



Designation: ~~C1116/C1116M – 10a (Reapproved 2015)~~ C1116/C1116M – 23

Standard Specification for Fiber-Reinforced Concrete¹

This standard is issued under the fixed designation C1116/C1116M; 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~~ Scope*

1.1 This specification covers ~~almost~~ forms of fiber-reinforced concrete ~~that are delivered to a purchaser with the ingredients manufactured in accordance with Specification C94/C94M uniformly mixed, and/or Specification C685/C685M that can be sampled and tested at the point of delivery, as modified herein.~~ It does not cover the placement, consolidation, curing, or protection of the fiber-reinforced concrete after delivery to the purchaser.

1.2 Certain sections of this specification are also applicable to fiber-reinforced concrete intended for shotcreting by the dry-mix process ~~when sampling and testing of concrete is possible only at the point of placement. In this case, or to zero-slump, and fiber-reinforced concrete used to manufacture precast elements. In these cases,~~ the sections dealing with batching plant, mixing equipment, mixing and delivery, and measurement of workability and air content, are not applicable.

1.3 This specification does not cover thin-section glass fiber-reinforced concrete manufactured by the spray-up process that is under the jurisdiction of ASTM Subcommittee C27.40.

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~~ not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other. ~~Combining~~ other, and values from the two systems ~~may result in non-conformance with the standard; shall not be combined.~~

1.5 If required results obtained from another standard are not reported in the same system of units as used by this standard, it is permitted to convert those results using the conversion factors found in the SI Quick Reference Guide.²

1.6 *The following precautionary statement pertains only to the test method portion, Sections 15 and 18, of this specification: 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 safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use. **Warning—Fresh hydraulic cementitious mixtures are caustic and may cause chemical burns to skin and tissue upon prolonged exposure.**³*

1.7 This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

¹ This specification is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.42 on Fiber-Reinforced Concrete.

Current edition approved April 1, 2015 Aug. 1, 2023. Published May 2015 August 2023. Originally approved in 1989. Last previous edition approved in 2010 2015 as ~~C1116/C1116M C1116/C1116M–10a(2015),–10a.~~ DOI: 10.1520/C1116-C1116M-10AR15-10.1520/C1116_C1116M-23.

² Annex A in Form and Style for ASTM Standards, www.astm.org/COMMIT/Blue_Book.pdf

³ Section on Safety Precautions, Manual of Aggregate and Concrete Testing, Annual Book of ASTM Standards, Vol. 04.02

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

2. Referenced Documents

2.1 *ASTM Standards:*⁴

- [A820/A820M](#) Specification for Steel Fibers for Fiber-Reinforced Concrete
[C31/C31M](#) Practice for Making and Curing Concrete Test Specimens in the Field
[C39/C39M](#) Test Method for Compressive Strength of Cylindrical Concrete Specimens
~~[C42/C42M](#) Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete~~
[C94/C94M](#) Specification for Ready-Mixed Concrete
[C125](#) Terminology Relating to Concrete and Concrete Aggregates
~~[C138/C138M](#) Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete~~
~~[C143/C143M](#) Test Method for Slump of Hydraulic-Cement Concrete~~
~~[C150](#) Specification for Portland Cement~~
~~[C172/C172M](#) Practice for Sampling Freshly Mixed Concrete~~
~~[C173/C173M](#) Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method~~
[C192/C192M](#) Practice for Making and Curing Concrete Test Specimens in the Laboratory
~~[C231](#) Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method~~
[C387/C387M](#) Specification for Packaged, Dry, Combined Materials for Concrete and High Strength Mortar
~~[C567](#) Test Method for Determining Density of Structural Lightweight Concrete~~
~~[C666/C666M](#) Test Method for Resistance of Concrete to Rapid Freezing and Thawing~~
~~[C684](#) Test Method for Making, Accelerated Curing, and Testing Concrete Compression Test Specimens (Withdrawn 2012)~~³
[C685/C685M](#) Specification for Concrete Made by Volumetric Batching and Continuous Mixing
[C1077](#) Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
~~[C1140/C1140M](#) Practice for Preparing and Testing Specimens from Shotcrete Test Panels~~
[C1385/C1385M](#) Practice for Sampling Materials for Shotcrete
~~[C1399](#) Test Method for Obtaining Average Residual-Strength of Fiber-Reinforced Concrete~~
[C1436](#) Specification Materials for Shotcrete (Withdrawn 2022)⁵
~~[C1480](#) Specification for Packaged, Pre-Blended, Dry, Combined Materials for Use in Wet or Dry Shotcrete Application~~
[C1550](#) Test Method for Flexural Toughness of Fiber Reinforced Concrete (Using Centrally Loaded Round Panel)
~~[C1602/C1602M](#) Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete~~
[C1602/C1602M](#) Test Method for Evaluating Plastic Shrinkage Cracking of Restrained Fiber Reinforced Concrete (Using a Steel Form Insert)
[C1604/C1604M](#) Test Method for Obtaining and Testing Drilled Cores of Shotcrete
[C1609/C1609M](#) Test Method for Flexural Performance of Fiber-Reinforced Concrete (Using Beam With Third-Point Loading)
[C1666/C1666M](#) Specification for Alkali Resistant (AR) Glass Fiber for GFRC and Fiber-Reinforced Concrete and Cement
[D6942](#) Test Method for Stability of Cellulose Fibers in Alkaline Environments
~~[D7357/D7357M](#) Specification for Cellulose Fibers for Fiber-Reinforced Concrete~~
[D7508/D7508M](#) Specification for Polyolefin Chopped Strands for Use in Concrete

