minimum yield strength shall be 90 % for low-relaxation strand and 85 % for stress-relieved (normal relaxation) strand of the breaking strength listed in Table 1. Initial loads for the test and minimum yield strengths are listed in Table 2.

6.4 *Elongation*—The total elongation under load shall not be less than 3.5 %. It shall be permissable to determine the total elongation value by adding to the 1.0 % yield extension the percent extension or movement between the jaws gripping the strand after yield determination. The percent is calculated on the new base length of jaw-to-jaw distance.

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6.5 *Relaxation Properties*—Low-relaxation strand shall have relaxation losses of not more than 2.5 % when initially loaded to 70 % of specified minimum breaking strength or not more than 3.5 % when loaded to 80 % of specified minimum breaking strength of the strand after 1000 h tested under conditions listed in 6.5.1 through 6.5.7.

6.5.1 If required, relaxation evidence shall be provided from the manufacturer's records of tests on similarly dimensioned strand of the same grade.

6.5.2 The temperature of the test specimen shall be maintained at 20 ± 2°C (68 ± 3.5°F).

6.5.3 The test specimen shall not be subjected to loading prior to the relaxation test.

6.5.4 The initial load shall be applied uniformly over a period of not less than 3 min and not more than 5 min and the gage length shall be maintained constant; load-relaxation readings shall commence 1 min after application of the total load.

6.5.5 Overstressing of the test specimen during the loading operation shall not be permitted.

6.5.6 The duration of the test shall be 1000 h or a shorter computed period extrapolated to 1000 h that can be shown by records to provide similar relaxation values.

6.5.7 The test gage length shall be at least 60 times the nominal diameter of the strand. If this gage length exceeds the capacity of the extensometer or the testing machine, then it is permitted to substitute a minimum gage length of 40 times the nominal diameter of the strand.

7. Dimensions and Permissible Variations

7.1 The size of the finished strand shall be expressed as the diameter of the strand as decimal fraction of an inch.

7.2 Variations in individual wire diameters shall not be cause for rejection provided that the other requirements of this specification are met.

7.3 *Specially-Dimensioned Strand*:

7.3.1 It shall be permitted to furnish, under this specification, strands with nominal diameters that are different than those listed in Table 1 and Table 2. The breaking strength shall be defined, and the yield strength, as defined in 6.3, shall not be less than 90 % and 85 % of the specified minimum breaking strength for low-relaxation and stress-relieved (normal-relaxation) strand, respectively. All other requirements shall apply.

7.4 *Permissible Variations in Diameter*:

7.4.1 All Grade 1725 (250) strand shall conform to a size tolerance of ±0.41 mm (±0.016 in.) from the diameter measured across the crowns of the wires (2-wire strand only). For 3-wire strand, the diameter is that diameter of a circle which can be tangentially circumscribed around the 3 wires. This can be confirmed by comparing the individual wire diameters in the strand to those listed in Table 1 and Table 2.

7.4.2 All Grade 1860 (270) strand shall conform to a size tolerance of +0.66 mm, −0.15 mm (+0.026 in., −0.006 in.) from the nominal diameter measured across the crowns of the wires (2-wire strand only). For 3-wire strand, the nominal diameter is that diameter of a circle which can be tangentially circumscribed around the 3 wires. This can be confirmed by comparing the individual wire diameters in the strand to those listed in Table 1 and Table 2.

8. Workmanship, Finish and Appearance

8.1 *Joints*:

8.1.1 There shall be no strand splices in any length of the completed strand.

8.1.2 There shall be no wire welds made in the finished strands. During manufacturing of individual wires for stranding, welding is permitted only prior to or at the size of the last thermal treatment (for example, patenting or control cooling). There shall be no welds in the wire after it has been drawn through the first die in wire drawing.

8.2 The finished strand shall be uniform in diameter and shall be free of imperfections not consistent with good commercial stranding practice.

8.3 When the strand is cut without seizings, the wire shall not fly out of position. If any wire flies out of position and can be replaced by hand, the strand will be considered satisfactory.

8.4 The strand shall not be oiled or greased. Slight rusting, provided it is not sufficient to cause pits visible to the unaided eye, shall not be cause for rejection.

9. Sampling

9.1 Test specimens cut from either end of the strand package are permitted.

10. Number of Tests

10.1 One specimen for test shall be taken from each 18-Mg (20-ton) production lot of finished strand, and tested for breaking strength, yield strength, and elongation.

11. Inspection

11.1 If outside inspection is required, the manufacturer shall afford the inspector representing the purchaser all reasonable facilities to satisfy 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 as not to interfere unnecessarily with the operation of the works.

NOTE 3—The purchaser should state at the time of order whether outside inspection is required or waived.

12. Rejection and Retesting

12.1 Failure of any test specimen to comply with the requirements of the specification shall constitute grounds for rejection of the lot represented by the specimen.

12.2 If any specimen being tested for breaking strength, yield strength, elongation, or stress-relaxation results in values outside the specified limits, two additional tests shall be made on specimens of strand from the same reel. If failure occurs in either of these tests, the strand shall be rejected.

12.3 It shall be permissable to resubmit the lot for inspection by testing a specimen from each reel or pack and sorting out nonconforming material.

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13. Certification

13.1 If outside inspection is waived, a manufacturer's certification that the material has been tested in accordance with and meets the requirements of this specification shall be the basis of acceptance of the material. The certification shall include the specification number, year-date of issue, and revision letter, if any.

13.2 The manufacturer shall, when requested in the order, furnish a representative load-elongation curve for each size and grade of strand shipped.

13.3 When the modulus of elasticity of a 2- or 3-wire strand is provided, the cross-sectional area used to compute the modulus shall also be provided. The area provided in the certification shall be the area used to calculate the modulus of elasticity.

13.4 A material test report, certification or 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 existing 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 4—The industry definition for EDI, as invoked here, is: "The computer-to-computer exchange of business information in a standards format, such as ANSI ASC X12."

14. Packaging and Marking

14.1 The strand shall be furnished on reels or in reelless packs having a minimum core diameter of 600 mm (24 in.), unless otherwise specified by the purchaser. Lengths on reels or in reelless packs shall be as agreed upon at the time of purchase. Each reel or reelless pack shall have two strong tags securely fastened to it showing the length, size, type and grade, ASTM designation, and the name or mark of the manufacturer. One tag shall be positioned where it will not be inadvertently lost during transit, such as the core of a reelless pack. The other should be on the outside where it will be accessible for easy identification.

14.2 *For Government Procurement Only*—When specified in the contract or order, 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 MIL-STD-163. The applicable levels shall be as specified in the contract. Marking for shipment of such material shall be in accordance with Fed. Std. No. 123 for civil agencies and MIL-STD-129 for military agencies.

15. Keywords

15.1 prestressed concrete; steel wire; strand (tendons)

SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this standard since the last issue (A 910/A 910M – 99) that may impact the use of this standard.

(1) Revised sections 4.1, 5.3, 6.3, 6.4, 6.5.2, 6.5.3, 6.5.5, 6.5.7, 7.3.1, 9.1, 12.2, 12.3, and Note 2.

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