



## SECTION 1043

### FENCE MATERIAL

**1043.1 Scope.** These specifications cover the material required in the construction of chain-link fence and woven wire fence.

#### Chain-Link Fence Material

**1043.2 Chain-Link Fence Description.** Chain-link fence and gates shall be comprised (1) of fabric composed of individual pickets helically wound and interwoven in the form of a continuous chain-link fabric without knots or ties except knuckling or twisting at the ends of pickets to form the selvage of the fabric, and (2) of posts, rails, ties, bands, bars, rods, tension wire and other fittings and hardware.

**1043.2.1 Fabric General Requirements.** Fabric shall consist of wire woven into the form of approximately uniform square mesh, having parallel sides and horizontal and vertical diagonals of approximately uniform dimensions.

**1043.2.1.1** The mesh size shall be 2 inches (50.8 mm), measured in either direction as the minimum clear distance between the wires forming the parallel sides of the mesh. A variation of mesh size of plus or minus 1/8 inch (3.2 mm) will be permitted.

**1043.2.1.2** The height of fabric shall be the overall dimension from ends of twists or knuckles, measured without tension applied. A variation in height of plus or minus one inch (25 mm) will be permitted.

**1043.2.1.3** Chain-link fabric shall be fabricated from wire with diameters as necessary to meet the requirements of Table I. A variation of plus or minus 0.005 inch (0.127 mm) will be permitted. For zinc coated or aluminum coated fabric, the specified diameter is the coated wire diameter and the permissible tolerance is applied to the coated wire. For vinyl coated (PVC) fabric the specified diameter is the metallic coated core wire and the permissible tolerance is applied only to the metallic coated core wire. The thickness of the PVC coating will not be used in determining wire size. For aluminum alloy fabric, the specified diameter is the finished wire.

**1043.2.1.4** Wire used for fabric shall meet the minimum breaking load as shown in Table II.

**1043.2.1.5** Fabric less than 72 inches (1829 mm) high shall be knuckled at both selvages. Fabric 72 inches (1829 mm) high or higher shall be knuckled at one selvage and twisted at the other. Knuckling is the selvage obtained by interlocking adjacent pairs of wire ends and bending the wire back into a loop. Twisting is the selvage obtained by twisting adjacent pairs of wire ends and bending together in a close helix of 1 1/2 machine turns, which is the equivalent of three full twists, and cutting the wire ends at an angle with the ends beyond the twist at least 1/4 inch (6 mm) long.

**1043.2.2 Zinc Coated Steel Fabric.** Wire used for zinc coated chain-link fabric may be coated before or after weaving into fabric. Fabric that is zinc coated after weaving shall be hot-dip galvanized in a continuous process and the coating shall not be applied to the fabric in

roll form. Wire that is zinc coated before weaving into fabric may be either hot-dip galvanized or electrolytically zinc-plated. The weight (mass) of zinc coating shall not be less than 2.0 ounces per square foot ( $610 \text{ g/m}^2$ ) of uncoated wire surface, determined from the average of all specimens representing the lot and not less than 1.8 ounces per square foot ( $550 \text{ g/m}^2$ ) on an individual specimen. Excessive lumps, beads and drops of zinc will be excluded in determining weight (mass) of coating.

**1043.2.3 Aluminum Coated Steel Fabric.** Wire used for aluminum coated chain-link fabric shall be coated by the hot-dip process before weaving into fabric. The weight (mass) of aluminum coating shall not be less than 0.40 ounce per square foot ( $122.1 \text{ g/m}^2$ ) of uncoated wire surface on 0.148 inch (3.76 mm) or 0.192-inch (4.88 mm) specified diameter wire and 0.35 ounce per square foot ( $106.8 \text{ g/m}^2$ ) of uncoated wire surface on 0.120-inch (3.05 mm) specified diameter wire, determined from the average of all specimens representing the lot. An individual specimen shall not have less than 0.30 ounce per square foot ( $92 \text{ g/m}^2$ ) of uncoated wire surface on 0.148 or 0.192-inch (3.76 or 4.88 mm) specified diameter wire and not less than 0.25 ounce per square foot ( $76.3 \text{ g/m}^2$ ) on 0.120-inch (3.05 mm) specified diameter wire.

