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Designation: ~~A1022/A1022M – 13~~ A1022/A1022M – 14

Standard Specification for Deformed and Plain Stainless Steel Wire and Welded Wire for Concrete Reinforcement[1]

This standard is issued under the fixed designation A1022/A1022M; 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 stainless steel wire and welded wire reinforcement produced from hot-rolled stainless steel rod. The stainless steel wire is cold-worked, drawn or rolled, plain (non-deformed) or deformed or a combination of deformed and plain. It is used as concrete reinforcement for applications requiring resistance to corrosion or controlled magnetic permeability, or both. Common wire sizes and dimensions are found in this specification. Actual wire sizes are not restricted to those shown in the tables.

1.2 Supplement S1 describes high strength wire, which shall be furnished when specifically ordered. It shall be permissible to furnish high strength wire in place of regular wire if mutually agreed to by the purchaser and supplier.

1.2.1 A supplementary requirement (S2) of an optional nature is provided. It shall apply only when specified by the purchaser. In order to obtain a corrosion tested or controlled magnetic permeability product, steel conforming to Supplementary Requirement S2 should be ordered.

1.3 The chemical composition of the steel (stainless grade) shall be selected for suitability to the application involved by agreement between the manufacturer and the purchaser. Use Specification A276 for chemical requirements. The UNS designations are to be included with the type number and noted in brackets, ~~i.e.~~ that is, austenitic stainless steels as Type 304 [S30400], 304L [S30403], 316 [S31600], 316L [S31603], 316N [S31651], 316LN [S31653] and duplex stainless steels, Types 2205 [S32205] and 329 [S32900].

NOTE 1—Only austenitic and duplex stainless steels are usually recommended for use as reinforcement in concrete because of their high corrosion resistance. Austenitic stainless steels have good general corrosion resistance, strength characteristics which can be improved by cold working, good toughness and ductility properties at low temperatures, and low magnetic permeability. Duplex stainless steels have generally a corrosion resistance greater than that of most austenitic steels and are magnetic. Other stainless steels with different chemical compositions than the series and types mentioned above, may be used for less restrictive applications.

1.4 Wire for welded wire reinforcement is generally manufactured at ~~520 MPa [75 ksi]~~75 ksi [520 MPa] yield strength level. Other strength levels shall be by agreement between the purchaser and manufacturer.

NOTE 2—The term used to refer to yield strength levels are the same as those in ASTM Standards for welded wire reinforcement.

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

A276 Specification for Stainless Steel Bars and Shapes

A342/A342M Test Methods for Permeability of Weakly Magnetic Materials

A370 Test Methods and Definitions for Mechanical Testing of Steel Products

A700 Practices for Packaging, Marking, and Loading Methods for Steel Products for Shipment (Withdrawn 2014)[3]

~~A1064/A1064M Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete~~

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

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

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E83 Practice for Verification and Classification of Extensometer Systems
2.2 *Military Standards:*[4]
MIL-STD-129 Marking for Shipment and Storage
2.3 *Federal Standard:*[4]
Fed. Std. No. 123 Marking for Shipments (Civil Agencies)
2.4 *ACI Standard:*[5]
ACI 318 Building Code Requirements for Structural Concrete
2.5 *Adjuncts:*
Weld Tester Drawing [6]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *stainless steel plain wire and welded plain wire reinforcement*—as used within the scope and intent of this specification, designates a material composed of cold-worked stainless steel wire, as cold-drawn or cold-rolled from stainless steel hot-rolled rod. ~~The welded intersections provide the bond strength for shear resistance.~~

[4] Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, http://www.dodssp.daps.mil.
[5] Available from American Concrete Institute (ACI), P.O. Box 9094, Farmington Hills, MI 48333-9094, http://www.aci-int.org.
[6] Available from ASTM International Headquarters. Order Adjunct No. ADJA0185. Original adjunct produced in 1967.

3.1.1.1 *Discussion—*

The welded intersections provide the bond strength for shear resistance.

