Designation: A603 – 98 (Reapproved 2014)

Standard Specification for Zinc-Coated Steel Structural Wire Rope[1]

This standard is issued under the fixed designation A603; 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 zinc-coated steel structural wire rope, prestretched or nonprestretched for use where a high-strength, relatively flexible prefabricated zinc-coated multiple-wire tension member is desired as a component part of a structure.

1.2 The wire rope is furnished with Class A weight zinc-coated wires throughout. It can be furnished with Class B weight or Class C weight zinc-coated outer wires or Class B weight or Class C weight zinc-coated wires throughout where additional corrosion protection is required.

1.3 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.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A90/A90M Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings

A902 Terminology Relating to Metallic Coated Steel Products

B6 Specification for Zinc

3. Terminology

3.1 *Definitions*—For definitions of terms used in this specification, see Terminology A902.

4. Ordering Information

4.1 Orders for material under this specification shall include the following information:

4.1.1 Length of wire rope,

4.1.2 Nominal diameter of wire rope (Tables 1-4),

4.1.3 Prestretched (see 8.3) or nonprestretched,

4.1.4 Coating-weight class if other than Class A (Table 5),

4.1.5 Mechanical tests if required (see 10.1),

4.1.6 Special packaging requirements (Section 13), and

4.1.7 Inspection (Section 12).

5. Materials and Manufacture

5.1 *Base Metal*—The base metal shall be carbon steel made by the open-hearth, basic-oxygen, or electric-furnace process and of such quality that the finished wire rope and the hard-drawn individual zinc-coated wires coated by the hot-dip or electrolytic process shall have the properties and characteristics as prescribed in this specification.

5.2 *Zinc*—The slab zinc when used shall conform to Specification B6 or better.

6. Physical Properties

6.1 *Tensile Properties:*

6.1.1 The zinc-coated wire used in the wire rope shall conform to the mechanical properties in Table 6 prior to fabrication, but the wire test sample may be prestretched to 55 % of the minimum tensile strength specified in Table 6 prior to conducting the tests.

6.1.2 The tensile strength and the stress at 0.7 % extension shall be based on the actual cross-sectional area of the finished wire, including the zinc coating.

6.1.3 *Test Specimens*—The test specimens shall be free of bends or kinks other than the curvature resulting from the usual coiling operation. The hand straightening necessary to permit insertion of the specimen in the jaws of the testing machine shall be performed by drawing between wood blocks or by some other equally satisfactory means.

6.2 *Stress at 0.7 % Extension Under Load*—The value of stress at 0.7 % extension under load shall be determined by one of the following procedures, depending on the type of extensometer used:

6.2.1 *Non-Autographic Extensometer*—When a non-autographic extensometer is used to measure the 0.7 % extension, it shall have a gage length of 10 in. (254 mm), and it shall be so graduated that the smallest division corresponds to a strain not larger than 0.0001 in./in. (0.0001 mm/mm) of gage length. Apply a load corresponding to the tensile stress indicated in Table 5, using the nominal diameter of the

[1] This specification is under the jurisdiction of ASTM Committee A05 on Metallic-Coated Iron and Steel Productsand is the direct responsibility of Subcommittee A05.12 on Wire Specifications.

Current edition approved Aug. 1, 2014. Published August 2014. Originally approved in 1970. Last previous edition approved in 2009 as A603 – 98 (2009)ε1. DOI: 10.1520/A0603-98R14.

[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.

TABLE 1 Properties of Single-Class Zinc-Coated Steel Structural Wire Rope (Inch-Pound Units)