**1043.2.4 Vinyl Coated Steel Fabric.** Wire used for vinyl coated chain-link fabric shall be coated before weaving into fabric. Vinyl used for coatings shall be polyvinyl chloride (PVC) and shall be plasticized and thoroughly compounded so there is full dispersement of pigments, stabilizers and other components. The color shall be uniformly green. The PVC coating shall meet the requirements of AASHTO M 181 for adhesion, accelerated aging, mandrel test and green color.

**1043.2.4.1** Extruded or extruded and bonded PVC coated wire shall be coated with zinc or aluminum by either the hot-dip or electrolytic process prior to being coated with PVC. The weight (mass) of zinc or aluminum and thickness of PVC shall be as shown in Table III.

**1043.2.4.2** Bonded PVC coated wire shall be coated with zinc by either the hot-dip or electrolytic process prior to having a PVC coating thermally fused and bonded to a primer that has been thermally cured onto the zinc coated wire. The weight (mass) of zinc or aluminum and thickness of PVC coating shall be as shown in Table III.

**1043.2.5 Aluminum Alloy Fabric.** Wire used for aluminum alloy fabric shall be aluminum alloy. The finished fabric shall be of uniform quality and have the properties and characteristics herein specified.

**1043.2.6 Posts, Braces, Rails and Gate Frames .** These members shall be of the shape and dimension as shown on the plans and shall be steel or aluminum alloy complying with the requirements of these specifications. Steel members shall have an interior and exterior coating as herein specified. These members may be used with either zinc coated, aluminum coated, aluminum alloy or vinyl coated fabric.

**1043.2.6.1 Zinc Coated Steel Members.** Zinc coated steel members shall comply with the requirements of ASTM F 1043, heavy industrial fence Group IA, with Type A interior and exterior coating, and the standard plans.

**1043.2.6.2 Zinc Plus Organic Coated Steel Members.** Zinc plus organic coated steel members shall comply with the requirements of ASTM F 1043, heavy industrial fence Group IC, with Type B or D interior coating and Type B exterior coating, and the standard plans.

**1043.2.6.3 Aluminum Alloy Members.** Aluminum alloy members shall comply with the requirements of ASTM F 1043, heavy industrial fence Group IB, and the standard plans.

**1043.2.7 Tension Wire .** Tension wire shall be of steel coil spring wire with a coated wire diameter of 0.177 inch (4.496 mm) plus or minus 0.005 inch (0.127 mm) and shall have a minimum breaking load of 1950 pounds force (8.7 kN). The tension wire shall have a zinc coating of not less than 0.80 ounce per square foot (240 g/m<sup>2</sup>) of uncoated wire surface or an aluminum coating of not less than 0.40 ounce per square foot (120 g/m<sup>2</sup>) of uncoated wire surface.

**1043.2.8 Fabric Fasteners.** Fabric fasteners shall consist of wire ties, hog rings and C-clips. Fasteners for use with zinc or aluminum coated steel fabric shall conform to [Sec 1043.2.8.1](#) or [1043.2.8.2](#) those for use with aluminum alloy fabric shall conform to [Sec 1043.2.8.2](#) and those for use with vinyl coated steel fabric shall conform to [Sec 1043.2.8.3](#). Fasteners shall be capable of withstanding a 180 degree bend over its own diameter without fracture of the wire or loss of adherence of coating. The wire shall have a finished or coated diameter of not less than 0.143 inch (3.632 mm), except C-clips for attaching fabric to H section posts shall have a finished or coated diameter of not less than 0.187 inch (4.750 mm). Aluminum alloy C-clips will not be permitted for fastening fabric to H section posts.

**1043.2.8.1 Zinc or Aluminum Coated Fabric Fasteners.** The wire shall be zinc coated at a rate of not less than 0.70 ounce per square foot (210 g/m<sup>2</sup>) or aluminum coated at a rate of not less than 0.30 ounce per square foot (91.5 g/m<sup>2</sup>).

**1043.2.8.2 Aluminum Alloy Fabric Fasteners.** The wire shall be of aluminum alloy having a minimum tensile strength of 16,000 pounds per square inch (110 MPa).

**1043.2.8.3 Vinyl Coated Fabric Fasteners.** The wire may be of steel or aluminum alloy and shall be uniformly coated with the same vinyl material as used to coat the fence fabric. Vinyl coating thickness shall be a minimum of 0.010 inch (254 μm). Aluminum alloy wire shall have a minimum tensile strength of 16,000 pounds per square inch (110 MPa).

