



# Standard Specification for Steel Fibers for Fiber-Reinforced Concrete<sup>1</sup>

This standard is issued under the fixed designation A 820; 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 ( $\epsilon$ ) 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. Four 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; or other 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 inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

## 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*:

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products<sup>2</sup>

C 1116 Specification for Fiber-Reinforced Concrete and Shotcrete<sup>3</sup>

2.3 *ACI Document*:

544.1R Committee Report on Fiber-Reinforced Concrete<sup>4</sup>

## 3. Terminology

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

$A$  = cross-sectional area, in.<sup>2</sup> (mm<sup>2</sup>)

$d$  = diameter, in. (mm)

$f_u$  = ultimate tensile strength, psi (MPa)

$l$  = length, in. (mm)

$\lambda = l/d$  = aspect ratio

3.1.1 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 weights (masses).

## 4. Classification

4.1 Four general types of steel fibers are identified in this specification based upon the product 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, other fibers.

4.2 Fibers may 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 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 (kg or Mg),

5.1.3 Type or types permissible (4.1),

5.1.4 Diameter or equivalent diameter (8.1), or range of equivalent diameters (8.1.5),

5.1.5 Length or nominal length (8.1),

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 contact the manufacturers regarding availability.

<sup>1</sup> 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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<sup>2</sup> *Annual Book of ASTM Standards*, Vol 01.03.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 04.02.

<sup>4</sup> Available from American Concrete Institute, P.O. Box 9094, Farmington Hills, MI 48333-9094.

## 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 one tensile test, consisting of 10 randomly selected finished fibers, shall be performed for each 5 tons (4.5 Mg). The average tensile strength,  $f_u$ , 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 of material or each shipment if less than 5 tons. The tensile strength of a single sample of source material shall not be less than 50 000 psi.

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, measured to the nearest  $2.2 \times 10^{-7}$  lb (0.0001 g), based on a density of 0.2836 lb/in<sup>3</sup> (7850 kg/m<sup>3</sup>); and (3) for melt-extraction fibers, Type III, or other fibers, Type IV, specified by equivalent diameter, the area calculated from the equivalent diameter of the fibers. See 8.1.5. 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 A 370, where applicable.

### 7.2 Bending Requirements:

7.2.1 Fibers shall withstand being bent around a 0.125-in. (3.18-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 (4.5 Mg) of material or each shipment if less than 5 tons. 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 ( $l/d$ ) 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 length

(out-to-out) after bending ( $l_n$ ). Nominal aspect ratio ( $\lambda_n$ ) is established as ( $l_n/d$ ) or ( $l_n/d_e$ ). See Fig. 1.

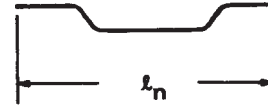


FIG. 1 Deformed Cold-Drawn Fibers

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

$$l / \sqrt{4A / \pi} = l / d_e$$

where:

$A = tw$ , and

$d_e =$  equivalent diameter. See Fig. 2.

8.1.4 Deformed cut sheet (Type II) fibers are specified by thickness ( $t$ ), width ( $w$ ), and out-to-out length after deformation ( $l_n$ ). Nominal aspect ratio ( $\lambda_n$ ) can be computed as follows. See Fig. 3.

$$l_n / \sqrt{4A / \pi} = l_n / d_e$$

8.1.5 Melt-extracted (Type III) or other fibers are specified by a range of equivalent diameters, ( $d_e$ ), and length ( $l$ ). Equivalent diameter is computed from measured average length and the weight (mass) of a known quantity of fibers, based upon 0.2836 lb/in<sup>3</sup> (7850 kg/m<sup>3</sup>). See Fig. 4.

### 8.2 Measurement of Dimensions:

8.2.1 Measurement of dimensions shall be performed on not less than 10 randomly selected specimens for each test to establish the average for conformance to specified tolerances. At least 90 % of the specimens in each test shall meet the specified tolerances for length, diameter or equivalent diameter, and aspect ratio.