Nominal Diameter, in.	Minimum Breaking Strength in Tons of 2000 lb			Approximate Gross Metallic Area, in.^{2}	Approximate Weight/ft, lb
	Class A Coating Throughout	Class B Coating Throughout	Class C Coating Throughout		
3/8	6.5	6.2	5.9	0.065	0.24
7/16	8.8	8.4	8.0	0.091	0.32
1/2	11.5	11.0	10.5	0.119	0.42
9/16	14.5	13.8	13.2	0.147	0.53
5/8	18.0	17.2	16.4	0.182	0.65
11/16	21.5	20.5	19.5	0.221	0.79
3/4	26.0	24.8	23.6	0.268	0.95
13/16	30.0	28.6	27.3	0.311	1.10
7/8	35.0	33.4	31.8	0.361	1.28
15/16	40.0	38.2	36.4	0.414	1.47
1	45.7	43.6	41.5	0.471	1.67
1 1/8	57.8	55.1	52.5	0.596	2.11
1 1/4	72.2	68.9	65.6	0.745	2.64
1 3/8	87.8	83.8	79.8	0.906	3.21
1 1/2	104.0	99.2	94.5	1.076	3.82
1 5/8	123.0	117.0	112.0	1.270	4.51
1 3/4	143.0	136.0	130.0	1.470	5.24
1 7/8	164.0	156.0	149.0	1.690	6.03
2	186.0	177.0	169.0	1.920	6.85
2 1/8	210.0	200.0	191.0	2.170	7.73
2 1/4	235.0	224.0	214.0	2.420	8.66
2 3/8	261.0	249.0	237.0	2.690	9.61
2 1/2	288.0	275.0	262.0	2.970	10.60
2 5/8	317.0	302.0	288.0	3.270	11.62
2 3/4	347.0	331.0	315.0	3.580	12.74
2 7/8	379.0	362.0	344.0	3.910	13.90
3	412.0	393.0	374.0	4.250	15.11
3 1/4	475.0	453.0	432.0	5.040	18.00
3 1/2	555.0	529.0	504.0	5.830	21.00
3 3/4	640.0	611.0	582.0	6.670	24.00
4	730.0	696.0	664.0	7.590	27.00

TABLE 2 Properties of Single-Class Zinc-Coated Steel Structural Wire Rope (SI Units)

Nominal Diameter, mm	Minimum Breaking Strength in Metric Tons			Approximate Gross Metallic Area, mm^2	Approximate Weight/m, kg
	Class A Coating Throughout	Class B Coating Throughout	Class C Coating Throughout		
9.53	5.9	5.6	5.4	41.9	0.36
11.11	8.0	7.6	7.3	58.7	0.48
12.70	10.4	10.0	9.5	76.8	0.62
14.29	13.2	12.5	12.0	94.8	0.79
15.88	16.3	15.6	14.9	117.4	0.97
17.46	19.5	18.6	17.7	142.6	1.18
19.05	23.6	22.5	21.4	172.9	1.41
20.64	27.2	25.9	24.8	200.7	1.64
22.23	31.8	30.3	28.8	232.9	1.90
23.81	36.3	34.7	33.0	267.1	2.19
25.40	41.5	39.6	37.6	303.9	2.48
28.58	52.4	50.0	47.6	384.5	3.14
31.75	65.5	62.5	59.5	480.7	3.93
34.93	79.7	76.0	72.4	584.6	4.78
38.10	94.3	90.0	85.7	694.2	5.68
41.28	112.0	106.0	101.0	819.4	6.71
44.45	130.0	124.0	118.0	948.4	7.80
47.63	149.0	142.0	135.0	1090.4	8.97
50.80	169.0	161.0	153.0	1238.8	10.19
53.98	190.0	182.0	173.0	1400.1	11.50
57.15	213.0	203.0	194.0	1561.4	12.89
60.33	237.0	226.0	215.0	1735.6	14.30
63.50	261.0	249.0	238.0	1916.2	15.77
66.68	288.0	274.0	261.0	2109.8	17.29
69.85	315.0	300.0	286.0	2309.8	18.96
73.03	344.0	328.0	312.0	2522.7	20.68
76.20	374.0	356.0	340.0	2742.1	22.48
82.55	431.0	411.0	392.0	3251.8	26.78
88.90	504.0	480.0	458.0	3761.5	31.25
95.25	581.0	554.0	528.0	4303.5	35.71
101.60	662.0	632.0	602.0	4897.1	40.18

TABLE 3 Properties of Multi-Class Zinc-Coated Steel Structural Wire Rope (Inch-Pound Units)

