Designation: D 3217 – 95

Standard Test Methods for Breaking Tenacity of Man-Made Textile Fibers in Loop or Knot Configurations[1]

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1. Scope

1.1 These test methods cover the measurement of the breaking tenacity of man-made textile fibers taken from filament yarns, staple, or tow fiber, either crimped or uncrimped, and tested in either a double loop or as a strand formed into a single overhand knot.

1.2 Methods for measuring the breaking tenacity of conditioned and wet (immersed) fibers in loop and knot form are included.

1.3 Elongation in loop or knot tests has no known significance, and is usually not recorded.

1.4 The basic distinction between the procedures described in these test methods and those included in Test Methods D 2101 is the configuration of the specimen, that is, either as a double loop or in the configuration of a single overhand knot.

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:*

D 76 Specification for Tensile Testing Machines for Textiles[2]

D 123 Terminology Relating to Textiles[2]

D 1577 Test Methods for Linear Density of Textile Fibers[2]

D 1776 Practice for Conditioning Textiles for Testing[2]

D 2101 Test Methods for Tensile Properties of Single Man-Made Textile Fibers Taken from Yarns and Tows[2]

D 2258 Practice for Sampling Yarn for Testing[2]

D 3333 Practice for Sampling Man-Made Staple Fibers, Sliver, or Tow for Testing[3]

D 4848 Terminology Relating to Force and Deformation Properties of Textiles[3]

3. Terminology

3.1 *Definitions:*

3.1.1 *breaking load*, *n*—the maximum force applied to a specimen in a tensile test carried to rupture.

3.1.1.1 *Discussion*—Force is commonly expressed in grams-force (gf), kilograms-force (kgf), pounds-force (lbf), newtons (N), or millinewtons (mN).

3.1.2 *breaking tenacity*, *n*—the tenacity corresponding to the breaking load.

3.1.2.1 *Discussion*—Breaking tenacity is commonly expressed as grams-force per tex (gf/tex), grams-force per denier (gf/den), millinewtons per tex (mN/tex), or grams-force per denier (gf/den). Millinewtons are numerically equal to grams-force times 9.81.

3.1.3 The breaking tenacity is calculated from the breaking force and the linear density of the unstrained specimen, or obtained directly from tensile testing machines which can be suitably adjusted to indicate tenacity instead of breaking force, for specimens of known linear density.

3.1.4 *linear density*, *n*—mass per unit length; the quotient obtained by dividing the mass of a fiber or yarn by its length.

3.1.4.1 *Discussion*—The preferred units of measurement are grams and metres, or multiples or submultiples of these. The tex unit, grams per kilometre, is recommended for yarns.

3.1.5 *man-made staple fiber*, *n*—fibers of spinnable length manufactured directly or by cutting filaments.

3.1.5.1 *Discussion*—Man-made staple fiber does not include cut waste.

3.1.6 *tenacity*, *n—in a tensile test*, the force exerted on the specimen based on the linear density of the unstrained material.

3.1.6.1 *Discussion*—Tenacity is commonly expressed as grams-force per tex (gf/tex), grams-force per denier (gf/den), millinewtons per tex (mN/tex), or grams-force per denier (gf/den).

3.1.7 For definitions of other textile terms used in these test methods, refer to Terminology D 123. For definitions of other terms related to force and deformation in textiles, refer to Terminology D 4848.

4. Summary of Test Methods

4.1 Single-fiber specimens in the form of a loop as described in 9.4.1 are broken on a constant-rate-of-extensiontype testing machine at a predetermined rate of elongation and the

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[2] *Annual Book of ASTM Standards*, Vol 07.01.

[3] *Annual Book of ASTM Standards*, Vol 07.02.

breaking load is determined.

4.2 Single-fiber specimens in the form of a knot as described in 9.4.2 are broken on a constant-rate-of-extensiontype testing machine at a predetermined rate of elongation, and the breaking load is determined.

4.3 The breaking tenacity is calculated from the breaking load registered on the load-elongation curve and the previously determined linear density.

