



Standard Specification for Steel Fibers for Fiber-Reinforced Concrete¹

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 (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. 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 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.

2.1 ASTM Standards:

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products²

C 1116 Specification for Fiber-Reinforced Concrete and Shotcrete³

2.2 ACI Document:

544.1R State-of-the-Art Report on Fiber-Reinforced Concrete⁴

3. Terminology

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

3.1.1 A —cross-sectional area, in.²(mm²).

3.1.2 d —diameter, in. (mm).

3.1.3 f_u —ultimate tensile strength, psi (MPa).

3.1.4 l —length, in. (mm).

3.1.5 λ — l/d = aspect ratio.

3.1.6 The subscript n on dimensional units indicates “nomi-

nal” 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 Orders for material under this specification shall include 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 (15.1).

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

6. Material 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. Responsibility for Quality Assurance

7.1 *Responsibility for Inspection*—Unless otherwise specified in the contract or purchase order, the manufacturer is responsible for the performance of all inspection and test requirements specified herein. Except as otherwise specified in the contract or order, 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 assure that material

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² *Annual Book of ASTM Standards*, Vol 01.03.

³ *Annual Book of ASTM Standards*, Vol 04.02.

⁴ Available from American Concrete Institute, P.O. Box 19150, Redford Station, Detroit, MI 48219.

conforms to prescribed requirements.

8. Dimensions and Tolerances

8.1 Dimensions:

8.1.1 Straight cold-drawn wire 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 fibers are specified by the diameter (d) or equivalent diameter (d_e) and length (out-to-out) after bending (l_n). Nominal aspect ratio (λ_n) is established as (l_n/d) or (l_n/d_e). See Fig. 1.

8.1.3 Cut sheet fibers are specified by thickness (t), width (w), and length (l). Nominal aspect ratio (λ_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 fibers are specified by thickness (t), width (w), and out-to-out length after deformation (l_n). Nominal aspect ratio (λ_n) can be computed as

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

See Fig. 3.

8.1.5 Melt-extracted 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.³(7850 kg/m³). See Fig. 4.

8.2 Tolerances:

8.2.1 The length shall not vary from its specified value more than $\pm 10\%$.

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

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

9. Tensile Requirements

9.1 The average tensile strength, f_u , shall not be less than 50 000 psi (345 MPa).

10. Bending Requirements

10.1 Fibers shall withstand being bent around a 0.125-in. (3.18-mm) inside diameter 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.

11. Surface Condition

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

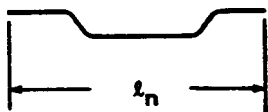


FIG. 1 Deformed Cold-Drawn Fibers

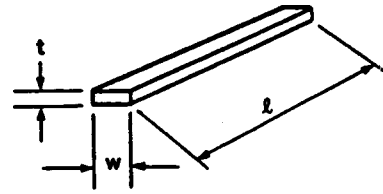


FIG. 2 Cut Sheet Fibers

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

11.2 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.

12. Measurement of Dimensions

12.1 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.

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

13. Tests

13.1 At least one tensile test, consisting of 10 randomly selected finished fibers, shall be performed for each 5 tons (4.5 Mg) of material or each shipment if less than 5 tons (4.5 Mg). The average value of f_u in these tests must 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 (4.5 Mg) of material or each shipment if less than 5 tons (4.5 Mg). The tensile strength of a single sample of source material shall not be less than 50 000 psi (345 MPa).

13.1.1 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, the area calculated from the actual diameter of the parent source material or finished fibers; (2) for cut sheet fibers, the area calculated from the actual thickness and width of the parent source specimen, or if fibers are tested, the area of each individual fiber calculated from the measured length and weight (mass) of the fiber, measured to the nearest 2.2×10^{-7} lb (0.0001 g), based on a density of 0.2836 lb/in.³(7850 kg/m³); and (3) for melt-extraction fibers or other fibers 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.

13.2 Bend tests in accordance with 10.1 shall be conducted on ten randomly selected specimens of finished fibers. It shall

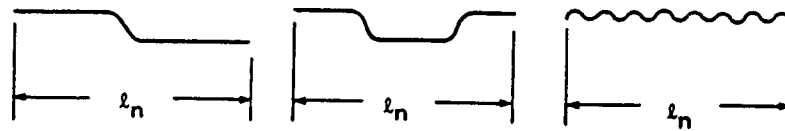


FIG. 3 Deformed Cut Sheet Fibers

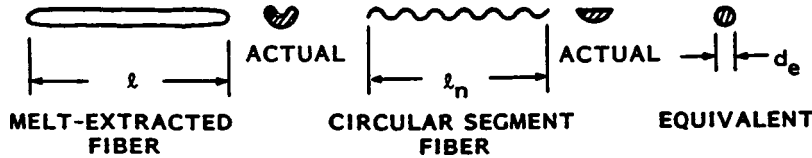


FIG. 4 Melt-Extracted and Other Fibers

be permissible to perform bend tests manually. At least one test consisting of 10 specimens shall be made for each 5 tons (4.5 Mg) of material or each shipment if less than 5 tons (4.5 Mg). At least 90 % of the specimens must pass the test.

14. Rejection and Retest

14.1 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. 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 the specification or the lot shall be rejected.

14.2 Rejection of fibers shall be reported to the manufacturer promptly and in writing. Rejected fibers shall be preserved for a period of at least two weeks from the date of inspection, during which time the manufacturer may make claim for a rehearing and retesting.

15. Certification

15.1 The manufacturer shall on request furnish to the purchaser a certificate stating that each lot has been sampled,

tested, and inspected in accordance with this specification and has met the requirements. When specified in the purchase order or contract, a report of the test results shall be furnished.

16. Packaging and Package Marking

16.1 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.

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

17. Keywords

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

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