2.2 *ACI Standards and Reports: European Standard:*⁶

- ~~[211-1EN 14651](#) Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete~~
~~[211.2](#) Standard Practice for Selecting Proportions for Structural Lightweight Concrete~~⁴
~~[506.2](#) Specification for Materials, Proportioning and Application of Shotcrete~~⁴

3. Terminology

3.1 Definitions

3.1.1 For definitions of terms used in this specification, refer to Terminology [C125](#).

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *manufacturer, n*—the producer who ~~furnishes~~^{supplies} the fiber-reinforced concrete.

3.2.2 *purchaser, n*—the owner, or representative thereof, who buys the fiber-reinforced concrete.

⁴ 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.

⁵ The last approved version of this historical standard is referenced on www.astm.org.

⁶ Available from European Standards s.r.o, www.en-standard.eu/store/



3.2.3 fiber ball, n—entangled clump of fibers that are intended to be dispersed uniformly.

3.2.4 fiber supplier, n—the seller who distributes the fiber to the market.

3.2.5 flexural toughness—energy absorption of a fiber-reinforced concrete test specimen in the post-crack range as measured by Test Method [C1550](#) and by Test Method [C1609/C1609M](#).

3.2.6 post-crack flexural performance—behavior of test specimen after the fiber-reinforced concrete has cracked as measured by Test Method [C1609/C1609M](#) or EN 14651.

3.2.6.1 Discussion—

EN 14651 uses a notched beam with center-point loading for measuring flexural strength and post-crack performance of fiber-reinforced concrete.

4. Classification

4.1 This specification classifies fiber-reinforced concrete by the material type of the fiber incorporated.

NOTE 1—The performance of fiber-reinforced concrete depends upon the susceptibility of the fibers to physical damage during mixing or shotcreting and to chemical damage on exposure to the cement paste solution, which is highly alkaline and may also contain carbon dioxide, chlorides, sulfates or oxygen. Improper methods of fiber addition to a concrete mix batch can lead to balling of some types of fiber; consult manufacturer for advice as to the correct method of adding fibers before use. The magnitude of improvements in the mechanical properties of the concrete or shotcrete imparted by fibers can also reflect are affected by the material characteristics, geometry, and design of the fiber type.

4.1.1 *Type I Steel Fiber-Reinforced Concrete*—Contains stainless steel, alloy steel, or carbon steel fibers conforming to Specification [A820/A820M](#).

4.1.2 *Type II Glass Fiber-Reinforced Concrete*—Contains alkali-resistant (AR) glass fibers conforming to Specification [C1666/C1666M](#).

4.1.3 *Type III Synthetic Fiber-Reinforced Concrete*—Contains synthetic fibers for which documentary evidence can be produced confirming their resistance to deterioration when in contact with the moisture and alkalis present in cement paste and the substances present in admixtures throughout the anticipated useful life of the structure (see [Note 2](#) and [4.2](#)). ~~When~~ If Type III fiber-reinforced concrete contains polyolefin fibers, they shall conform to Specification [D7508/D7508M](#).