**1043.2.9 Miscellaneous Fittings and Hardware .** Miscellaneous fittings and hardware may be zinc coated steel or aluminum alloy. Aluminum alloy fittings shall not be used with zinc coated steel posts, rails or gate frames.

**1043.2.9.1 Zinc Coated Steel Fittings and Hardware.** Miscellaneous steel fittings and hardware shall be of commercial grade steel or better quality, wrought or cast as appropriate to the article, and sufficient in strength and other properties to provide a balanced design when used with fabric, posts and wires of the qualities specified herein. All steel fittings and hardware including any items less than 1/8 inch (3 mm) thick shall be protected with a zinc coating conforming to the requirements of AASHTO M 111, except the weight (mass) of zinc coating shall not be less than 1.80 ounces per square foot (549 g/m<sup>2</sup>), determined from the average of all specimens representing the lot and not less than 1.60 ounces per square foot (488 g/m<sup>2</sup>) on an individual specimen.

**1043.2.9.2 Aluminum Alloy Fittings and Hardware.** Miscellaneous aluminum fittings and hardware shall be wrought or cast aluminum alloy conforming to the requirements set forth in Table IV.

**1043.2.10 Gates.** Frames shall be fastened at the corners by clamps and braces or by welding. If corners are to be welded, the ends of the vertical members shall be hemispherically notched, by removal of metal, to fit snugly to the horizontal members. The joint shall be uniformly and continuously fillet welded. The welded area and adjacent damaged coating shall be recoated by the hot-dip process or metallizing process; or covered with two coats of zinc-rich paint. The material for repair of welded areas and applications shall meet the approval of the engineer. Each gate frame shall be cross braced with not less than two 3/8-inch (9.5 mm) adjustable truss rods. The filler for gates shall be chain-link fabric

of the same kind used for the fence. This filler shall be attached to the frame with stretcher bars and wire ties or clamps. Gates 6 feet (1828 mm) high or less shall be equipped with two hinges, and gates more than 6 feet (1828 mm) high shall have three hinges. All gates, walk and drive, shall be equipped with a latch and locking attachment. Gatekeepers and center rests of an approved design shall be installed for double drive gates.

**1043.2.11 Barbed Wire.** Barbed wire for use with chain-link fence shall be zinc-coated steel, aluminum coated steel or aluminum alloy. Zinc coated barbed wire shall consist of two No. 12 1/2, 13 1/2 or 15 1/2 (2.51 mm, 2.18 mm or 1.70 mm) gage line wires twisted with 4-point barbs uniformly spaced approximately 4 or 5 inches (100 or 125 mm) apart and shall conform to requirements of AASHTO M 280 except the minimum weight (mass) of coating shall be 0.80 ounce per square foot (245 g/m<sup>2</sup>) of uncoated wire surface for all gages. Aluminum coated barbed wire shall conform to the requirements for zinc coated barbed wire except that the coating shall be aluminum alloy. The weight (mass) of coating per square foot (square meter) of surface shall not be less than 0.25 ounce (75 g/m<sup>2</sup>) for both line wires and barbs. However, barbs of suitable aluminum alloy will be permitted. Aluminum alloy barbed wire shall be aluminum alloy 5052-H38, ASTM B 211. Aluminum alloy barbed wire shall consist of two 0.110-inch (2.794 mm) line wires twisted with 4-point 0.080-inch (2.032 mm) diameter wire barbs spaced 5 inches (125 mm) apart.

### **Woven Wire Fence Material**

**1043.3 Woven Wire Fence Description.** Woven wire fence shall be composed of woven wire, barbed wire, brace wire, posts, ties, fittings and hardware.

**1043.3.1 Fabric.** The fabric shall be made of zinc coated or aluminum coated steel wire. Zinc coated fabric shall conform to the requirements of AASHTO M 279, for Design Number 939-6-11, Grade 60 or 939-6-12.5, Grade 125. The minimum weight (mass) of zinc coating shall be Class 3 for all gages. Line wires shall have tension curves. Aluminum coated fabric shall conform to the requirements for zinc coated fabric except that the coating shall be aluminum alloy applied at the rate of not less than 0.25 ounce per square foot (75 g/m<sup>2</sup>) of uncoated wire surface.

**1043.3.2 Barbed Wire.** Barbed wire for use with zinc coated steel fabric or aluminum coated steel fabric shall conform to the requirements of [Sec 1043.2.11](#).

