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Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete[1]

This standard is issued under the fixed designation A1064/A1064M; 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 carbon-steel wire and welded wire reinforcement produced from hot-rolled rod to be used for the reinforcement of concrete. The steel wire is cold-worked, drawn or rolled, plain (non-deformed, as-drawn or galvanized), or deformed. Welded wire reinforcement is made from plain or deformed wire, or a combination of plain and deformed wire. Common wire sizes and dimensions are given in Table 1, Table 2, Table 3, and Table 4. Actual wire sizes are not restricted to those shown in the tables.

NOTE 1—Welded wire for concrete reinforcement has historically been described by various terms: welded wire fabric, WWF, fabric, and mesh. The wire reinforcement industry has adopted the term *welded wire reinforcement* (WWR) as being more representative of the applications of the products being manufactured. Therefore, the term *welded wire fabric* has been replaced with the term *welded wire reinforcement* in this specification and in related specifications.

1.2 The values stated in either inch-pound units or SI units are to be regarded separately as standard. Within the text the SI units are shown in brackets (except in Table 2 and Table 4). 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 this specification.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A370 Test Methods and Definitions for Mechanical Testing of Steel Products

A641/A641M Specification for Zinc–Coated (Galvanized) Carbon Steel Wire

~~E83 Practice for Verification and Classification of Extensometer Systems~~

2.2 *U.S. Military Standard:*[3]

MIL-STD-129 Marking for Shipment and Storage

[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, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, http://www.dodssp.daps.mil.

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

TABLE 1 Dimensional Requirements for Plain Wire—Inch-Pound Units[A]

Size Number[B, C, D]	Nominal Diameter in. [mm][E]	Nominal Area in.^{2} [mm^2]
W 0.5	0.080 [2.03]	0.005 [3.23]
W 1.2	0.124 [3.14]	0.012 [7.74]
W 1.4	0.134 [3.39]	0.014 [9.03]
W 2	0.160 [4.05]	0.020 [12.9]
W 2.5	0.178 [4.53]	0.025 [16.1]
W 2.9	0.192 [4.88]	0.029 [18.7]
W 3.5	0.211 [5.36]	0.035 [22.6]
W 4	0.226 [5.73]	0.040 [25.8]
W 4.5	0.239 [6.08]	0.045 [29.0]
W 5	0.252 [6.41]	0.050 [32.3]
W 5.5	0.265 [6.72]	0.055 [35.5]
W 6	0.276 [7.02]	0.060 [38.7]
W 8	0.319 [8.11]	0.080 [51.6]
W 10	0.357 [9.06]	0.100 [64.5]
W 11	0.374 [9.50]	0.110 [71.0]
W 12	0.391 [9.93]	0.120 [77.4]
W 14	0.422 [10.7]	0.140 [90.3]
W 16	0.451 [11.5]	0.160 [103]
W 18	0.479 [12.2]	0.180 [116]
W 20	0.505 [12.8]	0.200 [129]
W 22	0.529 [13.4]	0.220 [142]
W 24	0.553 [14.0]	0.240 [155]
W 26	0.575 [14.6]	0.260 [168]
W 28	0.597 [15.2]	0.280 [181]
W 30	0.618 [15.7]	0.300 [194]
W 31	0.628 [16.0]	0.310 [200]
W 45	0.757 [19.2]	0.450 [290]

[A] Table 1 should be used on projects that are designed using inch-pound units; Table 2 should be used on projects that are designed using SI units.
[B] The number following the prefix indicates the nominal cross-sectional area of the wire in square inches multiplied by 100.
[C] For sizes other than those shown above, the Size Number shall be the number of one hundredth of a square inch in the nominal area of the wire cross section, prefixed by the W.
[D] These sizes represent the most readily available sizes in the welded wire reinforcement industry. Other wire sizes are available and many manufactures can produce them in 0.0015 in.^{2} increments.
[E] The nominal diameter is based on the nominal area of the wire.