NOTE 2—Fibers such as polyolefins (polypropylene and polyethylene), nylon, and carbon have been shown to be durable in concrete.

4.1.4 *Type IV Natural Fiber-Reinforced Concrete*—Contains natural fibers for which documentary evidence can be produced confirming their resistance to deterioration when in contact with the moisture and alkalis present in cement paste and the substances present in admixtures throughout the anticipated useful life of the structure. ~~When~~ admixtures. If Type IV fiber-reinforced concrete contains cellulose fibers, they shall conform to Specification [D7357/D7357M](#).

NOTE 3—The classification, natural fibers, refers to a population of fibers that are manufactured from natural fibrous resources and are used for the first time in concrete. Depending on the initial raw material and the manufacturing process employed to produce the fiber, the final physical and chemical fiber properties in this general classification can vary greatly. Some natural fibers are susceptible to deterioration from exposure to alkalis; Test Method [D6942](#) may be used to determine the susceptibility of these fibers to deterioration as a result of exposure to alkalis in concrete. Conversely, many other natural fiber types are highly resistant to alkalis and can remain in concrete with no degradation for the complete product life cycle.

4.2 ~~When~~ If the purchaser chooses to permit the use of fibers other than those complying with the classifications in [4.1](#), the manufacturer or fiber supplier shall show evidence satisfactory to the purchaser that the type of fiber proposed for use shows resistance to deterioration ~~when~~ if in contact with the moisture and alkalis present in cement paste and the substances present in admixtures throughout the anticipated useful life of the structure. ~~admixtures.~~

5. Basis of Purchase

5.1 The basis of purchase for fiber-reinforced concrete shall be in accordance with the section titled *Basis of Purchase Sections* of in Specification [C94/C94M](#) or Specification [C685/C685M](#).

6. Ordering Information

6.1 In the absence of designated applicable general specifications, the purchaser shall specify the following:

6.1.1 Type of fiber-reinforced concrete required. See Section 4.

6.1.2 Type of cement at the purchaser's option, otherwise the cement shall be Type 1 meeting the requirements of Specification ~~C150~~;

6.1.3 Designated size, or sizes, of coarse aggregates;

6.1.4 Slump required at the point of delivery, or when appropriate the point of placement, subject to the tolerances hereinafter specified;

6.1.5 Air content when air-entrainment is required, based on the air content of samples taken at the point of discharge, or when appropriate the point of placement, subject to the tolerances hereinafter specified;

Note 4—In selecting the specified air content, the purchaser should consider the exposure conditions to which the concrete will be subjected. Air contents less than shown in Table 1 may not produce adequate durability. Air contents higher than the levels shown may reduce strength without contributing further to freeze-thaw resistance.

6.1.6 When structural lightweight concrete is specified, the purchaser shall specify the density as freshly mixed density, equilibrium density, or oven-dry density.

Note 5—The freshly mixed density of lightweight concrete, that is the only density determinable at the time of delivery, is always higher than the equilibrium density or oven-dry density. Definitions of, and methods for determining or calculating freshly mixed, equilibrium, and oven-dry densities of lightweight concrete are covered in Test Methods ~~C138/C138M~~ and ~~C567~~.

6.1.2 If desired, any of the optional requirements Applicable ordering information given in the Section titled of Table 2 Ordering Information of Specification ~~C1602/C1602M~~ ~~C94/C94M~~ or Specification ~~C685/C685M~~.

6.1.8 One of the following Options A, B, or C, shall be used as the basis for determining the proportions of the fiber-reinforced concrete of the quality required.

6.2 ~~Option A:~~

6.2.1 When the purchaser assumes responsibility for mixture proportioning, the following parameters shall also be specified by the purchaser:

6.2.1.1 The cement content in kilograms per cubic metre [pounds per cubic yard];

6.2.1.2 If supplementary cementitious materials are required, the type, and amounts to be used in kilograms per cubic metre [pounds per cubic yard], or in percentages by mass of cement;

6.2.1.3 The maximum allowable amount of mixing water in litres per cubic metre [gallons per cubic yard], including surface moisture on the aggregates, but excluding water absorbed by the aggregate;

6.2.1.4 If air-entraining admixtures are required, the type, name, and dosage range to be used to achieve the specified air content, (see 6.1.4);

6.2.1.5 If chemical admixtures are required, the type, name, and dosage range to be used, and:

6.2.1.6 The type of fibers to be used and the amount in kilograms per cubic metre [pounds per cubic yard], (see Classification Section 4);

Note 6—The dosage of air-entraining, water-reducing (including high-range), accelerating, and retarding admixtures needed to satisfy the material performance requirements varies. Therefore, dosage ranges should be specified to ensure that the material performance requirements can be met.

