~~Designation:A648–11~~ Designation: A648 – 12

Standard Specification for ~~Steel Wire, Hard Drawn for Prestressing Concrete Pipe~~Steel Wire, Hard-Drawn for Prestressed Concrete Pipe[1]

This standard is issued under the fixed designation A648; 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 classes of uncoated, high-strength, hard-drawn steel wire for use in the manufacture of prestressed concrete pipe. In application, the wire is helically wrapped on the pipe maintaining tension by mechanical means not including drawing dies.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

~~1.3Supplementary requirements describe hydrogen embrittlement resistance test acceptance criteria.~~

1.3 A supplementary requirement (S1) is provided for use where hydrogen embrittlement (HE) resistance testing is required by the purchaser. Supplementary requirement (S1), which establishes acceptance criteria for HE resistance testing, applies only when specified in the purchase order or contract.

1.4 The following caveat pertains only to the test method portions of this specification, ~~6.2.3~~ 6.3.3 and ~~6.4.3~~6.5.3: *This ~~standard~~specification does not purport to address the safety concerns, if any, associated with its use. It is the responsibility of the user of this ~~standard~~specification 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
A510 Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel
A700 Practices for Packaging, Marking, and Loading Methods for Steel Products for Shipment
A1032 Test Method for Hydrogen Embrittlement Resistance for Steel Wire Hard Drawn Used for Prestressing Concrete Pipe
E328 Test Methods for Stress Relaxation for Materials and Structures

2.2 *ANSI Standard:*[3]

C 304 Standard for Design of Prestressed Concrete Cylinder Pipe

3. Ordering Information

~~3.1Orders for material to this specification should include the following information:~~

3.1 It shall be the responsibility of the purchaser to specify all requirements that are necessary for material under this specification. Such requirements to be considered include, but are not limited to, the following:

3.1.1 Quantity (weight),

3.1.2 Name of material (hard-drawn steel wire for ~~prestressing~~prestressed concrete pipe),

3.1.3 Wire diameter (see Table 1),

3.1.4 Class (see Table 1),

~~3.1.5Packaging (see Section 11~~

3.1.5 If outside inspection is required (9.1),

~~3.1.6ASTM designation and year of issue, and~~

~~3.1.7Special requirements, if any (see Supplementary Requirements).~~

[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 American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

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

TABLE 1 Tensile Requirements

Wire Gage or Fraction, in.	Decimal Size, in. (mm)	Class II Wire			Class III Wire		
		Minimum Tensile Strength,[A] ksi (MPa)	Breaking Strength, lbf (kN)		Minimum Tensile Strength,[A] ksi (MPa)	Breaking Strength, lbf (kN)	
			min	max		min	max
6	0.192 (4.88)	222 (1530)	6 430 (28.6)	7 300 (32.5)	252 (1740)	7 300 (32.5)	8 170 (36.3)
1/4	0.250 (6.35)	211 (1450)	10 360 (46.1)	11 830 (52.6)	240 (1650)	11 780 (52.4)	13 250 (58.9)
5/16	0.312 (7.92)	201 (1390)	15 370 (68.4)	17 660 (78.6)	221 (1520)	16 900 (75.2)	19 190 (85.4)

[A] Based on nominal wire diameter.

TABLE 2 Chemical Requirements

NOTE 1—Class I wire has been discontinued.

NOTE 2—Where "~~—~~ ." appear in this table, there is no requirement or limit.

	Classes II and III
~~Carbon, %~~	~~0.50–0.85~~
Carbon, %	0.50–0.85
~~Manganese, %~~	~~0.50–1.10~~
Manganese, %	0.50–1.10
~~Phosphorus, max, %~~	~~0.030~~
Phosphorus, max, %	0.030
~~Sulfur, max, %~~	~~0.035~~
Sulfur, max, %	0.035
~~Silicon, %~~	~~0.10–0.35~~
Silicon, %	0.10–0.35
~~Nitrogen, max, %~~	~~0.007~~
Nitrogen, max, %	0.007
~~Aluminum, %~~	~~—~~
Aluminum, %	. . .
~~Titanium, %~~	~~—~~
Titanium, %	. . .
~~Chromium, %~~	~~—~~
Chromium, %	. . .
~~Nickel, %~~	~~—~~
Nickel, %	. . .
~~Molybdenum, %~~	~~—~~
Molybdenum, %	. . .
~~Copper, %~~	~~—~~
Copper, %	. . .
~~Vanadium, %~~	~~—~~
Vanadium, %	. . .

~~NOTE1—A typical ordering description is as follows: 100000-lb, Hard-Drawn Steel Wire for Prestressing Concrete Pipe, 0.192 in. in diameter, Class III, 1500-lb coils, to ASTM A648–_____.~~

3.1.6 Packaging (see Section 12),

3.1.7 Supplementary Requirement S1 (if desired), and

3.1.8 ASTM designation and year of issue.

4. Manufacture

4.1 The steel shall be made by the electric-arc furnace, open-hearth, ~~basic-oxygen,~~ or basic-oxygen process.

4.2 The steel shall be free of injurious piping and undue segregation.

4.3 The wire shall be cold drawn to produce the prescribed mechanical properties. The wire manufacturer shall take dependable precautions during wire drawing to preclude detrimental strain aging of the wire.