TABLE 2 Dimensional Requirements for Plain Wire—SI Units[A]

Size Number[B, C, D]	Nominal Diameter mm [in.][E]	Nominal Area mm^2 [in.^{2}]
MW 5	2.52 [0.099]	5 [0.008]
MW 10	3.57 [0.140]	10 [0.016]
MW 15	4.37 [0.172]	15 [0.023]
MW 20	5.05 [0.199]	20 [0.031]
MW 25	5.64 [0.222]	25 [0.039]
MW 30	6.18 [0.243]	30 [0.047]
MW 35	6.68 [0.263]	35 [0.054]
MW 40	7.14 [0.281]	40 [0.062]
MW 45	7.57 [0.298]	45 [0.070]
MW 50	7.98 [0.314]	50 [0.078]
MW 55	8.37 [0.329]	55 [0.085]
MW 60	8.74 [0.344]	60 [0.093]
MW 65	9.10 [0.358]	65 [0.101]
MW 70	9.44 [0.372]	70 [0.109]
MW 80	10.1 [0.397]	80 [0.124]
MW 90	10.7 [0.421]	90 [0.140]
MW 100	11.3 [0.444]	100 [0.155]
MW 120	12.4 [0.487]	120 [0.186]
MW 130	12.9 [0.507]	130 [0.202]
MW 200	16.0 [0.628]	200 [0.310]
MW 290	19.2 [0.757]	290 [0.450]

[A] The wire sizes in Table 1 should be used on projects that are designed using inch-pound units; the wire sizes in Table 2 should be used on projects that are designed using SI units.
[B] The number following the prefix indicates the nominal cross-sectional area of the wire in square milimetres.
[C] For sizes other than those shown above, the Size Number shall be the number of square millimetres in the nominal area of the wire cross section, prefixed by the MW.
[D] These sizes represent the most readily available sizes in the welded wire reinforcement industry. Other wire sizes are available and many manufactures can produce them in 1 mm^2 increments.
[E] The nominal diameter is based on the nominal area of the wire.

2.3 *U.S. Military Standard:*[3]
Fed. Std. No. 123 Marking for Shipments (Civil Agencies)

TABLE 3 Dimensional Requirements for Deformed Wire—Inch-Pound Units

	Nominal Dimensions			Deformation Requirements
Deformed Wire Size[A, B, C, D]	Unit Weight, lb/ft	Diameter, in.[E]	Cross-Sectional Area, in.^{2} [F]	Minimum Average Height of Deformations, in.[G, H]
D 1	0.034	0.113	0.010	0.0045
D 2	0.068	0.160	0.020	0.0063
D 3	0.102	0.195	0.030	0.0078
D 4	0.136	0.226	0.040	0.0101
D 5	0.170	0.252	0.050	0.0113
D 6	0.204	0.276	0.060	0.0124
D 7	0.238	0.299	0.070	0.0134
D 8	0.272	0.319	0.080	0.0143
D 9	0.306	0.339	0.090	0.0152
D 10	0.340	0.357	0.100	0.0160
D 11	0.374	0.374	0.110	0.0187
D 12	0.408	0.391	0.120	0.0195
D 13	0.442	0.407	0.130	0.0203
D 14	0.476	0.422	0.140	0.0211
D 15	0.510	0.437	0.150	0.0218
D 16	0.544	0.451	0.160	0.0225
D 17	0.578	0.465	0.170	0.0232
D 18	0.612	0.479	0.180	0.0239
D 19	0.646	0.492	0.190	0.0245
D 20	0.680	0.505	0.200	0.0252
D 21	0.714	0.517	0.210	0.0259
D 22	0.748	0.529	0.220	0.0265
D 23	0.782	0.541	0.230	0.0271
D 24	0.816	0.553	0.240	0.0277
D 25	0.850	0.564	0.250	0.0282
D 26	0.884	0.575	0.260	0.0288
D 27	0.918	0.586	0.270	0.0293
D 28	0.952	0.597	0.280	0.0299
D 29	0.986	0.608	0.290	0.0304
D 30	1.02	0.618	0.300	0.0309
D 31	1.05	0.628	0.310	0.0314
D 45	1.53	0.757	0.450	0.0379

[A] The wire sizes in Table 3 should be used on projects that are designed using inch-pound units; the wire sizes in Table 4 should be used on projects that are designed using SI units.
[B] The number following the prefix indicates the nominal cross-sectional area of the deformed wire in square inches multiplied by 100.
[C] For sizes other than those shown above, the Size Number shall be the number of one hundredths of a square inch in the nominal area of the deformed wire cross section, prefixed by the D.
[D] These sizes represent the most readily available sizes in the welded wire reinforcement industry. Other wire sizes are available and many manufacturers can produce them in 0.0015 in.^{2} increments.
[E] The nominal diameter of a deformed wire is equivalent to the nominal diameter of a plain wire having the same weight per foot as the deformed wire.
[F] The cross-sectional area is based on the weight of the wire. The area in square inches may be calculated by dividing the weight in pounds by 0.2833 (weight of 1 in.^{3} of steel) or by dividing the weight per lineal foot of specimen in pounds by 3.4 (weight of steel 1 in. square and 1 foot long).
[G] Measurements shall be made as described in 7.2.4.7.
[H] See 7.2.4.3 for average number of deformations per unit length.

