Designation: A586 – 04a (Reapproved 2014)

Standard Specification for Zinc-Coated Parallel and Helical Steel Wire Structural Strand[1]

This standard is issued under the fixed designation A586; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.
These test methods have been approved for use by agencies of the Department of Defense to replace Method 1013 of Federal Test Method Standard 406.

1. Scope

1.1 This specification covers zinc-coated steel wire structural strand, for use where a high-strength, high-modulus, multiple-wire tension member is desired as a component part of a structure. The strand is available with parallel or helical wire construction.

1.1.1 The strand is available with several zinc coating classes and with two strength grades, as described in Section 4.

1.2 The strand 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 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 See Terminology A902 for definition of terms related to metallic-coated steel wire and strand.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *outer wires (of strand), n*—those wires in the one outer-most layer of the wires composing the strand.

4. Classification

4.1 The wire strand is classified as follows.

4.1.1 *Breaking Strength* is expressed as Grade 1 or Grade 2 for strand having a Class A zinc coating on the outer wires of the strand. Strand with heavier coating on the outer wires is available in only one grade.

4.1.2 *Coating Weight* is expressed as Class A, Class B, or Class C, based on the weight of coating on the outer wires in the strand. All inner wires have a Class A coating.

5. Ordering Information

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

5.1.1 Description of the product, as helical steel wire strand or parallel steel wire strand,

5.1.2 Length of strand,

5.1.3 Nominal diameter of strand (Table 1 and Table 2),

5.1.4 Coating class for outer wires (Table 3),

5.1.5 Grade, for strand with Class A coating on outer wires,

5.1.6 For helical strand, whether prestretched or nonprestretched,

5.1.7 Mechanical tests if required (see 9.5 and 11.1),

5.1.8 Special packaging requirements (14.1),

5.1.9 Inspection (12.1 and 13.1), and

5.1.10 ASTM Designation and year of issue, as ASTM A586 – ____.

NOTE 1—A typical ordering description is as follows: 2500 ft, 1 in., galvanized helical strand, Class A coating, Grade 1, on wooden reels, to ASTM Specification A586 – ____.

6. Material

6.1 *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 strand 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.

[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.

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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.

TABLE 1 Properties of Zinc-Coated Steel Structural Strand

Nominal Diameter, in.	Minimum Breaking Strength in Tons of 2000 lb				Approx Gross Metallic Area, in.^{2}	Approx Weight, lb/ft
	Grade 1			Grade 2		
	Class A Coating Throughout	Class A Coating Inner Wires, Class B Coating Outer Wires	Class A Coating Inner Wires, Class C Coating Outer Wires	Class A Coating Throughout		
½	15.0	14.5	14.2	17.3	0.15	0.52
9/16	19.0	18.4	18.0	21.9	0.19	0.66
5/8	24.0	23.3	22.8	27.6	0.23	0.82
11/16	29.0	28.1	27.5	33.4	0.28	0.99
¾	34.0	33.0	32.3	39.1	0.34	1.2
13/16	40.0	38.8	38.0	46.0	0.40	1.4
⅞	46.0	44.6	43.7	52.9	0.46	1.6
15/16	54.0	52.4	51.3	62.1	0.53	1.9
1	61.0	59.2	57.9	70.2	0.60	2.1
1 1/16	69.0	66.9	65.5	79.4	0.68	2.4
1 1/8	78.0	75.7	74.1	89.7	0.76	2.7
1 3/16	86.0	83.4	81.7	98.9	0.85	3.0
1 1/4	96.0	94.1	92.2	110	0.94	3.3
1 5/16	106	104	102	122	1.0	3.6
1 3/8	116	114	111	133	1.1	4.0
1 7/16	126	123	121	145	1.2	4.3
1 1/2	138	135	132	159	1.4	4.7
1 9/16	150	147	144	173	1.5	5.1
1 5/8	162	159	155	186	1.6	5.6
1 11/16	176	172	169	202	1.7	6.0
1 3/4	188	184	180	216	1.8	6.4
1 13/16	202	198	194	232	2.0	6.9
1 7/8	216	212	207	248	2.1	7.4
1 15/16	230	226	221	265	2.3	7.9
2	245	241	238	282	2.4	8.4
2 1/16	261	257	253	300	2.6	8.9
2 1/8	277	273	269	319	2.7	9.5
2 3/16	293	289	284	337	2.9	10
2 1/4	310	305	301	357	3.0	11
2 5/16	327	322	317	376	3.2	11
2 3/8	344	339	334	396	3.4	12
2 7/16	360	355	349	414	3.6	12
2 1/2	376	370	365	432	3.8	13
2 9/16	392	386	380	451	3.9	14
2 5/8	417	411	404	480	4.1	14
2 11/16	432	425	419	497	4.3	15
2 3/4	452	445	438	520	4.5	16
2 7/8	494	486	479	568	5.0	17
3	538	530	522	619	5.4	19
3 1/8	584	575	566	672	5.9	21
3 1/4	625	616	606	719	6.3	22
3 3/8	673	663	653	774	6.8	24
3 1/2	724	714	702	833	7.4	26
3 5/8	768	757	745	883	7.9	28
3 3/4	822	810	797	945	8.4	30
3 7/8	878	865	852	1010	9.0	32
4	925	911	897	1060	9.6	34