5. Significance and Use

5.1 Both the loop breaking tenacity and the knot breaking tenacity, calculated from the breaking load measured under the conditions specified herein and the linear density of the fiber, are fundamental properties that are used to establish limitations on fiber-processing and upon their end-use applications. Physical properties, such as brittleness, not well defined by tests for breaking load and elongation can be estimated from the ratio of breaking tenacity measured in loop or knot tests, or both, and the normal tenacity as measured by Test Methods D 2101.

5.2 This test method is not recommended for acceptance testing of commercial shipments in the absence of reliable information on between-laboratory precision (see Note 3). In some cases the purchaser and the seller may have to test a commercial shipment of one or more specific materials by the best available method, even though the method has not been recommended for acceptance testing of commercial shipments. In such a case, if there is a disagreement arising from differences in values reported by the purchaser and the seller when using this test method for acceptance testing, the statistical bias, if any, between the laboratory of the purchaser and the laboratory of the seller should be determined with each comparison being based on testing specimens randomly drawn from one sample of material of the type being evaluated.

6. Apparatus and Reagents

6.1 *Tensile Testing Machine*, conforming to Specification D 76 for Constant-Rate-of-Specimen-Extension-(CRE) type machines, having a full-scale capacity ranging from 2 to 100 g and equipped with provisions for breaking fibers immersed in a liquid if such tests on a wet specimen are desired.

6.2 *Clamps*, with flat jaws for gripping the fiber specimens designed to minimize slippage in the clamps during the tests, or

6.2.1 *Tabs*, of thin plastic or other material for use with cementing techniques, and

6.2.2 *Cement or Adhesive*—The adhesive must bind the tab to the fiber without affecting an appreciable solution of the latter or any change in the moisture content of the specimen.

6.3 *Wetting Agent* (0.1 % solution)—Use a nonionic aqueous solution.

6.4 *Jig*, to aid in accurately mounting specimens on tabs at the specified gage length.

7. Sampling

7.1 *Lot Sampling*—As a lot sample for acceptance testing, take at random the number of shipping containers directed in the applicable material specification or other agreement between the purchaser and the supplier, such as an agreement to use Practice D 3333 or Practice D 2258. Consider shipping containers to be the primary sampling units.

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

7.2 *Laboratory Sample*—As a laboratory sample for acceptance testing, take at random from each shipping container in the lot sample the number of laboratory sampling units as directed in an applicable material specification or other agreement between the purchaser and the supplier such as an agreement to use Practice D 3333 or Practice D 2258. Preferably, the same number of laboratory sampling units are taken from each shipping container in the lot sample. If differing numbers of laboratory sampling units are to be taken from shipping containers in the lot sample, determine at random which shipping containers are to have each number of laboratory units drawn.

7.2.1 *For Staple Fiber*—Take 50-g samples from laboratory sampling units.

7.2.2 *For Sliver (or Top) or Tow*—Take 1 m from the leading end which has a clean, uniform appearance.

7.2.3 *For Yarns*—Prepare at least a 50-m skein from each package.

7.3 *Test Specimens*—From each laboratory sampling unit, take ten specimens at random. If the standard deviation determined for the ten specimens is more than a value agreed upon between the purchaser and the supplier, continue testing in groups of ten specimens from the same laboratory sampling unit in the container until the standard deviation for all specimens tested is not more than the agreed to value or, by agreement, stop testing after a specified number.

7.3.1 Carefully remove twist before taking specimens from yarn. Using tweezers and grasping the specimens at the ends, gently remove the required number of specimens from the laboratory sampling units for testing. In some cases, if specimens are not to be tested immediately, place them on an identified short-pile of plush surface for storage until ready to test.

8. Conditioning

8.1 Precondition and condition the specimens, as directed in Practice D 1776.

8.1.1 Specimens that are to be tested wet need not be preconditioned or conditioned.

9. Procedure

9.1 *Test Conditions:*

9.1.1 *Standard*—Test the adequately conditioned fibers in the standard atmosphere for testing textiles which is 70 ± 2°F (21 ± 1°C) and 65 ± 2 % relative humidity.

9.1.2 *Wet*—Immerse the specimens in a 0.1 % solution of a nonionic wetting agent for a minimum of 2 min before testing. To save time in the tensile testing machine, specimens whose moduli are not affected by moisture may be immersed in separate container of solution while other specimens are being broken.

9.2 Measure and record the individual linear densities of the fibers to be tested as directed in the vibroscope procedure of