3.1.2 *stainless steel deformed wire and welded deformed wire* ~~*reinforcement —*~~*reinforcement—*as used within the scope and intent of this specification, designates a material composed of cold- worked deformed stainless steel wire as cold-drawn or cold-rolled from stainless steel hot-rolled rod. ~~Deformations shall be permitted to be indented or raised rib (protrusion) types. As with plain stainless steel welded wire, the welded intersections provide bond strength for shear resistance and the deformations add to the bond strength.~~

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3.1.2.1 *Discussion—*

Deformations shall be permitted to be indented or raised rib (protrusion) types. As with plain stainless steel welded wire, the welded intersections provide bond strength for shear resistance and the deformations add to the bond strength.

3.1.3 *convoluted wire*—when wire for welded wire reinforcement is formed into a sinusoidal wave shape, it is commonly referred to as convoluted wire. ~~The wire is used in the manufacture of cages for certain applications of concrete pipe reinforcement. Only plain wire is normally subject to convolution.~~

3.1.3.1 *Discussion—*

The wire is used in the manufacture of cages for certain applications of concrete pipe reinforcement. Only plain wire is normally subject to convolution.

4. Ordering Information

4.1 It shall be the responsibility of the purchaser to specify all requirements that are necessary for material ordered to this specification. Such requirement shall include but are not limited to the following:
4.1.1 ~~Quantity–mass (weight)~~Quantity–weight [mass] or square area.
4.1.2 Name of material (for example, stainless steel welded wire for concrete reinforcement).
4.1.3 Wire spacing and wire sizes.
4.1.4 Exclusion of over-steeling or using a larger area of steel than specified.
4.1.5 Length and width of sheets or rolls.
4.1.6 ASTM designation and year of issue.
4.1.7 Application (corrosion resistance or magnetic permeability).
4.1.8 Grade (strength level).
4.1.9 Chemical composition (stainless steel grade).
4.1.10 Heat treatment condition.
4.1.11 Supplementary requirements (if desired).

NOTE 3—A typical ordering description is as follows: For ~~metric~~in-lbs units: ~~10 000~~(100 000 square ~~metres~~feet of welded wire for concrete

TABLE 1 Dimensional Requirements for Plain Wire—SI Units

Size Number[A]	Nominal Diameter, mm	Nominal Area, mm^2
MW 5	2.50	5
MW 10	3.60	10
MW 15	4.40	15
MW 20	5.00	20
MW 25	5.60	25
MW 30	6.20	30
MW 35	6.70	35
MW 40	7.10	40
MW 45	7.60	45
MW 50	8.00	50
MW 55	8.40	55
MW 60	8.70	60
MW 65	9.10	65
MW 70	9.40	70
MW 80	10.10	80
MW 90	10.70	90
MW 100	11.30	100
MW 120	12.40	120
MW 130	12.90	130
MW 200	15.95	200
MW 290	19.22	290

[A] This table represents a hard metrication of the most readily available sizes in the welded wire reinforcement industry. Table 1 shall be used in projects that are designed using SI units: Table 2 shall be used on projects designed using inch-pound units. Areas of wire shall be checked with the most efficient and readily available material from producers. Other wire sizes are available and many manufacturers can produce them in 1-mm^2 increments.

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reinforcement, ~~305×305-MW65×MW65,~~ 12 × 12 – W10 × W10 in flat sheets ~~2438-mm~~96-in. wide by ~~4.6-mm long~~15-ft long) in secured bundles for crane or forklift truck lifts. For ~~in-lbs~~metric units: ~~(100 000~~10 000 square ~~feet~~metres of welded wire for concrete reinforcement, ~~12×12-W10×W10~~ 305 × 305 – MW65 × MW65, in flat sheets ~~96-in.~~2438-mm wide by ~~15-ft long)~~4.6-mm long in secured bundles for crane or forklift truck lifts. Testing shall be in accordance with Test Methods A370.