6.2 *Zinc*—The slab zinc when used shall conform to Specification B6.

7. Physical Requirements for Wire

7.1 *Tensile Properties:*

7.1.1 The zinc-coated wire used in the parallel wire strand shall, prior to fabrication, conform to the mechanical properties in Table 4. In this case the prestretching provision of the test sample of 7.1.2 is not permitted.

7.1.2 The zinc-coated wire used in the helical wire strand shall conform to the mechanical properties in Table 4 prior to fabrication. The wire test sample shall be prestretched, at the manufacturer's option to 55 % of the minimum tensile strength specified in Table 4 prior to conducting the tests.

7.1.3 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.

7.1.4 *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

TABLE 2 Properties of Zinc-Coated Steel Structural Strand

Nominal Diameter, mm	Approximate Minimum Breaking Strength in Kilonewtons				Approx Gross Metallic Area, mm^2	Approx Weight, kg/m
	Grade 1			Grade 2		
	Class A Coating Throughout	Class A Coating Inner Wires, Class B Coating Outer Wires	Class A Coating Inner Wires, Class C Coating Outer Wires	Class A Coating Throughout		
12.7	133	129	126	153	97	0.77
14.3	169	164	160	194	120	0.98
15.9	214	207	203	246	150	1.2
17.5	258	250	245	297	180	1.5
19.1	302	294	287	348	220	1.8
20.6	356	345	338	409	260	2.1
22.2	409	397	389	471	300	2.4
23.8	480	466	456	552	340	2.8
25.4	543	527	515	624	390	3.1
27.0	614	595	583	706	440	3.5
28.6	694	673	659	798	490	4.0
30.2	765	742	727	880	550	4.4
31.8	854	837	820	979	610	4.9
33.3	943	925	907	1090	660	5.4
34.9	1030	1010	988	1180	730	5.9
36.5	1120	1090	1080	1290	800	6.5
38.1	1230	1200	1170	1410	870	7.0
39.7	1330	1310	1280	1540	950	7.6
41.3	1440	1410	1380	1650	1000	8.3
42.9	1570	1530	1500	1800	1100	8.9
44.5	1670	1640	1600	1920	1200	9.6
46.0	1800	1760	1730	2060	1300	10
47.6	1920	1890	1840	2210	1400	11
49.2	2050	2010	1970	2360	1500	12
50.8	2180	2140	2120	2510	1500	13
52.4	2320	2290	2250	2670	1600	13
54.0	2460	2430	2390	2840	1700	14
55.6	2610	2570	2530	3000	1900	15
57.2	2760	2710	2680	3180	2000	16
58.7	2910	2860	2820	3350	2100	17
60.3	3060	3020	2970	3520	2200	18
61.9	3200	3160	3100	3680	2300	19
63.5	3350	3290	3250	3840	2400	20
65.1	3490	3430	3380	4010	2500	21
66.7	3710	3660	3590	4270	2700	22
68.3	3840	3780	3730	4420	2800	23
69.9	4020	3960	3900	4630	2900	24
73.0	4390	4320	4260	5050	3200	26
76.2	4790	4720	4640	5510	3500	28
79.4	5200	5120	5040	5980	3800	31
82.6	5560	5480	5390	6400	4100	33
85.7	5990	5900	5810	6890	4400	36
88.9	6440	6350	6250	7410	4700	38
92.1	6830	6730	6630	7860	5100	41
95.3	7310	7210	7090	8410	5400	44
98.4	7810	7700	7580	8990	5800	47
102	8230	8100	7980	9430	6200	50

shall be performed by drawing between wood blocks or by some other equally satisfactory means.

7.2 *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:

7.2.1 *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 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 4, 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

TABLE 3 Minimum Weight of Coating

Nominal Diameter of Coated Wire		Weight of Zinc Coating, min					
		oz/ft² of Uncoated Wire Surface			g/m² 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.

TABLE 4 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.