8.2.2 At least one test shall be performed for 5 tons (4.5 Mg) of material or each shipment if less than 5 tons.

### 8.3 Permissible Variations:

8.3.1 The length, or nominal length shall not vary from its specified value more than  $\pm 10$  %.

8.3.2 The diameter or equivalent diameter shall not vary from its specified value more than  $\pm 10$  %.

8.3.3 The aspect ratio or nominal aspect ratio shall not vary from its specified value more than  $\pm 15$  %.

## 9. Workmanship, Finish, and Appearance

### 9.1 Surface Condition:

9.1.1 Seams and surface irregularities shall not be cause for rejection provided that tensile properties are not less than

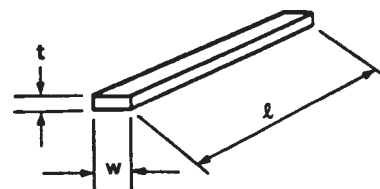
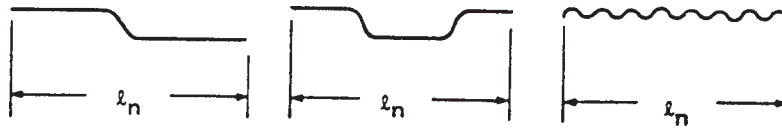
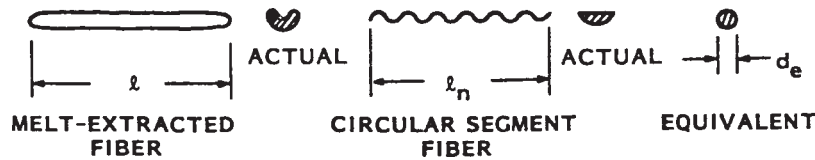


FIG. 2 Cut Sheet Fibers


**FIG. 3 Deformed Cut Sheet Fibers**

**FIG. 4 Melt-Extracted and Other Fibers**

requirements of this specification and mixing performance in concrete is not adversely affected.

9.1.2 Rust, mill scale, or other coatings shall not be cause for rejection provided that the individual fibers separate when mixed in concrete in accordance with Specification C 1116, and tensile and bending properties are not less than the requirements of this specification.

## 10. Inspection

10.1 Unless otherwise specified in the purchase order or contract, the manufacturer is responsible for the performance of all inspection and test requirements specified herein. Except as otherwise specified in the purchase order or contract, the manufacturer may use his own or any other suitable facility for the performance of the inspection and test requirements specified herein unless disapproved by the purchaser. The purchaser shall have the right to perform any of the inspections and tests set forth in this specification where such inspections are deemed necessary to ensure that material conforms to prescribed requirements.

## 11. Rejection and Rehearing

### 11.1 Rejection:

11.1.1 If any test fails to conform to the requirements of this specification, it shall be cause for rejection of the material represented by the test. Material that is found to be defective subsequent to its acceptance at the manufacturer's works may be rejected, and the manufacturer notified.

11.1.2 Rejection of fibers shall be reported to the manufacturer promptly and in writing. Samples representing fibers rejected by the purchaser shall be preserved until disposition of the claim has been agreed to between the supplier and the purchaser.

11.2 *Rehearing*—When any test fails to meet the requirements of tension, bending, or dimensional tolerances, a retest shall be allowed. This retest shall be performed on twice the number of randomly selected specimens originally tested. The results of the retest shall meet the requirements of this specification or the lot shall be rejected.

## 12. Certification

12.1 *Certificate of Compliance*—When specified in the purchase order or contract, the producer or supplier shall

furnish a certificate of compliance stating the product was manufactured, sampled, tested, and inspected in accordance with this specification (including year of issue) and any other requirements designated in the purchase order or contract, and has been found to meet such requirements.

12.2 *Test Reports*—When specified in the purchase order or contract, test reports shall be furnished to the purchaser containing the results of all tests required by this specification (including year of issue), and any other requirements designated in the purchase order or contract.

12.3 A signature or notarization is not required; however, the document shall clearly identify the organization submitting the document. Notwithstanding the absence of a signature, the organization submitting the document is responsible for its content.

12.4 Copies of the original manufacturer's test report shall be included with any subsequent test report. A certificate of compliance (or test report) printed from or used in electronic form from an electronic data interchange (EDI) shall be regarded as having the same validity as a counterpart printed in the certifying organization's facility. The content of the EDI-transmitted document must conform to any existing EDI agreement between the purchaser and the supplier.

## 13. Packaging and Package Marking

13.1 The material shall be packaged to provide adequate protection during normal handling and transportation and each package shall contain only one type and size of material unless otherwise agreed upon. The type of packaging and gross weight of containers shall, unless otherwise agreed upon, be at the manufacturer's discretion provided that they are such as to ensure acceptance by common or other carriers for safe transportation at the lowest rate to the delivery point.

13.2 Each shipping container shall be marked with the material, size, type, specification designation, net weight (mass), and the manufacturer's name or trademark.

## 14. Keywords

14.1 acceptance testing; classification; fiber-reinforced concrete; steel fibers; tensile strength; testing procedures

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