~~NOTE 7—The purchaser, in selecting requirements for which he assumes responsibility should give consideration to requirements for workability, placeability, durability, surface texture, and density. The purchaser is referred to ACI Practices 211.1 and 211.2 for selecting proportions that will result in concrete suitable for various types of structures and conditions of exposure, and to ACI Report 544.3R⁵ for selecting concrete and fiber parameters suitable for fiber-reinforced concrete. For guidance on selecting proportions for fiber-reinforced shotcrete, the purchaser is referred to ACI Reports 506.1R⁶ and 506.R⁷ and ACI Specification 506.2.~~

~~6.2.2 At the request of the purchaser, the manufacturer shall, prior to the actual delivery of concrete, furnish a statement to the purchaser giving the sources, relative densities, sieve analyses, and saturated surface-dry masses of fine and coarse aggregates, and the amount of mixing water per cubic metre [per cubic yard] that will be used in the manufacture of each class of concrete ordered by the purchaser.~~

~~6.2 *Option B*—The purchaser shall specify whether Option A or Option B shall be used as the basis for determining the mixture proportions for the fiber-reinforced concrete.~~

~~6.2.1 *Option A: Manufacturer is Responsible for Mixture Proportioning*—WhenIf the purchaser requires the manufacturer to assume full responsibility for mixture proportioning (see the mixture proportioning, **Note 7**), the purchaser shall also specify the following:the requirements under Option A of Specification **C94/C94M** or Specification **C685/C685M** shall apply.~~

~~6.2.1.1 The purchaser shall specify requirements for post-crack flexural performance or flexural toughness.~~

~~(1) Test Method **C1609/C1609M** or EN 14651 shall be used to measure post-crack flexural performance of fiber-reinforced concrete.~~

~~(2) Test Method **C1550** shall be used to measure the flexural toughness of fiber-reinforced shotcrete.~~

~~(3) Post-cracking flexural performance is not specified if the fiber reinforcement is used only to mitigate plastic shrinkage cracking.~~

~~6.2.1.2 Requirements for flexural performance determinedAll samples shall be obtained in accordance with one of the following: Test Method Practice **C1399/C172/C172M**, **C1550** or **C1609/C1609M**, using samples obtained at the point of discharge, or when appropriate at the point of placement. At the option of the purchaser, compressive strength (Test determined in accordance with Test Method **C39/C39M**) shall be specified whenif the flexural performance requirements are considered inadequate for ensuring the quality of the matrix of the fiber-reinforced concrete. Unless accelerated curing and testing in accordance with the warm water or boiling water procedures of Test Method Tests **C684** is specified, tests shall be performed after standard moist curing in accordance with PracticesPractice **C31/C31M** at 28 days, or such other ages as are other age specified by the purchaser.~~

~~NOTE 4—While flexural strength at first peak is affected by the type and amount of fibers, it is more dependent on the characteristics of the mortar or concrete matrix, somatrix. So, it is recommended that the purchaser, whenif specifying flexural strength at first peak, consider factors known to influence the strength of normalordinary concrete such as, water-cement ratio, aggregate maximum size, maximum size of aggregate, and the presence of chemical admixtures or supplementary cementitious materials.~~

~~NOTE 5—To control fiber alignment in preparing test specimens, it is essential to follow the consolidation procedures in the applicable test methods. The standard specimen consolidation procedures found in Practice **C31/C31M** and Practice **C192/C192M**, including rodding and filling the mold in layers, can lead to increased variability and bias of test results with fiber-reinforced concrete.~~

~~NOTE 6—Test Method **C1579** can be used to evaluate the effectiveness of fibers in controlling plastic shrinkage cracking.~~

