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# StandardSpecification for Steel Fibers for Fiber-Reinforced Concrete[1]

This standard is issued under the fixed designation A820/A820M; 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 minimum requirements for steel fibers intended for use in fiber-reinforced concrete. Five types of steel fibers for this purpose are defined as pieces of smooth or deformed cold-drawn wire; smooth or deformed cut sheet; melt-extracted fibers; mill-cut or modified cold-drawn wire steel fibers that are sufficiently small to be dispersed at random in a concrete mixture.

1.2 This specification provides for measurement of dimensions, tolerances from specified dimensions, and required minimum physical properties, and prescribes testing procedures to establish conformance to these requirements.

1.3 In the case of conflict between a requirement of a product specification and a requirement of this specification, the product specification shall prevail. In the case of a conflict between a requirement of the product specification or a requirement of this specification and a more stringent requirement of the purchase order, the purchase order shall prevail. The purchase order requirements shall not take precedence if they, in any way, violate the requirements of the product specification or this specification; for example, by the waiving of a test requirement or by making a test requirement less stringent.

1.4 The values stated in either SI units or inch-pound units are to be regarded separately as standard. 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 The following documents, of the issue in effect on the date of material purchase, form a part of this specification to the extent referenced herein.

2.2 *ASTM Standards:*[2]

A370 Test Methods and Definitions for Mechanical Testing of Steel Products

A700 Practices for Packaging, Marking, and Loading Methods for Steel Products for Shipment

C1116/C1116M Specification for Fiber-Reinforced Concrete

2.3 *ACI Documents:*[3]

ACI 506.1 Guide to Fiber-Reinforced Shotcrete

ACI 544.1R Committee Report on Fiber-Reinforced Concrete

2.4 *U.S. Federal Standards:*[4]

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)

2.5 *U.S. Military Standards:*[4]

MIL-STD-129 Marking for Shipment and Storage

## 3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *deformed fiber, n*—a fiber that is bent, flattened, or roughened to improve mechanical bond to the concrete matrix.

3.1.2 *modified fiber, n*—a cold-drawn wire fiber whose cross-section has been changed from circular by shaving the wire.

3.1.3 *nominal length, n*—the length of a deformed fiber, out-to-out, after being deformed.

3.1.4 *range of equivalent diameter, $d_{e-r}$, n*—a set of limits placed on the equivalent diameter by the specifier. See 8.1.6 and Note 3.

3.2 *Symbols*—The following symbols used in this specification are defined as follows:

$A$ = cross-sectional area, in.$^2$ [mm$^2$]
$d$ = diameter, in. [mm]
$f_u$ = ultimate tensile strength, psi [MPa]
$l$ = length, in. [mm]
$\lambda = l/d$ = aspect ratio

[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 American Concrete Institute (ACI), P.O. Box 9094, Farmington Hills, MI 48333-9094, http://www.concrete.org.

[4] Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, http://dodssp.daps.dla.mil.

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

3.2.1 The subscript *n* on dimensional units indicates "nominal" and the subscript *e* indicates "equivalent." "Nominal" and "equivalent" dimensions are calculated from other measurable dimensions or average weight [mass].

## 4. Classification

4.1 Five general types of steel fibers are identified in this specification based upon the product or process used as a source of the steel fiber material.

4.1.1 Type I, cold-drawn wire.
4.1.2 Type II, cut sheet.
4.1.3 Type III, melt-extracted.
4.1.4 Type IV, mill cut.
4.1.5 Type V, modified cold-drawn wire.

4.2 Fibers shall be straight or deformed.

## 5. Ordering Information

5.1 It shall be the responsibility of the purchaser to specify all requirements that are necessary for the product under this specification. Such requirements to be considered include, but are not limited to, the following:

5.1.1 ASTM designation and year of issue,
5.1.2 Quantity in pounds or tons [kilograms],
5.1.3 Type or types permissible (4.1),
5.1.4 Diameter or equivalent diameter (8.1.4), or range of equivalent diameters (8.1.6),
5.1.5 Length or nominal length (3.1.3),
5.1.6 Deformations, if required, and
5.1.7 Whether certification by the manufacturer is required including whether a report is to be furnished (Section 11).

NOTE 1—For information on satisfactory sizes and aspect ratios, see ACI 544.1R and ACI 506.1, and contact the manufacturers regarding availability.

