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An American National Standard

Standard Specification for Polyolefin Chopped Strands for Use in Concrete[1]

This standard is issued under the fixed designation D7508/D7508M; 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 polyolefin chopped strands (fibers) for use in concrete.

1.2 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.

1.3 *The following safety hazards caveat pertains only to the test methods described in 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 practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C1116/C1116M Specification for Fiber-Reinforced Concrete
D123 Terminology Relating to Textiles
D1577 Test Methods for Linear Density of Textile Fibers
D1776 Practice for Conditioning and Testing Textiles
D1907 Test Method for Linear Density of Yarn (Yarn Number) by the Skein Method
D2256 Test Method for Tensile Properties of Yarns by the Single-Strand Method
D2257 Test Method for Extractable Matter in Textiles
D2258 Practice for Sampling Yarn for Testing
D3218 Specification for Polyolefin Monofilaments

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms used in this Specification, refer to Terminology D123.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *chopped strand, n*—cut staple polymer fiber of specified lengths.

3.2.2 *fiber, n—as used for concrete reinforcement*, chopped strand that is mixed into concrete or mortar.

3.2.2.1 *Discussion*—Fiber used for concrete or mortar reinforcement is available in various deniers. These include:

(a) Macro polyolefin fiber which has linear density greater than or equal to 580 denier (equivalent diameter ≥ 0.3 mm).

(b) Micro polyolefin fiber which has a linear density of less than 580 denier (equivalent diameter < 0.3 mm).

(c) Hybrid fiber which include a combination of macro polyolefin and micro polyolefin fibers.

(d) Multi-length fibers which consist of chopped strands of various lengths of fiber.

(e) Graded fiber which consists of a gradation of multiple length and multiple denier fibers.

3.2.3 *fiber reinforced concrete (FRC), n*—hydraulic cement concrete that includes chopped strands (fibers).

3.2.4 *finish content, n*—the percent by mass of finish extractions on the fiber.

3.2.5 *high-tenacity fiber, n*—a manufactured fiber that belongs to a generic class of fibers having exceptional breaking strength; or having a breaking strength significantly greater than the average strength of other (regular tenacity) fibers in the same generic class of equivalent linear densities.

3.2.6 *polyolefin, n*—any long-chain synthetic polymer composed of at least 85 % by weight of ethylene, propylene, or other olefin units (monomers), except amorphous (noncrystalline) polyolefin.

3.2.7 *reprocessed materials, n*—materials that have been recycled from another process.

3.2.8 *strand, n*—a single fiber, filament, or monofilament.

3.2.9 *skein, n*—a continuous strand of yarn, wound on a hand or motorized reel.

3.2.10 *yarn, n—as used for fiber concrete reinforcement*, narrow slit extruded film.

[1] This specification is under the jurisdiction of ASTM Committee D13 on Textiles and is the direct responsibility of Subcommittee D13.58 on Yarns and Fibers.

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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.

SPECIFICATIONS

4. Chopped Strands for FRC

4.1 Polyolefin chopped strands shall be manufactured and tested to specific targets and tolerances as detailed in the manufacture's product specifications.

4.2 Materials shall be tested during processing (skeins or uncut strands) and after processing (chopped strands).

5. Summary

5.1 Summaries of the various testing procedures are included in the referenced test methods, or in pertinent sections of this specification.

5.1.1 *Denier:* D1577 Test Method for Linear Density of Textile Fibers

D1907 Linear Density of Yarn by Skein Method

5.1.2 *Tensile:* D2256 Test Method for Tensile Properties of Yarns by the Single-Strand Method

D3218 Specification for Polyolefin Monofilaments

5.1.3 *Tenacity*—The tensile stress expressed force per unit linear density of the unstrained specimen. (Sometimes expressed in grams per denier, or GPD.)

D2256 Test Method for Tensile Properties of Yarns by the Single-Strand Method

5.1.4 *Elongation:* D2256 Test Method for Tensile Properties of Yarns by the Single-Strand Method

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5.1.5 *Initial Modulus:* D2256 Test Method for Tensile Properties of Yarns by the Single-Strand Method

D3218 Specification for Polyolefin Monofilaments

5.1.6 *Equivalent Diameter*—The diameter of a circle having the same cross-sectional area as the fiber or strand. The measurement may be derived from stated calculation provided in Eq 1.

5.1.7 *Finish Content*—Based on percent of total mass. Several methods of finish extractions are recognized including the use of a NMR system (Nuclear Magnetic Residence), Rapid Oil Extraction Apparatus, and spin finish analysis based on Test Method D2257. None of these systems or this standard addresses the chemical properties or types of chemicals that may be contained in the finish applied. Certain chemicals at various dosages may cause change in the properties of concrete mix performance such as air gain.