2.4 *American Concrete Institute (ACI) Standard:*[4]
ACI 318 Building Code Requirements for Structural Concrete
2.5 *Adjuncts:*
Weld Tester Drawing [5]

3. Terminology

3.1 *Definitions of Terms Specific to This Specification:*

3.1.1 *convoluted wire*—plain wire for welded wire reinforcement that is formed into a sinusoidal wave shape; deformed wire is not subject to convolution unless agreed upon by the purchaser and manufacturer.

3.1.1.1 *Discussion*—
The wire is used in the manufacture of cages for certain applications of concrete pipe reinforcement.

3.1.2 *deformed wire and deformed welded wire reinforcement*—a material composed of cold-worked deformed steel wire as cold-drawn or cold-rolled from hot-rolled steel rod.

[4] Available from American Concrete Institute (ACI), P.O. Box 9094, Farmington Hills, MI 48333-9094, http://www.concrete.org.
[5] Available from ASTM International Headquarters. Order Adjunct No. ADJA0185. Original adjunct produced in 1967.

TABLE 4 Dimensional Requirements for Deformed Wire—SI Units

Nominal Dimensions					Deformation Requirements
Deformed Wire Size[A, B, C, D]	D [in.^{2} × 100]	Unit Mass, kg/m	Diameter, mm[E]	Cross-Sectional Area, mm^2 [F]	Minimum Average Height of Deformations, mm[G, H]
MD 25	[D 3.9]	0.196	5.64	25	0.252
MD 30	[D 4.7]	0.235	6.18	30	0.279
MD 35	[D 5.4]	0.275	6.68	35	0.302
MD 40	[D 6.2]	0.314	7.14	40	0.320
MD 45	[D 7.0]	0.353	7.57	45	0.342
MD 50	[D 7.8]	0.392	7.98	50	0.360
MD 55	[D 8.5]	0.432	8.37	55	0.378
MD 60	[D 9.3]	0.471	8.74	60	0.392
MD 65	[D 10.1]	0.510	9.10	65	0.455
MD 70	[D 10.9]	0.549	9.44	70	0.470
MD 80	[D 12.4]	0.628	10.1	80	0.505
MD 90	[D 14.0]	0.706	10.7	90	0.535
MD 100	[D 15.5]	0.785	11.3	100	0.565
MD 120	[D 18.6]	0.942	12.4	120	0.620
MD 130	[D 20.2]	1.02	12.9	130	0.645
MD 200	[D 31.0]	1.57	16.0	200	0.800
MD 290	[D 45.0]	2.28	19.2	290	0.961

[A] The wire sizes in Table 3 should be used on projects that are designed using inch-pound units; the wire sizes in Table 4 should be used on projects that are designed using SI units.
[B] The number following the prefix indicates the nominal cross-sectional area of the deformed wire in square millimetres.
[C] For sizes other than those shown above, the Size Number shall be the number of square millimetres in the nominal area of the deformed wire cross section, prefixed by the MD.
[D] These sizes represent the most readily available sizes in the welded wire reinforcement industry. Other wire sizes are available and many manufacturers can produce them in 1 mm^2 increments.
[E] The nominal diameter of a deformed wire is equivalent to the nominal diameter of a plain wire having the same weight per metre as the deformed wire.
[F] The cross-sectional area is based on the mass of the wire. The area in square millimetres may be calculated by dividing the unit mass in kg/mm by 7.849 × 10^{-6} (mass of 1 mm^3 of steel) or by dividing the unit mass in kg/m by 0.007849 (mass of steel 1 mm square and 1 m long).
[G] Measurements shall be made as described in 7.2.4.7.
[H] See 7.2.4.3 for average number of deformations per unit length.

3.1.2.1 *Discussion*—
Deformations can be either indented or raised transverse ribs (protrusions). The deformations and the welded intersections provide bond strength and anchorage.

3.1.3 *plain wire and plain welded wire reinforcement*—a material composed of cold-worked plain steel wire, as cold-drawn or cold-rolled from hot-rolled steel rod.

3.1.3.1 *Discussion*—
The welded intersections provide anchorage.