Nominal Diameter, in.	Minimum Breaking Strength in Tons of 2000 lb			Approximate Gross Metallic Area, in.^{2}	Approximate Weight/ft, lb
	Class A Coating Throughout	Class B Coating Outer Wires Class A Coating Inner Wire	Class C Coating Outer Wires Class A Coating Inner Wires		
3/8	6.5	6.3	6.1	0.065	0.24
7/16	8.8	8.5	8.2	0.091	0.32
1/2	11.5	11.1	10.7	0.119	0.42
9/16	14.5	14.0	13.5	0.147	0.53
5/8	18.0	17.4	16.8	0.182	0.65
11/16	21.5	20.8	20.0	0.221	0.79
3/4	26.0	25.1	24.2	0.268	0.95
13/16	30.0	29.0	28.0	0.311	1.10
7/8	35.0	33.8	32.6	0.361	1.28
15/16	40.0	38.6	37.3	0.414	1.47
1	45.7	44.1	42.6	0.471	1.67
1 1/8	57.8	55.8	53.9	0.596	2.11
1 1/4	72.2	69.7	67.3	0.745	2.64
1 3/8	87.8	84.8	81.8	0.906	3.21
1 1/2	104.0	100.0	96.9	1.076	3.82
1 5/8	123.0	120.0	117.0	1.270	4.51
1 3/4	143.0	140.0	136.0	1.470	5.24
1 7/8	164.0	160.0	156.0	1.690	6.03
2	186.0	182.0	177.0	1.920	6.85
2 1/8	210.0	205.0	200.0	2.170	7.73
2 1/4	235.0	230.0	224.0	2.420	8.66
2 3/8	261.0	255.0	249.0	2.690	9.61
2 1/2	288.0	281.0	275.0	2.970	10.60
2 5/8	317.0	310.0	302.0	3.270	11.62
2 3/4	347.0	339.0	331.0	3.580	12.74
2 7/8	379.0	372.0	365.0	3.910	13.90
3	412.0	405.0	397.0	4.250	15.11
3 1/4	475.0	466.0	457.0	5.040	18.00
3 1/2	555.0	545.0	534.0	5.830	21.00
3 3/4	640.0	628.0	616.0	6.670	24.00
4	730.0	717.0	703.0	7.590	27.00

specimen. Maintain this load while a 10-in. extensometer is attached and adjusted to the initial setting shown in Table 5. Then increase the load uniformly until the extensometer indicates an extension of 0.07 in. (1.78 mm) or 0.7 % extension. Record the load for this extension. The stress corresponding to this load shall meet the requirements for the stress of 0.7 % extension specified in Table 6, depending on the class of coating under consideration. Hold the specimen at 0.7 % extension under load and remove the extensometer used to measure the stress at 0.7 % extension; then replace it with an elongation extensometer. Continue the application of load until fracture occurs. Record the elongation attained from the elongation extensometer and add to it 0.7 % obtained from the stress at 0.7 % extensometer to get the total elongation.

6.2.2 *Autographic Extensometer*—When an autographic extensometer is used, it shall have a gage length of at least 2 in. (50.8 mm) and the magnification of strain shall not be less than 250. Apply a load, corresponding to the tensile stress indicated in Table 5, using the nominal diameter of the specimen. Maintain this load and attach the extensometer. Then increase the load uniformly until the extension recorded by the extensometer is at least 0.7 %. Determine the load at 0.7 % extension from the load-strain curve. The stress corresponding to this load shall meet the requirements for stress at 0.7 % extension prescribed in Table 6, depending on the class of coating under consideration. Hold the specimen at 0.7 % extension under load and remove the extensometer used to measure the stress at 0.7 % extension; then replace it with an elongation extensometer. Continue the application of load until fracture occurs. Record the elongation attained from the elongation extensometer and add to it 0.7 % obtained from the stress at 0.7 % extensometer to get the total elongation.

NOTE 1—The extensometer used for the stress at 0.7 % extension and the elongation extensometer may be the same instrument. Two separate instruments are advisable in that the more sensitive stress at 0.7 % extensometer which could be damaged when the wire fractures, may be removed following the determination of the 0.7 % extension. The elongation extensometer may be constructed with less sensitive parts or be constructed in such a way that little damage would result if fracture occurs while the extensometer is attached to the specimen.

6.3 *Elongation*—In determining total elongation (elastic plus plastic extension) autographic or extensometer methods may be employed. If fracture takes place outside the middle third of the gage length, the elongation value obtained may not be representative of the material.

6.4 *Tensile Strength*—The tensile strength is determined from the maximum load during the total elongation test.

6.5 *Ductility of Steel*—The zinc-coated wire, prior to fabrication into wire rope, shall be capable of being wrapped two turns in a close helix at a rate not exceeding 15 turns/min around a cylindrical steel mandrel equal to three times the nominal diameter of the wire under test without fracture of the wire.

