Designation: D7357 – 07 (Reapproved 2012)

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

This standard is issued under the fixed designation D7357; 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 cellulose fibers intended for use in fiber-reinforced concrete, and other cementitious products.

1.2 This specification provides for measurement of properties, definition of types, typical properties, and prescribes testing procedures to establish conformance to these requirements.

1.3 In the case of conflict between a more stringent 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.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C1116 Specification for Fiber-Reinforced Concrete and Shotcrete

D6942 Test Method for Stability of Cellulose Fibers in Alkaline Environments

2.2 *TAPPI (Technical Association of the Pulp and Paper Industry):*[3]

T 205 Forming handsheets for physical tests of pulps

T 222 Acid-insoluble lignin in wood and pulp

T 231 Zero-span breaking strength of pulp (dry zero-span tensile)

T 232 Fiber length of pulp by projection

T 233 Fiber length of pulp by classification

T 234 Coarseness of pulp fibers

T 236 Kappa number of pulp

T 259 Species identification of non-wood plant fibers

T 263 Identification of wood and fibers from conifers

2.3 *ACI (American Concrete Institute) Documents:*[4]

544.1R Committee Report on Fiber-Reinforced Concrete

2.4 *ICC-ES Documents:*[5]

AC 217 Acceptance Criteria for Concrete with Virgin Cellulose Fibers

3. Terminology

3.1 *Definitions:*

3.1.1 *alkaline stability, n*—resistance to strength loss due to exposure to alkaline environments, as measured in Test Method D6942.

3.1.2 *coarseness, n*—linear density given in units of mg/100m. (See TAPPI T 234.) This unit is termed *decigrex*, and can be converted to the standard textile linear density unit, *denier*, which is weight in grams of 9000 meters of synthetic fiber.

3.1.3 *durability/compatibility with concrete, n*—resistance to strength loss based on ZSSR testing (Test Method D6942) using saturated calcium hydroxide and 1N sodium hydroxide as alkaline environments. (See ICC-ES AC 217, section 4.6.)

[1] This specification is under the jurisdiction of ASTM Committee D01 on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee D01.36 on Cellulose and Cellulose Derivatives.

Current edition approved June 1, 2012. Published August 2012. Originally approved in 2007. Last previous edition approved in 2007 as D7357 – 07. DOI: 10.1520/D7357-07R12.

[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 Technical Association of the Pulp and Paper Industry (TAPPI), 15 Technology Parkway South, Norcross, GA 30092, http://www.tappi.org.

[4] Available from American Concrete Institute (ACI), P.O. Box 9094, Farmington Hills, MI 48333-9094, http://www.aci-int.org.

[5] Available from ICC-ES, 5360 Workman Mill Road, Whittier, CA 90601, http://www.icc-es.org, under "Approved Criteria."

3.1.4 *zero-span stability ratio (ZSSR), n*— the ratio of the zero-span tensile after exposure to an alkaline environment to the zero-span tensile of the control fibers (that is, fibers not exposed to an alkaline environment) as defined in Test Method D6942.

3.1.5 *zero-span tensile, n*—measurement of individual fiber strength, as defined in TAPPI Method T 231 based on testing standard handsheets made according to TAPPI Method T 205.

4. Classification

4.1 Cellulose fibers are described in ACI 544.1R-96, chapter 5 as a class of natural fibers. Specification C1116 also uses the term natural fiber to describe cellulosic fibers.

4.2 Unknown cellulosic plant fibers must be identified as such or identified by appropriate microscopic examination. (TAPPI T 259 provides for the identification of non-wood plant fibers, and T 263 provides for the identification of fibers from conifers.)

4.3 If known, the common name and scientific classification of the fibers will be provided. For example, wood fibers derived from pulping slash pine trees should be designated; "slash pine (*Pinus elliottii*) fibers." A classification for mixed vegetable fibers would be 1:1 elephant grass (*Pennisetum purpureum*) and esparto (*Stipa tenacissima*).

4.4 Processed fibers shall also be classified by process. Process types are mechanical and chemical. Mechanical processes include stone ground (SG), refiner mechanical pulping (RMP), thermo-mechanical pulping (TMP), and chemi-thermo-mechanical pulping (CTMP). Chemical pulping includes the kraft process, the soda process, and the sulfite process.

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 (Section 4).

5.1.4 Manufacturers product code.

5.1.5 Whether Certificate of Analysis by the manufacturer is required.

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. Chemical Composition

7.1 Cellulosic fibers contain polysaccharides, lignin, extractives and minerals. The polysaccharides consist of cellulose (poly-1,4-β-D-anhydroglucopyranose) and hemicellulose (polymers of mixed pentoses and hexoses).

7.2 Unbleached, semibleached and fully bleached chemical wood pulps have cellulose as the predominant polymer. Unpurified vegetable fibers will have hemicelluloses as the predominate polymer.

7.3 Mechanical wood pulps will have approximately equal amounts of cellulose, hemicellulose, and lignin.

7.4 Purified chemical ("fully bleached") wood pulps do not contain lignin, but mechanical, unbleached, and semi-bleached pulps still retain some residual lignin. Fibers that are not lignin-free should be certified by the level of lignin present using either the kappa number test (TAPPI T 236) or the acid-insoluble lignin test (TAPPI T 222).

8. Physical Properties

8.1 The average fiber length of the cellulosic fibers will be specified based on projected length (TAPPI T 232), classified length (TAPPI T 233) or instrumental determination by a fiber analyzer.

8.2 The average fiber coarseness of the cellulosic fibers will be specified based on microscopic examination (TAPPI T 234) or instrumental determination by a fiber analyzer.

8.3 The average zero-span tensile strength of the cellulosic fibers will be specified based on standard testing and reported in grams, kilograms or breaking length (the test protocol will be consistent with TAPPI T 231).

9. Performance Requirements

9.1 Certified test results based on standard test methods may be required by the purchaser.

10. Other Requirements

10.1 As specified by purchaser.

11. Workmanship, Finish, and Appearance

11.1 Fibers shall meet specifications for basis weight, brightness, viscosity, sheet density, dirts, and other parameters desired by purchaser.

12. Hazards

12.1 Cellulose fibers are generally regarded as safe, but care must be taken in storage since cellulose fibers are flammable. During processing cellulosic fines may be generated as dust, which could require the use of dusk masks. MSDS must be available.

13. Inspection

13.1 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 purchased 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.

13.2 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.

14. Rejection and Rehearing

14.1 *Rejection*—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 manufacturer notified. Rejection of fibers shall be reported to the manufacturer promptly and in writing, stating the lot number from the bag or the box of the rejected fibers. 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.

14.2 *Rehearing*—When any test fails to meet requirements, 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.

15. Certification

15.1 *Certification of Compliance/Analysis*—When specified in the purchase order or contract, the producer or supplier shall furnish a certificate of compliance/analysis 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 purchased order or contract, and has been found to meet such requirements.

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

15.3 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.

16. Packaging and Package Marking

16.1 The product shall be packaged to provide adequate protection during normal handling and transportation. 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.

16.2 Each shipping container shall be clearly labeled and show manufacturer's name or trademark, product code, lot number or manufacturing code, and net mass (weight). At the manufacturer's discretion other information may be given.

17. Precision and Bias

17.1 For precision and bias statements, see the individual test standards referenced in this specification.

18. Keywords

18.1 acceptance testing; cellulose fibers; classification; fiber-reinforced concrete