**1043.3.3 Wood Posts.** Wood posts and braces shall conform to the requirements of [Sec 1050.2.3](#).

**1043.3.4 Steel Posts.** Steel posts and braces shall conform to the requirements of [Sec 1043.2.6](#). Corner, end and pull posts shall be pipe of the sizes and weights (masses) shown on the plans. Line posts shall be of the lengths and shapes shown on the plans. They shall have a nominal weight (mass) of 1.33 pounds per linear foot (1.98 kg/m) and a minimum weight (mass) of 1.28 pounds per linear foot (1.90 kg/m), exclusive of anchor plate.

**1043.3.5 Post Tops and Miscellaneous Hardware .** Post tops and miscellaneous fittings and hardware shall conform to the requirements of [Sec 1043.2.9.1](#).

**1043.3.6 Brace Wire.** Brace wire shall not be less than 0.143-inch (3.632 mm) diameter and of material conforming to the requirements of [Sec 1043.3.1](#).

**1043.3.7 Staples.** Staples shall be of the screw shank type or equivalent, a minimum of 1 1/4 inches (30 mm) long, galvanized and of good commercial quality.

**1043.3.8 Wire Ties.** Wire used for ties shall conform to the requirements of [Sec 1043.2.8](#) except that the wire may have a minimum diameter of 0.115 inch (2.921 mm).

**1043.3.9 Gates.** Gates for woven wire fence shall conform to the requirements of [Sec 1043.2.10](#) except that the filler shall be woven wire fabric meeting these specifications.

#### **Workmanship and Finish**

**1043.4** Fabrication of chain-link or woven wire fencing material furnished under these specifications shall conform to the sizes, shapes and dimensions shown on the plans and shall show careful finished workmanship. Excessive roughness, blisters, sal-ammoniac spots, bruises, flaking, voids in coating, frozen knuckles or other defects if present to any considerable extent shall provide a basis for rejection. Polyvinyl chloride coating shall be without voids and without tears or cuts that reveal the substrate. Welded seam pipe shall have smooth welds without skips or gaps. Non-uniform or damaged organic topcoats shall provide a basis for rejection whether caused by fabrication, shipping or handling on the job. All burrs at the ends of posts and rails shall be removed.

#### **Sampling and Testing**

**1043.5 Sampling.** The engineer will determine the sample size and frequency.

**1043.6 Testing.** When fencing material are tested, the tests shall be in accordance with the following methods.

**1043.6.1** Weight (mass) of hot-dip zinc coatings shall be determined in accordance with AASHTO T 65 or, at the option of the engineer, material may be accepted on the basis of magnetic gauge determinations made in accordance with ASTM E 376.

**1043.6.2** Thickness of zinc-rich organic coating shall be determined by magnetic gauge determinations made in accordance with ASTM E 376.

**1043.6.3** Weight (mass) of aluminum coating shall be determined in accordance with AASHTO T 213 or, at the option of the engineer, material may be accepted on the basis of magnetic gauge determinations made in accordance with ASTM E 376.

**1043.6.4** Thickness of organic topcoat shall be determined by first determining the total thickness of the organic topcoat and exterior hot-dip zinc coating by magnetic gauge determinations made in accordance with ASTM E 376, then chemically stripping the organic topcoat and determining the thickness of only the exterior hot-dip zinc in accordance with AASHTO T 65 or ASTM E 376. The difference between the two measurements is the thickness of the organic topcoat.

**1043.6.5** Tensile strength or breaking load - AASHTO T 68.

#### **Inspection**

**1043.7** The engineer shall have free entry, at all times, to all parts of the manufacturer's or fabricator's works that concern the manufacture or fabrication of material furnished under this specification. Each product or article furnished under this specification shall be subject to inspection at the factory, fabricating plant, in laboratories of the engineer's choosing or at the point of delivery. The engineer reserves the right to sample and test each product or article subsequent to acceptance at the place of manufacture or fabrication, to determine conformance with the requirements of this specification, or to verify a certification.

## Certification

**1043.8** Certifications in triplicate are required as follows.

**1043.8.1 Vinyl Coated Material.** The contractor shall submit to the engineer a certification certifying that the vinyl material and vinyl coated fabric meets the requirements of these specifications. If vinyl coated items other than chain-link fabric are furnished, a certification is also required.