4. Ordering Information

4.1 Orders for wire or welded wire reinforcement under this specification shall contain the following information:

4.1.1 Quantity (weight [mass]) or square area for welded wire reinforcement,

4.1.2 Name of material (cold-drawn or rolled steel wire, or welded wire reinforcement, plain or deformed, for concrete),

4.1.3 Wire size number, wire spacing, and sheet or roll width and length for welded wire reinforcement,

4.1.4 Minimum yield strength or Grade,

4.1.5 Packaging (see Section 15), and

4.1.6 ASTM designation and year of issue.

4.2 The purchaser shall have the option to specify additional requirements, including but not limited to, the following:

4.2.1 Exclusion of over-steeling (see 10.4.2 and 10.5.1),

4.2.2 Report on tests performed on the steel wire or welded wire reinforcement being furnished (see 14.1), and

4.2.3 Special requirements (if desired).

5. Materials

5.1 The steel shall be made by any commercially accepted process.

5.2 Unless otherwise specified, the wire shall be supplied uncoated. When plain wire is specified as galvanized, it shall be galvanized at finish size as described in Specification A641/A641M.

5.3 Wire used in the manufacture of welded wire reinforcement shall conform to this specification either solely ~~or in combination of~~ plain or ~~deformed wire, or~~ solely deformed, or a combination of both.

6. Manufacture

6.1 The wire shall be cold-worked, drawn or rolled, from rods that have been hot-rolled from billets.

6.2 For welded wire reinforcement, the wires shall be assembled by automatic machines or by other suitable mechanical means which will assure accurate spacing and alignment of all wires of the finished product. The finished welded wire reinforcement shall be furnished in flat or bent sheets or in rolls as specified by the purchaser.

6.3 Longitudinal and transverse wires shall be securely connected at every intersection by a process of electrical resistance welding which employs the principle of fusion combined with pressure.

6.4 Welded wire reinforcement of proper yield strength and quality when manufactured in the manner herein required shall result in a strong, serviceable mat-type product having substantially square or rectangular openings, and shall conform to this specification.

NOTE 2—A variation of manufacturing includes the application of one or more longitudinal convoluted wires at one edge of welded wire reinforcement for concrete pipe reinforcing cages. This shape allows the cage ends to be expanded to a larger diameter to accommodate the bell-shaped ends of concrete pipe.

7. Mechanical Property Requirements—Wire, Plain and Deformed

7.1 *General Requirements for Plain Wire:*

7.1.1 The relation between size number, diameter, and area shown in Table 1 or Table 2 shall apply, whichever is applicable.

7.1.2 Specimens for mechanical properties testing shall be full wire sections and shall be obtained from ends of wire coils as drawn or rolled. The specimens shall be of sufficient length to perform testing described in Test Methods and Definitions A370.

7.1.3 If any test specimen exhibits obvious isolated imperfections not representative of the product, it shall be discarded and another specimen substituted.

7.1.4 *Tension Test:*

7.1.4.1 Plain wire to be used in the manufacture of welded wire reinforcement shall meet or exceed minimum tensile strength, yield strength, and reduction of area requirements in Table 5. Plain wire not used in welded wire reinforcement shall meet or exceed minimum tensile strength, yield strength, and reduction of area requirements in Table 6. Testing shall follow Test Methods and Definitions A370 and shall be based on nominal wire area.

7.1.4.2 Yield strength shall be determined and reported according to the certification criteria in 14.3 and ~~as described in~~ Test Methods and Definitions A370 ~~using a Class B-1 extensometer as in Practice E83~~at an extension under load of 0.5 % of gage length or by the offset method (0.2 %). It shall be permissible to remove the extensometer after the yield strength has been determined. The wire shall meet the requirements of Table 6 or Table 5, whichever is applicable.

7.1.5 *Bend Test*—The bend test specimen shall be bent at room temperature through 180° without cracking on the outside of the

TABLE 5 Tension Test Requirements—Plain Wire for Welded Wire Reinforcement

Size W1.2 [MW 7.7] and Larger						
	Grade 65 [450]	Grade 70 [485]	Grade 72.5 [500]	Grade 75 [515]	Grade 77.5 [533]	Grade 80 [550]
Tensile strength, min, psi [MPa]	75 000 [515]	80 000 [550]	82 500 [568]	85 000 [585]	87 500 [603]	90 000 [620]
Yield strength, min, psi [MPa]	65 000 [450]	70 000 [485]	72 500 [500]	75 000 [515]	77 500 [533]	80 000 [550]
Reduction of area, min, %	30[A]	30[A]	30[A]	30[A]	30[A]	30[A]

Smaller than Size W1.2 [MW 7.7]	
	Grade 56 [385]
Tensile strength, min, psi [MPa]	70 000 [485]
Yield strength, min, psi [MPa]	56 000 [385]
Reduction of area, min, %	30[A]

[A] For material testing over 100 000 psi [690 MPa] tensile strength, the reduction of area shall be not less than 25 %.