~~6.2.2 At the request of the purchaser, the manufacturer shall, prior to the actual delivery of concrete, furnish a statement to the purchaser giving the sources, relative densities, sieve analyses, and saturated surface-dry masses of fine and coarse aggregates, the dry masses of cement and supplementary cementitious materials, the type, dimensions, and weight of fibers, the quantities, types and names of chemical and air-entraining admixtures (if any), and the amount of mixing water per cubic metre [per cubic yard] that will be used in the manufacture of each class of concrete ordered by the purchaser. The manufacturer shall also furnish evidence satisfactory to the purchaser that the materials to be used and the proportions selected will produce fiber-reinforced concrete of the quality specified. *Option B: Purchaser is Responsible for Mixture Proportioning*:~~

~~6.2.2.1 If the purchaser assumes responsibility for mixture proportioning, the requirements under Option B of Specification **C94/C94M** or Specification **C685/C685M** shall apply.~~

~~6.2.2.2 The purchaser shall specify the fiber type in accordance with Section 4 and the amount of fibers per unit volume of fiber-reinforced concrete.~~

NOTE 7—The purchaser, in selecting requirements for which he assumes responsibility should consider requirements for workability, placeability, durability, surface texture, and density. The purchaser is referred to ACI PRC-211.1⁷ for selecting proportions that will result in concrete suitable for various types of structures and conditions of exposure, and to ACI PRC-544.3⁸ for selecting concrete and fiber parameters suitable for fiber reinforced concrete. For guidance on selecting proportions for fiber-reinforced shotcrete, the purchaser is referred to ACI PRC-506.1⁹ and ACI PRC-506¹⁰.

6.4 ~~Option C:~~

6.4.1 ~~When the purchaser requires the manufacturer to assume responsibility for mixture proportioning with the minimum allowable cement content specified (see Note 7), the purchaser shall also specify the following:~~

6.4.1.1 ~~Requirements for flexural performance determined in accordance with one of the following: Test Method C1399, C1550, or C1609/C1609M, using samples obtained at the point of discharge, or when appropriate the point of placement. At the option of the purchaser, compressive strength (Test Method C39/C39M) shall be specified when the flexural requirements are considered inadequate for ensuring the quality of the matrix of the fiber-reinforced concrete. Unless accelerated curing and testing in accordance with the warm water or boiling water procedures of Test Method C684 is specified, tests shall be performed after standard moist curing in accordance with Practices C31/C31M at 28 days, or such other ages as are specified by the purchaser (see Note 8).~~

6.4.1.2 ~~Minimum cement content in kilograms per cubic metre [pounds per cubic yard].~~

6.4.1.3 ~~If admixtures are required, the type, name, and dosage to be used. The cement content shall not be reduced when admixtures are used.~~

NOTE 9—Option C can be distinctive and useful only if the designated minimum cement content is at about the same level that would ordinarily be required for the mechanical properties, aggregate size, and workability specified. It must be an amount that will be sufficient to ensure durability under expected service conditions, as well as satisfactory surface texture and density. For additional information refer to ACI Practices 211.1 and 211.2.

6.4.2 ~~At the request of the purchaser, the manufacturer shall, prior to the actual delivery of the concrete, furnish a statement to the purchaser giving the sources, relative densities, sieve analyses and saturated surface-dry masses of fine and coarse aggregates, the dry masses of cement and supplementary cementitious materials, the type, dimensions, and weight of fibers, the quantities, types and names of chemical and air-entraining admixtures (if any), and the amount of mixing water per cubic metre [per cubic yard] that will be used in the manufacture of each class of concrete ordered by the purchaser. The manufacturer shall also furnish evidence satisfactory to the purchaser that the materials to be used and the proportions selected will produce fiber-reinforced concrete of the quality specified.~~

<https://standards.iteh.ai/catalog/standards/sist/2383dfe-33e6-4e79-ad18-8947f14b10b/astm-c1116-c1116m-23>

6.5 ~~The proportions arrived at by Options A, B, or C for each class of fiber-reinforced concrete approved for use in a project shall be assigned a designation to facilitate identification of each mixture delivered to the project. A certified copy of the proportions of all mixtures as established in Options A, B, or C shall be kept on file by the manufacturer.~~

6.6 ~~The purchaser shall ensure that the manufacturer is provided copies of all reports of tests performed on concrete samples taken to determine compliance with specification requirements. Reports shall be provided on a timely basis.~~

7. Materials and Manufacture

7.1 In the absence of designated applicable specifications covering requirements for quality of materials, the following specifications shall govern:

7.1.1 Except for fibers, materials for the manufacture of fiber-reinforced concrete shall conform to Specification C94/C94M, or Specification C685/C685M, and materials for the manufacturer of fiber-reinforced concrete intended for shotcreting ~~shotcret~~ shall conform to Specification C1436.