**1043.8.2 Aluminum Alloy Material.** The contractor shall submit to the engineer a certification certifying that the material conforms to the requirements specified and shall include or have attached typical physical properties representative of the material.

**1043.8.3 Organic Topcoated Material.** The contractor shall submit to the engineer a certification certifying that the material conforms to the requirements specified and that the material is the same as prequalified by the engineer.

## Packaging and Marking

**1043.9** Packaging and marking of the material shall provide ease of handling, storage and identification.

**1043.9.1** Each length of chain-link fabric, woven wire fabric or barbed wire shall be tightly rolled and firmly tied. Each roll shall carry a tag showing, as applicable to the product, the length, kind of base metal, type of coating, specified wire size, mesh size, design (style), height or width of fabric, and the producer name, brand or trademark of the manufacturer.

**1043.9.2** Each bundle or container of posts, hardware and fittings shall be marked with the name, brand or trademark of the manufacturer, type of material (steel, cast iron, aluminum alloy number, etc.), type of coating and any additional data required for proper identification or to determine apparent conformance to specified quality requirements.

<b>TABLE I</b>		
<b>Wire Size and Height of Fabric</b>		
<b>Specified Diameter<sup>a</sup></b>		<b>Height of Fabric,</b>
<b>in. (mm)</b>	<b>Gage</b>	<b>In. (mm)</b>
0.120 (3.048)	11	36, 42 (914, 1068)
0.148 (3.759)	9	48, 60 (1219, 1524)
0.192 (4.877)	6	72-144 (1829- 3658)

<sup>a</sup> See [Sec 1043.2.1.3](#) for definition of specified diameter and tolerances.

<b>TABLE II</b>				
<b>Breaking Load of Wire</b>				
<b>Specified Diameter</b>		<b>Breaking Load, min., lbf (N)</b>		
<b>in. (mm)</b>	<b>Gage</b>	<b>Zinc Coated and Aluminum Coated</b>	<b>Aluminum Alloy</b>	<b>PVC Coated<sup>a</sup></b>
0.120 (3.05)	11	850 (3780)	610 (2713)	850 (3780)
0.148 (3.76)	9	1290 (5738)	930 (4136)	1290 (5738)
0.192 (4.88)	6	2170 (9652)	1560 (6939)	2170 (9652)

<sup>a</sup> The PVC coating may be mechanically or chemically removed prior to testing, if desired.

<b>TABLE III</b>			
<b>PVC Coated Wire Coating Thickness and Weight (Mass)</b>			
		<b>PVC Thickness, Range</b>	
<b>Specified Diameter of Metallic Coated Core Wire<sup>a</sup></b> <b>in. (mm)</b>	<b>Weight (Mass) of Zinc or Aluminum Coating of Uncoated Wire Surface, min.,</b> <b>oz/ft<sup>2</sup>(g/m<sup>2</sup>)</b>	<b>Bonded Coatings</b> <b>in. (mm)</b>	<b>Extruded or Extruded and Bonded Coatings,</b> <b>in. (mm)</b>
0.120 (3.05)	0.30 (91.5)	0.006 - 0.010 (0.15 - 0.25)	0.015 - 0.025 (0.38 - 0.64)
0.148 (3.76)	0.30 (91.5)	0.006 - 0.010 (0.15 - 0.25)	0.015 - 0.025 (0.38 - 0.64)
0.192 (4.88)	0.40 (122.1)	All Gages	All Gages

<sup>a</sup> The PVC coating shall not be used when determining wire size.

<b>TABLE IV</b>			
<b>Miscellaneous Aluminum Alloy Fittings and Hardware</b>			
		<b>Aluminum Alloy</b>	
<b>Item</b>	<b>Type of Material</b>	<b>Alloy &amp; Temper</b>	<b>ASTM Designation</b>
Rail and Brace Ends, Post Tops and Turnbuckles	Castings	356.0-T6 712.0-T5, 713.0-T5, A360.0, 360.0, 413.0	B26, B85, B108
Gate Hinges, Barbed Wire Extension Arms and Other Fittings	Castings	Same as above	----
Stretcher Bars and Bands	Bar	6063-T6	B 221
Truss or Brace Rods		6061-T6	B 221
Flat Band Ties	Sheet	3003-H14	B 209
Bolts		2024-T4	F 468
Nuts		6061-T6	F 467