6.6 *Weight of Zinc Coating*—The weight of the zinc coating on the individual wires prior to the fabrication of the wire rope

TABLE 4 Properties of Multi-Class Zinc-Coated Steel Structural Wire Rope (SI Units)

Nominal Diameter, mm	Minimum Breaking Strength in Metric Tons			Approximate Gross Metallic Area, mm^2	Approximate Weight/m, kg
	Class A Coating Throughout	Class B Coating Outer Wires Class A Coating Inner Wires	Class C Coating Outer Wires Class A Coating Inner Wire		
9.53	5.9	5.7	5.5	41.9	0.36
11.11	8.0	7.7	7.4	58.7	0.48
12.70	10.4	10.1	9.7	76.8	0.62
14.29	13.2	12.7	12.2	94.8	0.79
15.88	16.3	15.8	15.2	117.4	0.97
17.46	19.5	18.9	18.1	142.6	1.18
19.05	23.6	22.8	22.0	172.9	1.41
20.64	27.2	26.3	25.4	200.7	1.64
22.23	31.8	30.7	29.6	232.9	1.90
23.81	36.3	35.0	33.8	267.1	2.19
25.40	41.5	40.0	38.6	303.9	2.48
28.58	52.4	50.6	48.9	384.5	3.14
31.75	65.5	63.2	61.1	480.7	3.93
34.93	79.7	76.9	74.2	584.6	4.78
38.10	94.3	91.2	87.9	694.2	5.68
41.28	112.0	109.0	106.0	819.4	6.71
44.45	130.0	127.0	124.0	948.4	7.80
47.63	149.0	145.0	142.0	1090.4	8.97
50.80	169.0	165.0	161.0	1238.8	10.19
53.98	190.0	186.0	182.0	1400.1	11.50
57.15	213.0	208.0	203.0	1561.4	12.89
60.33	237.0	231.0	226.0	1735.6	14.30
63.50	261.0	255.0	249.0	1916.2	15.77
66.68	288.0	281.0	274.0	2109.8	17.29
69.85	315.0	308.0	300.0	2309.8	18.96
73.03	344.0	338.0	331.0	2522.7	20.68
76.20	374.0	367.0	360.0	2742.1	22.48
82.55	431.0	423.0	415.0	3251.8	26.78
88.90	504.0	494.0	485.0	3761.5	31.25
92.25	581.0	570.0	559.0	4303.5	35.71
101.60	662.0	650.0	638.0	4897.1	40.18

TABLE 5 Initial Settings for Determining Stress at 0.7 % Extension

Nominal Diameter		Initial Stress		Initial Setting of Extensometer, in./in. or mm/mm
in.	mm	ksi	MPa	
0.040 to 0.089, incl	1.270 to 2.283, incl	14	100	0.0005 (0.05 % extension)
0.090 to 0.119, incl	2.286 to 3.045, incl	28	190	0.0010 (0.10 % extension)
0.120 and larger[A]	3.048 and larger[A]	42	290	0.0015 (0.15 % extension)

[A] This is not to imply that larger wire will be manufactured to any unlimited diameter. It only implies that the wire sizes chosen by the strand manufacturer must meet the requirements of this specification.

TABLE 6 Mechanical Requirements

Zinc Coating Class	Nominal Diameter		Stress at 0.7 % Extension Under Load, min		Tensile Strength, min		Total Elongation in 10 in. or 250 mm, min, %
	in.	mm	psi	MPa	psi	MPa	
A	0.040 to 0.110	1.016 to 2.794	150 000	1030	220 000	1520	2.0
	0.111 and larger[A]	2.820 and larger[A]	160 000	1100	220 000	1520	4.0
B	0.090 and larger[A]	2.286 and larger[A]	150 000	1030	210 000	1450	4.0
C	0.090 and larger[A]	2.286 and larger[A]	140 000	970	200 000	1380	4.0

[A] This is not to imply that larger wire will be manufactured to any unlimited diameter. It only implies that the wire sizes chosen by the strand manufacturer must meet the requirements of this specification.

shall be not less than that specified in Table 7 when tested in accordance with the stripping test of Test Method A90/A90M.

6.7 *Adherence of Coating*—The zinc-coated wire, prior to fabrication into wire rope, shall be capable of being wrapped two turns in a close helix at a rate not exceeding 15 turns/min around a cylindrical steel mandrel equal to five times the nominal diameter of the wire under test without cracking or flaking the zinc coating to such an extent that any zinc can be removed by rubbing with the bare fingers. Loosening or detachment during the adherence test of superficial small particles of zinc, formed by mechanical polishing of the surface of zinc-coated wire, shall not be considered cause for rejection.

6.8 *Finish*—The zinc-coated wire surface shall be free of imperfections not consistent with good commercial practice. The coating shall be continuous and reasonably uniform.