NOTE ~~2~~1—Allowing wire to remain at elevated temperatures, such as 400°F (204°C) for more than 5 s or 360°F (182°C) for more than 20 s, can result in detrimental strain aging of the wire. Detrimentally strain-aged wire typically has reduced ductility and increased susceptibility to hydrogen embrittlement.

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

5. Chemical Requirements

5.1 The heat analysis of the steel shall conform to the chemical requirements specified in Table 2.

5.2 An analysis of each heat of steel shall be furnished by the manufacturer showing the percentages of all the elements specified in Table 2. The wire shall be subject to permissible variation for product analysis specified in Specification A510, Table 7.

6. Mechanical Property Requirements ~~Note3—Mechanical~~

6.1 Mechanical property requirements are applicable only prior to or during pipe manufacture.

6.16.2 *Test Specimens*—Wire specimens for tensile and torsion tests shall be taken from either end of a coil but mustand shall be representative of that coil's wire drawing conditions with regard to wire temperature.

6.26.3 *Tension TestsTest*:

6.2.1

6.3.1 *Tensile Requirements*—Tensile requirements shall conform to those prescribed in Table 1 for the specified size and class.

6.2.2

6.3.2 *Number of Tests*—One test specimen shall be taken from each coil.

6.2.3

6.3.3 *Test Method*—Tension tests shall be made in accordance with Test Methods and Definitions A370, Annex A4. Tension test reports shall include the coil number tested, the measured wire diameter, and the measured breaking strength.

6.2.4

6.3.4 *Reduction-of-Area Test*—The reduction of area requirement for the specimens used for the tension test in 6.1 6.2 shall be a minimum of 35 % for 0.192 in. (4.88 mm) wire and 30 % for larger wire as described and tested in accordance with Test Methods and Definitions A370, Annex A4.

6.3

6.4 *Relaxation Test:*

6.3.1

6.4.1 *Number of Tests*—Relaxation test results shall be provided for purposes of qualifying the procedures used to manufacture wire for prestressing prestressed concrete pipe. Relaxation test results shall include one specimen from a minimum of three coils of wire from the same or different heats of steel where the wire specimens are of the same nominal size, the same class, and manufactured using the same drawing machine and drawing procedures. It shall be permissible to provide the relaxation test results from the wire manufacturer's historical records.

6.3.26.4.2 *Test Method*—Wire shall be tested as described in Test Methods E328.

6.3.3

6.4.3 *Conditions of Tests*—The conditions of the tests are:

6.34.3.1 At least one of the tests performed shall have a duration of 1000 h minimum, and all other tests shall have a duration of at least 200 h. Measurements shall be made and recorded for at least five data points during each time interval of (*1*) 0 to 10 h, (*2*) 10 to 100 h, and (*3*) 100 to 1000 h, except that, if a test is terminated in less than 1000 h, measurements shall be made for at least two data points in the third interval. For tests terminated in less than 1000 h, the expected relaxation of the specimen at 1000 h shall be determined from the linear-regression curve of stress loss on a logarithm time scale.

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

6.34.3.3 The test specimen shall not be subjected to loading, including specimen straightening, prior to the relaxation test, except that it shall be permissible to straighten the specimen ends to fit in the testing machine jaws.

6.34.3.4 Loading shall be applied at an essentially constant rate over a period of not less than 3 min and not more than 5 min until the initial load is reached. Thereafter, the gage length shall be maintained constant. Load-relaxation readings shall commence 1 min after the initial load has been reached.

6.34.3.5 The initial load shall be 70 % of the specifed minimum breaking strength of the wire. Overstressing of the test specimen to a level greater than 70 % of the specified minimum breaking strength during loading shall not be permitted.

6.34.3.6 The test gage length shall be at least 60 times the nominal diameter of the wire.

6.34.3.7 The result of each relaxation test shall be reported either as the actual percent of stress loss after 1000 h or the extrapolated percent of stress loss after 1000 h as determined from the linear-regression curve.

NOTE4—In 2—In accordance with ANSI/AWWA C 304, ordinary prestressed concrete pipe design is based on an assumed maximum wire relaxation of 7.48 % at 1000 h. Wire with higher relaxation can be used, but the higher relaxation loss must be known for consideration in the pipe design.

6.4

6.5 *Torsion Test*:

6.4.1

6.5.1 *Torsion Requirements*—Torsion requirements shall conform to those prescribed in Table 3 for the specified size and class.

6.4.2

6.5.2 *Number of Tests*—One test specimen shall be taken from each coil.

6.4.3

6.5.3 *Test Method*—Conduct the torsion test in accordance with the following:

TABLE 3 Torsion Requirements

Wire Gage or Fraction in.	Decimal Size, in. (mm)	Class II and Class III min turns per 8 in. (203 mm)
6	0.192 (4.88)	10
1/4	0.250 (6.35)	8
5/16	0.312 (7.92)	7