## 6. Materials and Manufacture

6.1 The materials and manufacturing methods used shall be such that the fibers produced conform to the requirements in this specification.

## 7. Mechanical Properties

7.1 *Tensile Requirements:*

7.1.1 At least ten individual tensile tests of randomly selected finished fibers shall be performed for each 5 tons [4 500 kg] of product. This is an approximate distribution of one fiber tensile test per every 0.5 ton [450 kg] of finished product. The average tensile strength, $f_u$, of each fiber shall not be less than 50 000 psi [345 MPa]. The tensile strength of any one of the ten specimens shall not be less than 45 000 psi [310 MPa]. Where the parent source material consists of sheet or wire, tensile tests by the manufacturer may be performed on larger samples of source material. One sample of each different source material used shall then be tested for each 5 tons [4 500 kg] of material. The tensile strength of a single sample of source material shall not be less than 50 000 psi [345 MPa].

7.1.2 The cross-sectional area used to compute $f_u$ shall be carried out to five decimal places, in units of square inches [square millimetres], and shall be: *(1) for drawn wire fibers, Type I*, the area calculated from the actual diameter of the parent source material or finished fiber; *(2) for cut sheet fibers, Type II*, the area calculated from the actual thickness and width of the parent source material specimen, or if fibers are tested, the area of each individual fiber calculated from measured length and weight [mass] of the fiber. See 8.1.5. *(3) for melt-extracted fibers, Type III, or mill-cut fibers, Type IV, specified by equivalent diameter*, the area calculated from the equivalent diameter of the fibers. See 8.1.5; and *(4) for modified cold drawn wire fibers, Type V, specified by a range of equivalent diameters*, the area of each individual fiber calculated from the measured length and weight [mass] of the fiber. See 8.1.6. The ultimate tensile load in pounds-force [newtons] for individual fibers shall be measured to at least three significant figures. Testing shall be in accordance with Test Methods and Definitions A370, where applicable.

7.2 *Bending Requirements:*

7.2.1 Fibers shall withstand being bent around a 0.125 in. [3.2 mm] diameter pin to an angle of 90° at temperatures not less than 60°F [16°C] without breaking.

NOTE 2—The bending requirements of this specification provide a general indication of fiber ductility, as may be important in resisting breakage during handling and mixing operations. Ductility measures of fiber-reinforced concrete are outside the scope of this specification; see ACI 544.1R.

7.2.2 Bend tests shall be conducted on ten randomly selected specimens of finished fibers. It shall be permissible to perform bend tests manually. At least one test consisting of ten specimens shall be made for each 5 tons [4 500 kg] of material. At least 90 % of the specimens must pass the test.

## 8. Dimensions and Permissible Variations

8.1 *Dimensions:*

8.1.1 Straight cold-drawn wire (Type I) fibers are specified by diameter ($d$) or equivalent ($d_e$) and length ($l$), that establish a specified aspect ratio, ($\lambda$), or ($\lambda_e$), as ($l / d$) or ($l / d_e$).

8.1.2 Deformed cold-drawn wire (Type I) fibers are specified by the diameter ($d$) or equivalent diameter ($d_e$) and nominal length after bending ($l_n$). Nominal aspect ratio ($\lambda_n$) is established as ($l_n / d$) or ($l_n / d_e$).

8.1.3 Cut sheet (Type II) fibers are specified by thickness ($t$), width ($w$), and length ($l$). Aspect ratio ($\lambda$) can be computed as:

$$\lambda = l/d_e$$

where:

$A$ = $tw$, and
$d_e$ = equivalent diameter $= \sqrt{4A/\pi}$ .

8.1.4 Deformed cut sheet (Type II) fibers are specified by thickness ($t$), width ($w$), and nominal length after deformation ($l_n$). Nominal aspect ratio ($\lambda_n$) can be computed as follows.

$$\lambda = l_n/d_e$$

where:

$A$ = $tw$, and
$d_e$ = equivalent diameter $= \sqrt{4A/\pi}$ .

8.1.5 Melt-extracted (Type III) and mill-cut (Type IV) fibers are specified by equivalent diameter, ($d_e$), and length ($l$), or nominal length ($l_n$). Equivalent diameter is computed from