5.1.8 *Fiber Length*—Total distance from the outer ends of the finished fiber or developed length.

6. Significance and Use

6.1 *Acceptance Testing*—The test methods in Specification D2256 and D3218 for the determination of the properties of polyolefin cut strands are considered satisfactory for acceptance testing of commercial shipments of polyolefin cut strands for use in concrete.

6.2 *Laboratory Correlation Testing*—If there are differences of practical significance between reported test results for two laboratories (or more) a comparative test should be performed to determine if there is a statistical bias between them, using competent statistical assistance. As a minimum, use test samples that are as homogeneous as possible, drawn from the material from which the disparate test results were obtained, and randomly assigned in equal numbers to each laboratory for testing. The test results from the two laboratories should be compared using a statistical test for unpaired data, at a probability level chosen prior to the testing series. If a bias is found either its cause must be found and corrected or future test results for that material must be adjusted in consideration of the known bias.

7. Sampling and Number of Specimens

7.1 Take samples as directed in the applicable material specification, or as agreed upon by the purchaser and the supplier. In the absence of an applicable material specification, or other agreement, take a lot sample and laboratory samples as directed in Practices D2258 or D3218.

NOTE 1—An adequate specification or other agreement between the purchaser and the supplier requires taking into account variability between shipping units, between packages, or ends within a shipping unit, and between specimens from a single package so as to provide a sampling plan with a meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

8. Fiber Length and Permissible Variations

8.1 A representative fiber sample of an order quantity shall be 30 fibers obtained from three grab samples by combining 10 randomly selected fibers from each grab sample. If deemed necessary, the producer shall choose to select the 10 specimens at different set intervals in order to obtain a more accurate representation of the production lot. Fiber length or lengths, for a given order quantity, shall be determined as the average length of the 30 fibers to the nearest mm.

8.2 Average fiber length, shall be within +10 % and –10 % of the specified length.

8.3 Fiber products that are defined by a range of lengths or graded lengths, shall have 95 % of measured lengths fall within the specified range.

8.4 *Report:*

8.4.1 Fiber length to nearest mm.

8.4.2 For hybrids and multi-length fibers, range of equivalent diameters, linear densities, and fiber lengths as appropriate.

9. Linear Density, Cross Sectional Area, Equivalent Diameter of FRC Strand and Finish Content

9.1 *Linear Density of FRC Chopped Strand:*

9.1.1 *Apparatus*—Balance, calipers, skein reel, or templates may be used. All measuring equipment, including templates, must be calibrated and inspected at regular intervals.

9.1.2 *Procedure by Denier or Tex Method*—Determine the direct yarn number in tex to three significant figures or denier to one significant figure as directed in 5.1.1.

9.2 *Equivalent Diameter of FRC Chopped Strand, d:*

9.2.1 If strands have a cross section that is circular, measure the diameter with a set of calipers that measure to at least two significant figures in mm. The measured diameter is the equivalent diameter, *d*.

9.2.2 If the strands have a cross section that is rectangular, measure the width, *w*, and thickness, *t*, with a set of calipers

that measure to at least two significant figures in mm. Calculate the equivalent diameter using the following equation:

$$d = \sqrt{\frac{4wt}{\pi}} \quad (1)$$

where:

d = equivalent diameter, mm,
t = measured thickness of strand, mm, and
w = measured width of strand, mm.

9.2.3 If the strands have an irregular cross section, calculate the equivalent diameter from the linear density (tex or denier) using the following equation:

$$d = \sqrt{\frac{4\left(\frac{tex}{1000}\right)}{\pi\rho}} \quad \text{or} \quad d = \sqrt{\frac{4\left(\frac{denier}{9000}\right)}{\pi\rho}} \quad (2)$$

where:

d = equivalent diameter, mm, and
ρ = unit density in grams per cubic centimeter (specific gravity) of the polyolefin material.

9.3 *Report:*

9.3.1 That the specimens were tested in accordance with Specification D7508/D7508M, and describe the material or product sampled and the method of sampling used,

9.3.2 Equivalent diameter in two significant figures in mm for macro polyolefin fiber, and three significant figures in mm for micro polyolefin fiber,

9.3.3 Linear density (tex or denier) to the nearest whole number, and

9.3.4 Fiber length to nearest mm.

9.4 *Finish Content:*

9.4.1 There are multiple methods and systems used to analyze the level of finish applied. Any system used in this analysis shall have multiple laboratory correlation studies or MSA (Measurement System Analysis) from at least two separate labs to ensure the accuracy and repeatability of measurement system. See 6.2.

9.4.2 *Report*—The percent by mass of finish content and system/process used to perform the analysis.