NOTE 4—Longitudinal wires can be variably spaced. (For example, ~~305×305-MW65×MW65,12×12-W10×W10 or V×305-MD65×MD65 or V×12-D10×D10).~~ V × 12 – D10 × D10 or V × 305 – MD65 × MD65). See the Tables 1 and 2 for wire sizes.

5. Materials

5.1 Stainless steel wire for welded wire reinforcement shall be cold worked, either drawn or rolled from steel rod, which is rolled from properly identified heats of mold or strand cast steel.

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5.2 Cold worked wire or rod used in the manufacture of stainless steel welded reinforcement shall follow the chemical and physical requirements of Specification A276.

6. Manufacture

6.1 The wire or rod 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 welded wire reinforcement. The finished welded wire reinforcement shall be furnished in flat or bent sheets or in rolls as specified by the purchaser.

6.2 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.

6.3 Wire of proper grade and quality when fabricated in the manner herein required shall result in a strong, serviceable product having substantially square or rectangular openings. It shall be fabricated and finished in a quality manner and conform to this specification.

6.4 *General Requirements for Plain Wire:*

6.4.1 *Plain Wire Criteria:*

6.4.1.1 When plain wire is ordered by size number, the relation between size number, diameter, and area shown in Tables 1 and 2 shall apply.

6.4.2 *Testing:*

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

~~6.4.2.2 Test specimens for determining weld-shear properties shall be obtained by cutting from the finished welded wire, a full width section of sufficient length to perform testing described in Specification A1064/A1064M.~~

6.4.2.2 Measurements for conformance to dimensional characteristics shall be made on full sheets or rolls.

TABLE 2 Dimensional Requirements for Plain Wire—Inch-pound Units

Size Number[A]	Nominal Diameter, in.	Nominal Area, in^2
W 0.5	0.080	0.005
W 1.2	0.124	0.012
W 1.4	0.134	0.014
W 2	0.160	0.020
W 2.5	0.178	0.025
W 2.9	0.192	0.029
W 3.5	0.211	0.035
W 4	0.226	0.040
W 4.5	0.239	0.045
W 5	0.252	0.050
W 5.5	0.265	0.055
W 6	0.276	0.060
W 8	0.319	0.080
W 10	0.357	0.100
W 11	0.374	0.110
W 12	0.391	0.120
W 14	0.422	0.140
W 16	0.451	0.160
W 18	0.479	0.180
W 20	0.505	0.200
W 22	0.529	0.220
W 24	0.533	0.240
W 26	0.575	0.260
W 28	0.597	0.280
W 30	0.618	0.300
W 31	0.628	0.310
W 45	0.757	0.450

[A] This table represents the most readily available sizes in the welded wire reinforcement industry in sizes using inch-pound units. Areas of wire shall be checked with the most efficient and readily available material from producers. Other wire sizes are available and many manufacturers can produce them in 0.0015-$in.^2$ increments.

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TABLE 3 Bend Test Requirements—Plain Wire

Size Number Of Wire	Bend Test
~~MW 45 [W 7] and smaller~~	~~Bend around a pin the diameter that is equal to the diameter of the specimen~~
~~Larger than MW 45 [W 7]~~	~~Bend around a pin the diameter that is equal to twice the diameter (2d) of the specimen~~

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TABLE 3 Bend Test Requirements—Plain Wire

Size Number Of Wire	Bend Test
W7 [MW 45] and smaller	Bend around a pin the diameter that is equal to the diameter of the specimen
Larger than W7 [MW 45]	Bend around a pin the diameter that is equal to twice the diameter (2d) of the specimen

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

6.4.2.4 *Reduction of Area*—Shall be determined as described in Test Methods and Definitions A370. The wire shall conform to the reduction of area requirements in Tables 5 and 6.

6.4.2.5 One tension and one bend test shall be made from each ~~9000 kg [10 tons]~~10 tons [9000 kg] or less of each size of wire or fraction thereof.