TABLE 7 Minimum Weight of Coating

Nominal Diameter of Coated Wire		Weight of Zinc Coating, min					
		oz/ft ^{2}of Uncoated Wire Surface			g/m ^{2} of Uncoated Wire Surface		
in.	mm	Class A Coating	Class B Coating	Class C Coating	Class A Coating	Class B Coating	Class C Coating
0.040 to 0.061, incl	1.016 to 1.549, incl	0.40	0.80	1.20	122	244	366
0.062 to 0.079, incl	1.575 to 2.007, incl	0.50	1.00	1.50	153	305	458
0.080 to 0.092, incl	2.032 to 2.337, incl	0.60	1.20	1.80	183	366	549
0.093 to 0.103, incl	2.362 to 2.616, incl	0.70	1.40	2.10	214	427	641
0.104 to 0.119, incl	2.642 to 3.023, incl	0.80	1.60	2.40	244	488	732
0.120 to 0.142, incl	3.048 to 3.607, incl	0.85	1.70	2.55	259	519	778
0.143 to 0.187, incl	3.632 to 4.750, incl	0.90	1.80	2.70	275	549	824
0.188 and larger[A]	4.775 and larger[A]	1.00	2.00	3.00	305	610	915

[A] This is not to imply that larger wire will be manufactured to any unlimited diameter. It only implies that the wire sizes chosen by the strand manufacturer must meet the requirements of this specification.

NOTE 2—It is recognized that the surface of heavy zinc coatings, particularly those produced by the hot-dip galvanizing process, are not perfectly smooth and not devoid of irregularities.

7. Test for Coating Weight

7.1 The weight of the zinc coating shall be determined by a stripping test made on the individual wires prior to fabrication of strand, in accordance with Test Method A90/A90M.

8. Wire Rope

8.1 The zinc-coated wire rope shall consist of a plurality of strands helically preformed and laid around a core composed of a strand or another wire rope. The number and size of wires and the number of layers of wires in the strands shall be determined by the manufacturer.

8.2 The wire rope properties are shown in Tables 1-4.

8.3 When specified, the wire rope shall be prestretched. The prestretched rope shall meet the minimum modulus of elasticity as shown in Table 8.

9. Joints and Splices

9.1 No splicing or joining of strands shall be permitted in the manufactured length of rope.

9.2 Welds made prior to wire drawing are permitted. Joining of wires by welding during the stranding operation is permissible, and such joints shall be dispersed sufficiently so as to maintain the minimum breaking strength as listed in Tables 1-4. Joints made during stranding in any wire shall be recoated in a workmanlike manner with zinc or a lead-zinc compound containing a minimum of 50 % zinc.

10. Sampling and Testing of Rope

10.1 If specified, a test specimen shall be taken from each manufactured length of wire rope and tested to minimum breaking strength. If a specimen fails to attain a strength equal to 95 % of the minimum breaking strength requirement, the wire rope represented shall be rejected. If a specimen attains a strength equal to at least 95 % but less than 100 % of the minimum breaking strength requirement, two additional test specimens shall be cut from the same manufactured length and tested. If the average test results of the original specimen and the two retest specimens fail to meet the minimum breaking strength requirement, the wire rope shall be rejected. Any test, however, that fails due to faulty attachment of the sockets shall be disregarded.

11. Rejection and Retest of Wire

11.1 If any wire test specimens breaking within the grips or the jaws of the testing machine results in values below the specified limits for tensile strength, stress at 0.7 % extension or elongation, the results shall be considered invalid and retesting shall be required.

11.2 In case there is reasonable doubt in the first trial as the ability of the wire to meet the requirements of Sections 6 and 7, two additional tests shall be made on samples of wire from the same coil or reel. If failure occurs in either of these tests, the wire shall be rejected.

12. Inspection

12.1 All tests and inspection shall be made at the place of manufacture unless otherwise specified and shall be so conducted as not to interfere unnecessarily with the operation of the works. The manufacturer shall afford the inspector representing the purchaser all reasonable facilities to satisfy the inspector that the material is being furnished in accordance with this specification. When specified, inspection may be waived, and certified copies of test reports furnished.

13. Packaging

13.1 Structural wire rope shall be packaged in coils or on reels at the discretion of the manufacturer unless otherwise

TABLE 8 Minimum Modulus of Elasticity of Prestretched Structural Wire Rope

Nominal Diameter Wire Rope		Minimum Modulus—Class A Coating[A]	
in.	mm	psi	GPa
⅜ to 4	9.52 to 101.60	20 000 000	140

[A] For Class B or Class C weight of zinc-coated outer wires, reduce minimum modulus 1 000 000 psi or 7 GPa. For Class B or Class C weight of zinc-coated wires throughout, consult manufacturer.

specified. Wire rope shall be packaged in such a manner so that no permanent deformation of wires in the strand or strands in the wire rope will occur.

14. Keywords

14.1 steel wire; wire; wire rope; zinc-coated wire