10. Tensile and Tenacity Properties

10.1 *Apparatus*—Tensile testing machine of a type as specified in Test Methods D2256 and D3218. All types of tensile machines described in Test Methods D2256 and D3218 are adequate to test polyolefin strand materials. Ensure that the load cell(s) chosen are relative to the size and strength of the strand being tested. The load cell capacity should be in range and comparable of the expected ultimate tensile strength. Type of grips or jaws used to hold specimens must be adequate to properly secure strand ends and to prevent strands from slips or false breaks.

10.2 *Procedure*—Determine the breaking force, the breaking tenacity, and the elongation of adequately conditioned polyolefin filaments, using Practice D1776. The initial modulus shall also be calculated during the testing if required by the purchaser. Tensile, tenacity and modulus of deformed fibers may be tested prior to the deforming process, but not required.

10.3 *Calculate:*

10.3.1 *Tenacity*—Using linear density as the breaking load determined in 10.2 divided by the linear density determined in 9.1, grams/denier, or

10.3.2 *Tenacity*—Using tex as the breaking load determined in 10.2 divided by 9 times the tex determined in 9.1, and

10.3.3 *Relative Tensile Strength*—From the breaking load determined in 10.2 and the equivalent diameter determined in 9.2, using the following equation:

$$T_r = \frac{4L_b}{\pi d^2} \quad (3)$$

where:

T_r = relative tensile strength, MPa,
L_b = breaking load. N, and
d = equivalent diameter of fiber, mm.

10.3.4 *Using Denier*—Peak load in grams/denier = breaking tenacity (grams per denier or GPD).

10.3.5 *Using Tex*—Peak load in grams/(tex)(9) = breaking tenacity (grams per denier or GPD).

10.4 *Relative Tensile Strength:*

10.4.1 Relative Tensile Strength shall also be reported. This shall be calculated from both the cross sectional area and the breaking force.

NOTE 2—The relative tensile strength of macro polyolefin fibers is a common requirement due to the significant correlation of fiber strength to concrete performance.

10.5 *Report:*

10.5.1 That the specimens were tested as directed in Section 10 of this Specification D7508. Describe the material or product sampled and the method of sampling used.

10.5.2 The following information for each laboratory sampling unit and for the lot:

10.5.2.1 Breaking tenacity stated in grams per denier, or

10.5.2.2 Relative tensile strength, MPa.

10.5.2.3 Elongation at break, as a percentage of the nominal gage length, and

10.5.2.4 At the option of the specifier of tests, the initial modulus, MPa.

10.5.3 Hybrids (macro) must state all fiber types' tensile properties.

11. Conformance

11.1 The purchaser and the supplier shall agree on a procedure to establish conformance, including control charts furnished by the supplier, a sequential-sampling plan, or the double-sampling plan outlined in 11.2.

11.2 In the absence of a control-chart or sequential-sampling plan, proceed as directed in 11.2.1 – 11.2.3.

11.2.1 If the test results for the lot conform to the tolerances for all characteristics agreed upon, consider the lot a valid delivery.

11.2.2 If the test results for one or more characteristics do not conform to the tolerances, take a new laboratory sample from either the original lot sample or a new lot sample. Retest the lot for the characteristic(s) that did not conform to the tolerances in the first test, and average the results of the first

TABLE 1 Conformance Requirements for Chopped Strands for Use in Concrete

Chopped Strands Attributes	Micro Chopped Strands	Macro Chopped Strands	Hybrids Chopped Strands
Compliance with Specification C1116/C1116M, Type III	Required	Required	Required
Denier	580 or less	581 or greater	As Designated – Must be stated
Finish Content	1.5 % max	1 % max	1.5 % max on Micro Portion 1 % max on Macro Portion
Tensile Strength	N/A	Greater than 344.4 MPa [50 000 psi]	Micro Portion (N/A) Macro Portion – Greater than 344.4 MPa [50 000 psi]
Cut Length	3 – 50 mm	12 – 65 mm	As Designated – Must be stated

and second samples as if all results were from one test of double the original number of specimens. If the new average(s) conform(s) to the specified tolerances, consider the lot a valid delivery.

11.2.3 If the test results obtained as directed in 11.2.2 do not conform to the specified tolerances, consider the lot a nonconforming delivery.

11.3 All Polyolefin Chopped Stands designated for use in concrete shall comply with Specification C1116/C1116M and this specification. Noted compliance will include identification of Type of Fiber per Specification C1116/C1116M. Polyolefin chopped strands for use in concrete shall meet the requirements of Table 1.

12. Keywords

12.1 appearance; chopped strands; concrete; denier; equivalent diameter; fiber; polyolefin; tension (tensile) properties/tests; thickness; width