6.5 *General Requirements for Deformed Wire:*

6.5.1 *Deformation Criteria:*

6.5.1.1 Deformations shall be spaced along the wire at a substantially uniform distance and shall be symmetrically disposed 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.

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

6.5.1.3 The average longitudinal spacing of deformations shall be not less than 3.5 nor more than 5.5 deformations per ~~25 mm (1 in.)~~1 in. [25 mm] in each line of deformations on the wire.

TABLE 4 Permissible Variation in Wire Diameter—Plain Wire

Size Number ~~metric [in-lbs.]~~	Nominal Diameter, ~~mm [in.]~~	Permissible Variation Plus and Minus, ~~mm [in.]~~
~~Smaller than MW 32 [W 5], MW 32 [W 5] to MW 77 [W 12], incl~~	~~Under 6.4 [0.252]~~	~~0.08 [0.003]~~
	~~6.4 [0.252] to 9.93 [0.391], incl~~	~~0.10 [0.004]~~
~~Over to MW 130 [W 20], incl~~	~~Over 9.93 [0.391] to 12.83 [0.505], incl~~	~~0.15 [0.006]~~
~~Over MW 130 [W 20]~~	~~Over 12.83 [0.505]~~	~~0.20 [0.008]~~

TABLE 4 Permissible Variation in Wire Diameter—Plain Wire

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 W5 [MW 32], W5 [MW 32] to W12 [MW 77], incl	Under 0.252 [6.4]	0.003 [0.08]	0.003 [0.08]
	0.252 [6.4] to 0.391 [9.93], incl	0.004 [0.10]	0.004 [0.10]
Over to W20 [MW 130], incl	Over 0.391 [9.93] to 0.505 [12.83], incl	0.006 [0.15]	0.006 [0.15]
Over W 20 [MW 130]	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.

TABLE 5 Tension Test Requirement—Plain Wire

~~Tensile strength, min, MPa [ksi]~~	~~550 [80]~~
Tensile strength, min, psi [MPa]	80 000 [550]
~~Yield strength, min, MPa [ksi]~~	~~485 [70]~~
Yield strength, min, psi [MPa]	70 000 [485]
Reduction of area, min. %	30[A]

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

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TABLE 6 Tension Test Requirement Plain Wire (Material for Welded Wire)

	Size ~~MW 8 [W 1.2]~~W1.2 [MW 8] and Larger	Smaller than Size ~~MW 8[W 1.2]~~W1.2 [MW 8]
~~Tensile strength, min, MPa [ksi]~~	~~515 [75]~~	~~485 [70]~~
Tensile strength, min, psi [MPa]	75 000 [515]	70 000 [485]
~~Yield strength, min, MPa [ksi]~~	~~450 [65]~~	~~385 [56]~~
Yield strength, min, psi [MPa]	65 000 [450]	56 000 [385]
Reduction of area, min. %	30[A]	30[A]

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

6.5.1.4 The minimum average height of the center of typical deformations based on the nominal wire diameters shown in Tables 7 and 8 shall be as follows:

Wire Sizes	Minimum Average Height of Deformations, Percent of Nominal Wire Diameter
~~MD 19 [D 3] and finer~~	~~4~~
~~Coarser than MD 19 [D 3] through MD 65 [D 10]~~	~~4½~~
~~Coarser than MD 65 [D 10]~~	~~5~~

TABLE 7 Dimensional Requirements for Deformed Wire for Concrete Reinforcement in SI Units