⁷ Available from ACI PRC-211.1-22 "Selecting Proportions of Normal-Density and High-Density Concrete – Guide", American Concrete Institute (ACI), P.O. Box 9094, Farmington Hills, MI 48333-9094, <http://www.aci-int.org>.

⁸ ACI 544.3R-08, "Guide PRC-544.3-08, Guide for Specifying, Proportioning and Production of Fiber-Reinforced Concrete," American Concrete Institute (ACI), P.O. Box 9094, Farmington Hills, MI 48333-9094, www.concrete.org

⁹ ACI 506.1R-08, "Guide to Fiber-Reinforced Shotcrete," PRC-506.1-21, "Fiber-Reinforced Shotcrete—Guide," American Concrete Institute (ACI), PO Box 9094, Farmington Hills, MI 48333-9094, www.concrete.org

¹⁰ ACI 506R-05, PRC-506-16, "Guide to Shotcrete," American Concrete Institute (ACI), P.O. Box 9094, PO Box 9094, Farmington Hills, MI 48333-9094, www.concrete.org



~~7.1.2 Fibers—Fibers shall be capable of producing fiber-reinforced concrete meeting the requirements of this specification. Steel fibers shall conform to Specification C94/C94M, alkali-resistant (AR) glass fibers shall conform to applicable specifications given in Section 4, and cellulose fibers shall conform to Specification D7357.~~

8. Measuring Materials

8.1 Except as otherwise specifically permitted by the purchaser, cement, supplementary cementitious materials, fine and coarse aggregates, mixing water, and admixtures shall be measured in accordance with the applicable requirements of Specification C94/C94M or Specification C685/C685M.

8.2 Fibers shall be batched by mass or volume with an accuracy of -3% and $+5\%$ of the amount required per batch.

8.3 Fibers shall be measured by mass ~~when~~ fiber-reinforced concrete is produced in accordance with Specification C94/C94M; and by volume ~~when the fiber-reinforced concrete is produced in accordance with Specification C685/C685M~~. ~~When~~ If the fibers are to be measured by mass, bags, boxes, or like containers are acceptable provided that such like containers are sealed by the fiber manufacturer and have the mass contained therein clearly marked. No fraction of a container delivered unsealed, or left over from previous work, shall be used unless weighed.

8.4 Prepackaged, dry, combined materials, including fibers, shall comply with the packaging and marking requirements of Specification C387/C387M or C1480 and shall be accepted for use provided that after addition of water, the resulting fiber-reinforced concrete meets the performance requirements of this specification.

9. Batching Plant

9.1 ~~Batching plant used for the preparation of batch-mixed fiber-reinforced concrete shall comply with the applicable requirements of Specification C94/C94M.~~

NOTE 10—A vibrating screen or other device for separating fibers may be required to avoid clumping of some types of fibers prior to mixing with concrete.

9.2 ~~Batching plant used for the preparation of continuously-mixed fiber-reinforced concrete shall comply with the applicable requirements of Specification C685/C685M.~~

10. Mixing Equipment

10.1 ~~Mixers or agitators for batch-mixed fiber-reinforced concrete shall comply with the applicable requirements of Specification C94/C94M.~~

10.2 ~~Mixers for continuously mixed fiber-reinforced concrete shall comply with the applicable provisions of Specification C685/C685M.~~

9. Mixing and Delivery

9.1 ~~Batch-mixed fiber-reinforced concrete, whether prepared on site or at a location remote from the site, shall be mixed and delivered to the point designated by the purchaser in accordance with the applicable requirements of Specification C94/C94M including the requirements for uniformity in the Annex.~~

9.2 ~~Continuously mixed fiber-reinforced concrete, whether prepared on site or at a location remote from the site, shall be mixed and delivered to the point designated by the purchaser in accordance with the applicable requirements of Specification C685/C685M including the requirements for uniformity in the Annex.~~

9.3 ~~Fiber-reinforced concrete shall be free of fiber balls when delivered. If the fiber-reinforced concrete is found to contain fiber balls upon delivery, the manufacturer shall determine what adjustments, if any, shall be made to the batching and mixing procedure. If the proposed adjustments are acceptable to the purchaser, concrete delivery shall proceed with the adjustments.~~