TABLE 6 Tension Test Requirements—Plain Wire

	Grade 70 [485]	Grade 72.5 [500]	Grade 75 [515]	Grade 77.5 [533]	Grade 80 [550]
Tensile strength, min, psi [MPa]	80 000 [550]	82 500 [568]	85 000 [585]	87 500 [603]	90 000 [620]
Yield strength, min, psi [MPa]	70 000 [485]	72 500 [500]	75 000 [515]	77 500 [533]	80 000 [550]
Reduction of area, min, %	30[A]	30[A]	30[A]	30[A]	30[A]

[A] For material testing over 100 000 psi [690 MPa] tensile strength, the reduction of area shall be not less than 25 %.

bent portion visible to a person with normal or corrected vision, as prescribed in Table 7.

TABLE 7 Bend Test Requirements—Plain Wire

Size Number of Wire	Pin Diameter for Bend Tests[A]
W 7 [MW 45] and smaller	1d[B]
Larger than W 7 MW 45]	2d

[A] Bend specimen 180° unless noted otherwise.
[B] d = nominal wire diameter.

TABLE 8 Permissible Variation in Plain Wire Diameter

Size Number, in.-lbs [SI]	Nominal Diameter in. [mm]	Permissible Variation Plus and Minus, in. [mm]	Maximum Permissible Out-of-Round, in. [mm][A]
Smaller than W 5 [MW 32]	under 0.252 [6.40]	0.003 [0.08]	0.003 [0.08]
W 5 [MW 32] to W 12 [MW 77], incl	0.252 [6.40] to 0.391 [9.93] incl	0.004 [0.10]	0.004 [0.10]
Over W 12 [MW 77] to W 20 [MW 129], incl	over 0.391 [9.93] to 0.505 [12.83], incl	0.006 [0.15]	0.006 [0.15]
Over W 20 [MW 129]	over 0.505 [12.83]	0.008 [0.20]	0.008 [0.20]

[A] Out-of-round is the difference between maximum and minimum diameters of the wire, measured at the same transverse cross section.

7.1.6 *Permissible Variation in Wire Diameter:*

7.1.6.1 The permissible variation in wire diameter shall conform to the requirements in Table 8.

7.1.6.2 The difference between the maximum and minimum diameters, as measured on any given cross section of the wire, shall not exceed the tolerances listed in Table 8 for the given wire size.

NOTE 3—Cold-worked wire generally does not exhibit a definite yield point as evidenced by a distinct arrest or halt in the load indication gauge of the testing machine prior to reaching ultimate tensile load.

7.2 *General Requirements for Deformed Wire:*

7.2.1 The relation between size number, diameter, and area shown in Table 3 or Table 4 shall apply, whichever is applicable.

7.2.2 Specimens for mechanical properties testing shall be full wire sections and shall be obtained from ends of wire coils as rolled. The specimens shall be of sufficient length to perform testing described in Test Methods and Definitions A370.

7.2.3 If any test specimen exhibits obvious isolated imperfections not representative of the product, it shall be discarded and another specimen substituted.

7.2.4 *Deformation Criteria:*

7.2.4.1 Deformations shall be spaced along the wire at a substantially uniform distance and shall be symmetrically dispersed around the perimeter. The deformations on all longitudinal lines of the wire shall be similar in size and shape. A minimum of 25 % of the total surface area shall be deformed by measurable deformations.

7.2.4.2 Deformed wire shall have two or more lines of deformations.

7.2.4.3 The average longitudinal spacing of deformations shall be not less than 3.5 nor more than 5.5 deformations per inch [25 mm] in each line of deformations on the wire.

7.2.4.4 The minimum average height of the center of typical deformations based on the nominal wire diameters shown in Table 3 or Table 4 shall be as follows:

Wire Sizes	Minimum Average Height of Deformations Percent of Nominal Wire Diameter
D 3 [MD 20] and smaller	4
Larger than D 3 [MD 20] through D 10 [MD 65]	4½
Larger than D 10 [MD 65]	5