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American Association State
Highway and Transportation Officials Standard
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Standard Specification for Uncoated Stress-Relieved Steel Wire for Prestressed Concrete¹

This standard is issued under the fixed designation A421/A421M; 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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope*

1.1 This specification covers two types of uncoated stress-relieved round high-carbon steel wire commonly used in prestressed linear concrete construction, as follows:

1.1.1 *Type BA* wire is used for applications in which cold-end deformation is used for anchoring purposes (Button Anchorage), and

1.1.2 *Type WA* wire is used for application in which the ends are anchored by wedges, and no cold-end deformation of the wire is involved (Wedge Anchorage).

1.2 Supplement I describes low relaxation wire and relaxation testing for that product.

1.3 The values stated in either inch-pound or SI units are to be regarded separately as standard. Within the text, the inch-pound units are shown in parentheses. 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 standard.

2. Referenced Documents

2.1 ASTM Standards:²

A370 Test Methods and Definitions for Mechanical Testing of Steel Products

E30 Test Methods for Chemical Analysis of Steel, Cast Iron, Open-Hearth Iron, and Wrought Iron³

E328 Test Methods for Stress Relaxation for Materials and Structures

2.2 Military Standards:⁴

MIL-STD-129 Marking for Shipment and Storage

MIL-STD-163 Steel Mill Products, Preparation for Shipment and Storage

2.3 *Federal Standard:*⁴

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

3. Ordering Information

3.1 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:

3.1.1 Quantity (kg [lb]),

3.1.2 Diameter,

3.1.3 Type of anchorage (BA or WA),

3.1.4 Packaging,

3.1.5 ASTM designation and date of issue, and

3.1.6 Special requirements, if any.

NOTE 1—A typical ordering description is as follows: 10 000 kg of 6.35-mm diameter wire, Type BA in approximately 450 kg 1.5-m diameter coils to ASTM A421/A421M—_____(22 000 lb 0.250-in. diameter wire, Type BA in approximately 1000 lb 60-in. diameter coils to ASTM A421/A421M—_____.)

4. Manufacture

4.1 *Process*—The steel shall be made by the basic-oxygen, open-hearth, or electric-furnace process.

4.2 *Internal Soundness*—A sufficient discard shall be made to ensure freedom from injurious piping and undue segregation.

4.3 *Wire*—The wire shall be cold-drawn to size and suitably stress relieved after cold drawing by a continuous heat treatment to produce the prescribed mechanical properties.

5. Physical Requirements

5.1 *Tensile Strength*—The tensile strength of Type BA wire and Type WA wire shall conform to the requirements prescribed in **Table 1**, and shall be determined as prescribed in Test Methods and Definitions **A370**, including Annex A4.

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 Withdrawn. The last approved version of this historical standard is referenced on www.astm.org.

⁴ 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.

**TABLE 1 Tensile Strength Requirements**

Nominal Diameter, mm (in.)	Tensile Strength, min, MPa (psi)	
	Type BA	Type WA
4.88 (0.192)	^A	1725 (250 000)
4.98 (0.196)	1655 (240 000)	1725 (250 000)
6.35 (0.250)	1655 (240 000)	1655 (240 000)
7.01 (0.276)	1620 (235 000)	1620 (235 000)

^AThis size is not commonly furnished in Type BA wire.

5.2 Yield Strength:

5.2.1 The minimum yield strength for all wire, measured by the 1.0 % extension under load method, shall not be less than 85 % of the specified minimum breaking strength.

5.2.2 The extension under load shall be measured by an extensometer calibrated with the smallest division not larger than 0.0001 mm/mm (0.0001 in./in.) of gage length.

5.2.3 The initial load corresponding to the initial stress prescribed in **Table 2** shall be applied to the specimen, at which time the extensometer is attached and adjusted to a reading of 0.001 mm/mm (0.001 in./in.) of gage length. The load shall then be increased until the extensometer indicates an extension of 1 %. The load for this extension shall be recorded. The stress corresponding to this load shall meet the requirements for stress at 1 % extension prescribed in **Table 2**.