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	1.070 to 2.26, incl	14	100	0.0005 (0.05 % extension)
0.090 to 0.119, incl	2.29 to 3.02, incl	28	190	0.0010 (0.10 % extension)
0.120 and larger	3.05 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.

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.

7.2.2 *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 4, 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 2—The extensometer used for the stress at 0.7 % extension and the elongation extensometer may be the same instrument. Two separate instruments are advisable since the more sensitive stress at 0.7 % extensometer that 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.

7.3 *Elongation*—In determining total elongation (elastic plus plastic extension) use either autographic or extensometer methods. If fracture takes place outside the middle third of the gage length, the elongation value obtained is not necessarily representative of the material.

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

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

7.6 *Weight of Zinc Coating*—The weight of zinc coating on the individual wires prior to fabrication of strand shall be not less than that specified in Table 3.

7.7 *Adherence of Coating*—The zinc-coated wire, prior to fabrication into strand, shall be capable of being wrapped two turns in a close helix at a rate not exceeding 15 turns per minute 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.

7.8 If any sample 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.

7.8.1 If any test fails to meet the minimum value required, two additional tests shall be made on samples of wire from the same coil or reel and if failure occurs in either of these tests, the coil or reel shall be rejected. If both of these tests pass, the coil or reel shall be accepted.

7.9 *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.

NOTE 3—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.

8. Test for Coating Weight

8.1 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.

9. Strand

9.1 The zinc-coated strand shall consist of layers of wire about a center wire. The number of layers and number and size of wires in each layer shall be determined by the manufacturer.

9.2 The minimum breaking strength of helical strand properties are shown in Table 1 and Table 2. Specifically dimensioned strand bigger than 4 in. (101.6 mm) may be employed provided that the breaking strength, gross metallic area, and weight per unit length are defined. The properties of parallel wire strand shall be as agreed upon between the purchaser and the manufacturer.

9.3 When specified, the helical strand shall be prestretched under tension of not more than 55 % of the breaking strength listed in Table 1 and Table 2.

9.4 The modulus of elasticity shall be as shown in Table 6.

9.5 If specified, a test for modulus of elasticity shall be made on each manufactured length of strand. The modulus of elasticity shall be determined from gage length of not less than 100 in. (2.54 m) and shall be computed on the sum of the gross metallic cross-sectional areas of the wire making up the strand, including the zinc coating. Throughout the range from 10 % to 50 % of the breaking strength listed in Table 1 and Table 2, the modulus of elasticity shall not be less than the value shown in Table 6.

TABLE 6 Minimum Moduli of Elasticity of Prestretched Structural Strand

Nominal Diameter Strand		Minimum Modulus—Class A Coating[A]	
in.	mm	ksi	MPa
½ to 2⁹⁄₁₆	12.70 to 65.09	24 000	165 500
2⅝ and larger	66.67 and larger	23 000	158 600

[A]For Class B or Class C weight of zinc-coated outer wires, reduce minimum modulus 1000 ksi or 6900 MPa.

10. Joints and Splices

10.1 The wires shall be made in such lengths that the helical strands can be manufactured with no splices or joints in the finished outer wires. Welds made in the outer wires prior to drawing are permitted. Splicing of the inner wires during the stranding operation is permissible. Joints in the wires of strand shall be dispersed sufficiently so as to maintain the minimum breaking strength as listed in Table 1 and Table 2. When joints are necessary in any wires, they shall be made in accordance with best known acceptable practices and shall be recoated in a workmanlike manner with zinc or a lead-zinc compound containing a minimum of 50 % zinc.

11. Sampling and Testing

11.1 If specified, a test sample shall be taken from each manufactured length of strand and tested to the minimum breaking strength. If it fails to meet the minimum breaking strength requirement, and has not broken in the cone or grips, two additional samples shall be cut from the same manufactured length and tested. If either additional sample fails the retest for breaking strength, the manufactured length in question shall be rejected. If both of these two samples pass the retest for breaking strength, the manufactured length in question shall be accepted. Any test, however, which fails due to faulty attaching of the sockets shall be disregarded.

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 operations of the works. 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.

13. Certification

13.1 When specified in the purchase order or contract, a producer's or supplier's certification shall be furnished to the purchaser that the material was manufactured, sampled, tested, and inspected in accordance with this specification and has been found to meet the requirements. When specified in the purchase order or contract, a report of the test results shall be furnished.

14. Packaging

14.1 Structural strand shall be packaged in coils or on reels at the discretion of the manufacturer unless otherwise specified. Strand shall be packaged in such a manner so that no permanent deformation of wires in the strand will occur.

15. Keywords

15.1 structural strand; zinc-coated strand