Nominal Dimensions					Deformation Requirements
Deformed Wire Size[A,B,C]	D [in^2 X 100]	Unit Mass, kg/m	Diameter, mm[D]	Cross-Sectional Area, mm^2[E]	Minimum Average Height of Deformations, mm[F,G,H]
MD 25	[D 3.9]	0.1962	5.60	25	0.25
MD 30	[D 4.6]	0.2355	6.20	30	0.28
MD 35	[D 5.4]	0.2747	6.70	35	0.30
MD 40	[D 6.2]	0.3140	7.10	40	0.32
MD 45	[D 7.0]	0.3532	7.60	45	0.34
MD 50	[D 7.7]	0.3925	8.00	50	0.36
MD 55	[D 8.5]	0.4317	8.40	55	0.38
MD 60	[D 9.3]	0.4709	8.70	60	0.39
MD 65	[D 10.1]	0.5102	9.10	65	0.46
MD 70	[D 10.8]	0.5494	9.40	70	0.47
MD 80	[D 12.4]	0.6279	10.10	80	0.50
MD 90	[D 13.9]	0.7065	10.70	90	0.54
MD 100	[D 15.5]	0.7849	11.30	100	0.57
MD 120	[D 18.6]	0.9419	12.40	120	0.62
MD 130	[D 20.1]	1.0204	12.90	130	0.64
MD 200	[D 31.0]	1.5700	15.95	200	0.80
MD 290	[D 45.0]	2.2700	19.22	290	0.96

[A] The number following the prefix indicates the nominal cross-sectional area of the deformed wire in square millimetres.
[B] 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 letters MD.
[C] 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.
[D] The nominal diameter of a deformed wire is equivalent to the diameter of a plain wire having the same mass per meter as the deformed wire.
[E] The cross-sectional area is based on the nominal diameter. 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).
[F] The minimum average height of the deformations shall be determined from measurements made on not less than two typical deformations from each line of deformations on the wire. Measurements shall be made at the center of indentation as described in 6.5.1.7.
[G] Spacing of deformations shall not be greater than 7.24 mm nor less than 4.62 mm for all wire sizes.
[H] See 6.5.1.6 for average longitudinal number of deformations per unit length.

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Wire Sizes	Minimum Average Height of Deformations, Percent of Nominal Wire Diameter
D3 [MD 19] and smaller	4
Larger than D3 [MD 19] through D10 [MD 65]	4½
Larger than D10 [MD 65]	5

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6.5.1.5 The deformations shall be placed with respect to the axis of the wire so that the included angle is not less than 45°; or if deformations are curvilinear, the angle formed by the transverse axis of the deformation and the wire axis shall be not less than 45°. Where the line of deformations forms an included angle with the axis of the wire from 45° to 70° inclusive, the deformations shall alternately reverse in direction on each side, or those on one side shall be reversed in direction from those on the opposite side. Where the included angle is over 70°, a reversal in direction is not required.

6.5.1.6 The average spacing of deformations shall be determined by dividing a measured length of the wire specimen by the number of individual deformations in any one row of deformations on any side of the wire specimens. A measured length of the wire specimen shall be considered the distance from a point on a deformation to a corresponding point on any other deformation in the same line of deformations on the wire.

6.5.1.7 The minimum average height of deformations shall be determined from measurements made on not less than two typical deformations from each line of deformations on the wire. Measurements shall be made at the center of indentations or raised ribs.

6.5.2 *Mechanical Property Requirements for Deformed Wire:*

6.5.2.1 *Testing:*

~~(1) When tested as described in Test Methods and Definitions A370, the material, except as specified in 6.5.2.1.2 shall conform to the tensile property requirements in Table 9, based on nominal area of wire.~~

(1) When tested as described in Test Methods and Definitions A370, the material, except as specified in 6.5.2.1 (*2*) shall conform to the tensile property requirements in Table 9, based on nominal area of wire.

(2) The yield strength shall be determined as described in Test Methods and Definitions A370 at an extension of 0.5 % of gage length. For determining the yield strength use a Class B-1 extensometer as described in E83.

(3) For material to be used in the fabrication of welded wire, the tensile and yield strength properties shall conform to the requirements given in Table 6, based on nominal area of the wire.

(4) Materials shall be measured at extension under load and shall not be required to 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. The purchaser shall have the option to accept this feature as sufficient evidence of compliance with the specified minimum yield strength tests covered in this specification.