Designation: A 820/A 820M – 06

Standard Specification for Steel Fibers for Fiber-Reinforced Concrete[1]

This standard is issued under the fixed designation A 820/A 820M; 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 the standard. Within the text, the inch-pound 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 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]

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

A 700 Practices for Packaging, Marking, and Loading Methods for Steel Products for Shipment

C 1116 Specification for Fiber-Reinforced Concrete and Shotcrete

2.3 *ACI Document:*

544.1R Committee Report on Fiber-Reinforced Concrete[3]

2.4 *U.S. Military Standard:*

MIL-STD-129 Marking for Shipment and Storage[4]

2.5 *U.S. Federal Standard:*

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)[4]

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,* $d_{e\text{-}r}$, *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, mm^2[in.^{2}]

d = diameter, mm [in.]

f_u = ultimate tensile strength, MPa [psi]

l = length, mm [in.]

$\lambda = l/d$ = aspect ratio

3.2.1 The subscript *n* on dimensional units indicates "nominal" and the subscript *e* indicates "equivalent." "Nominal" and

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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, 38800 Country Club Drive, Farmington Hills, MI 48331.

[4] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS. Or visit: http://assist.daps.dla.mil/online.

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

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"equivalent" dimensions are calculated from other measurable dimensions or average mass [weight].

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 kg [pounds or tons],

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 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 4 500 kg [5 tons] of product. This is an approximate distribution of one fiber tensile test per every 450 kg [0.5 ton] of finished product. The average tensile strength, f_u, of each fiber shall not be less than 345 MPa [50 000 psi]. The tensile strength of any one of the ten specimens shall not be less than 310 MPa [45 000 psi]. 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 4 500 kg [5 tons] of material. The tensile strength of a single sample of source material shall not be less than 345 MPa [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 millimetres [square inches], 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 mass [weight] 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 mass [weight] of the fiber. See 8.1.6. The ultimate tensile load in newtons [pounds-force] 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 3.2 mm [0.125] diameter pin to an angle of 90° at temperatures not less than 16°C [60°F] 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 4 500 kg [5 tons] 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, (λ), or (λ_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 (λ_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 (λ) 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 (λ_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 measured average nominal length and the mass [weight] of a

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known quantity of fibers, based upon 7 865 kg/m^3 [0.284 lb/in.^{3}] measured to the nearest 0.1 mg [2 x 10^{-6} lb]. Nominal aspect ratio, (λ_n), can be computed as follows:

$$\lambda_n = l / d_e, \text{ or } = l_n / d_e$$

8.1.6 Modified cold-drawn wire fibers (Type V) are specified by a range of equivalent diameters, ($d_{e\text{-}r}$), and length (l), or nominal length (l_n). Equivalent diameter is computed as in 8.1.5. A range of nominal apsect ratios, ($\lambda_{n\text{-}r}$) can be computed as follows:

$$\lambda_{n-r} = l / d_{e-r}, \text{ or } = l_n / d_{e-r}$$

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NOTE 3—Specifying a specific diameter or equivalent diameter for Type V fibers is not applicable as the diameters of many Type V fibers vary more than ± 10 % in each lot. Therefore a user should provide the limits on diameter or equivalent diameter allowable.

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 4 500 kg [5 tons] of finished product.

8.3 *Permissible Variations*:

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

8.3.2 The diameter, equivalent diameter, or range of equivalent diameters shall not vary from its specified value more than ±10 %.

8.3.3 The aspect ratio, nominal aspect ratio, or range of aspect ratios shall not vary from its specified value more than ±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 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 Packaging, marking, and loading for shipment shall be in accordance with Practices A 700.

13.2 When specified in the contract or order, and for direct procurement by or direct shipment to the U.S. government, marking for shipment, in addition to requirements specified in the contract or order, shall be in accordance with MIL-STD-129 for military agencies and with Fed. Std. No. 123 for civil agencies.

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13.3 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 mass [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.

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

14. Keywords

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

SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this standard since the last issue (A 820 – 04) that may impact the use of this standard.

(1) Revised section 2.2 and Section 13.

(2) Added sections 2.4 and 2.5.

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