5.3 *Elongation*—The total elongation under load of all wire shall not be less than 4.0 % when measured in a gage length of 250 mm (10 in.). The elongation shall be determined by an extensometer which is placed on the test specimen after a load corresponding to the initial stress prescribed in **Table 2** is applied. If the fracture takes place outside of the gage length and the elongation so measured meets the minimum requirements, no further testing shall be required. If the elongation is less than the minimum requirements, the test shall be considered an invalid test and a retest made.

6. Diameter and Permissible Variations

6.1 Wire meeting the requirements of this specification is normally ordered in the diameters shown in **Table 1**.

6.2 The diameter of the wire shall not vary from the nominal diameter specified by more than ± 0.05 mm (0.002 in.).

6.3 The wire shall not be out-of-round by more than 0.05 mm (0.002 in.).

7. Workmanship and Finish

7.1 *Cast*—A wire sample having a chord length of 1524 mm (60 in.) shall have an offset at the center of the chord of not more than 76 mm (3 in.). This is equivalent to a chord of an arc of a circle not less than 7.6 m (25 ft) in diameter.

TABLE 2 Yield Strength Requirements

Nominal Diameter, mm (in.)	Initial Stress, MPa (psi)	Minimum Stress at 1 % Extension, MPa (psi)	
		Type BA	Type WA
4.88 (0.192)	200 (29 000)	^A	1465 (212 500)
4.98 (0.196)	200 (29 000)	1407 (204 000)	1465 (212 500)
6.35 (0.250)	200 (29 000)	1407 (204 000)	1407 (204 000)
7.01 (0.276)	200 (29 000)	1377 (199 750)	1377 (199 750)

^AThis size is not commonly furnished in Type BA wire.

7.2 *Type BA Wire*—Type BA wire shall be of suitable quality to permit cold forming of buttons for anchorage. Splitting shall not be considered a cause for rejection if the button anchorage is capable of developing the minimum required tensile strength of the wire.

7.3 The wire shall be free of kinks.

7.4 The wire shall be furnished in firmly tied coils having a minimum inside diameter of 1219 mm (48 in.). Each coil shall be of one continuous length.

7.5 There shall be no welds or joints in the finished wire. Any welds or joints made during manufacture to promote continuity of operations shall be removed.

7.6 The wire shall not be oiled or greased. Slight rusting, provided it is not sufficient to cause pits visible to the naked eye, shall not be cause for rejection.

7.7 Temper colors which result from the stress-relieving operation are considered normal for the finished appearance of this strand.

8. Chemical Requirements

8.1 Variations in manufacturing processes and equipment among wire manufacturers necessitate the individual selection of an appropriate chemical composition at the discretion of the manufacturer.

8.2 Phosphorus and sulfur values shall not exceed the following:

Phosphorus	0.040%
Sulfur	0.050%

8.3 The purchaser shall have the right to make an analysis from finished wire representing each heat of steel. Samples for analysis shall be obtained by milling the wire in such a manner as to obtain a sample representative of the entire cross section. Prior to milling, the surface shall be cleaned to remove all foreign matter. All such individual determinations shall not vary from the limits shown in **8.2** by more than 0.008 %.

8.4 For referee purposes, Methods **E30** shall be applied.

9. Sampling

9.1 Unless otherwise agreed upon between the manufacturer and the purchaser, one test specimen shall be taken from each 10 coils or less in a lot (**Note 2**) and tested to determine compliance with **5.1**, **5.2**, **5.3**, **6**, and **7.1**.

NOTE 2—The term “lot” means all the coils of wire of the same nominal wire size contained in an individual shipping release or shipping order.

10. Inspection

10.1 The purchaser shall state at the time of order whether outside inspection is required or waived. 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 as not to interfere unnecessarily with the operation of the works.