



Designation: D2256/D2256M – 21

Standard Test Method for Tensile Properties of Yarns by the Single-Strand Method¹

This standard is issued under the fixed designation D2256/D2256M; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 This test method covers the determination of tensile properties of monofilament, multifilament, and spun yarns, either single, plied, or cabled with the exception of yarns that stretch more than 5.0 % when tension is increased from 0.05 to 1.0 cN/tex [0.5 to 1.0 gf/tex].

1.2 This test method covers the measurement of breaking force and elongation of yarns and includes directions for the calculation of breaking tenacity, initial modulus, chord modulus, and breaking toughness.

1.2.1 Options are included for the testing of specimens in: (A) straight, (B) knotted, and (C) looped form.

1.2.2 Conditions of test are included for the testing of specimens that are: (1) conditioned air, (2) wet, not immersed, (3) wet, immersed, (4) oven-dried, (5) exposed to elevated temperature, or (6) exposed to low temperature.

NOTE 1—Special methods for testing yarns made from specific fibers; namely, glass, flax, hemp, ramie, and kraft paper and for specific products; namely, tire cords and rope, have been published: Test Methods D885, and Specification D578.

NOTE 2—For directions covering the determination of breaking force of yarn by the skein method refer to Test Method D1578.

1.3 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.

1.4 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *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.

2. Referenced Documents

2.1 ASTM Standards:²

D76/D76M Specification for Tensile Testing Machines for Textiles

D123 Terminology Relating to Textiles

D578 Specification for Glass Fiber Strands

D885 Test Methods for Tire Cords, Tire Cord Fabrics, and Industrial Filament Yarns Made from Manufactured Organic-Base Fibers

D1578 Test Method for Breaking Strength of Yarn in Skein Form

D1776 Practice for Conditioning and Testing Textiles

D2258 Practice for Sampling Yarn for Testing

D2904 Practice for Interlaboratory Testing of a Textile Test Method that Produces Normally Distributed Data (Withdrawn 2008)³

D2906 Practice for Statements on Precision and Bias for Textiles (Withdrawn 2008)³

D4848 Terminology Related to Force, Deformation and Related Properties of Textiles

D4849 Terminology Related to Yarns and Fibers

E178 Practice for Dealing With Outlying Observations

3. Terminology

3.1 Definitions:

3.1.1 Refer to Terminology D4848 for definitions of the following terms used in this standard: breaking force, breaking strength, breaking tenacity, breaking toughness, chord modulus, elongation, elongation at break, elongation at rupture, initial modulus, knot-breaking force, knot breaking strength, linear density, loop breaking force, loop-breaking strength, single-strand breaking force, single-strand breaking strength, strength and tenacity.

¹ This test method 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.

³ The last approved version of this historical standard is referenced on www.astm.org.

3.1.2 Refer to Terminology D123 and Terminology D4849 and for definitions of other terms used in this standard.

4. Summary of Test Method

4.1 Single-strand yarn specimens are broken on a tension testing machine at a predetermined elongation rate and the breaking force and the elongation at break are determined. Elongation at a specified force or the force or tenacity at a specified elongation may also be obtained. Breaking force, breaking tenacity, elongation, initial and chord modulus, and breaking toughness of the test specimen, in terms of linear density, may be calculated from machine scales, dials, recording charts, or by an interfaced computer.

4.2 This test method offers the following three physical configurations of the specimen:

- 4.2.1 *Configuration A*, straight.
- 4.2.2 *Configuration B*, knotted.
- 4.2.3 *Configuration C*, looped.

4.3 This test method also offers the following six conditions of test with respect to moisture content of the specimens at the time of testing:

- 4.3.1 *Condition 1*, conditioned to moisture equilibrium for testing with standard atmosphere for testing textiles.
- 4.3.2 *Condition 2*, wet not immersed.
- 4.3.3 *Condition 3*, wet immersed.
- 4.3.4 *Condition 4*, oven-dried.
- 4.3.5 *Condition 5*, high temperature.
- 4.3.6 *Condition 6*, low temperature.

4.4 A test option is specified by combining a specimen configuration and a moisture content condition, for example, Option A1 means a straight specimen conditioned and tested in a standard atmosphere for testing textiles.

4.5 Unless otherwise indicated, the phrase “single-strand breaking force” is associated with Option A1.

5. Significance and Use

5.1 *Acceptance Testing*—Option A1 of Test Method D2256 is considered satisfactory for acceptance testing of commercial shipments because the test method has been used extensively in the trade for acceptance testing. However, this statement is not applicable to knot and loop breaking force tests, tests on wet specimens, tests on oven-dried specimens, or tests on specimens exposed to low or high temperatures and should be used with caution for acceptance testing because factual information on between-laboratory precision and bias is not available.

5.1.1 If there are differences of practical significance between reported test results for two laboratories (or more), comparative tests should be performed to determine if there is a statistical bias between them, using competent statistical assistance. As a minimum, use the samples for such a comparative tests that are as homogeneous as possible, drawn from the same lot of material as the samples that resulted in disparate results during initial testing and randomly assigned in equal numbers to each laboratory. The test results from the laboratories involved should be compared using a statistical test for unpaired data, 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.

5.2 *Fundamental Properties*—The breaking tenacity, calculated from the breaking force and the linear density, and the elongation are fundamental properties that are widely used to establish limitations on yarn processing or conversion and on their end-use applications. Initial modulus is a measure of the resistance of the yarn to extension at forces below the yield point. The chord modulus is used to estimate the resistance to imposed strain. The breaking toughness is a measure of the work necessary to break the yarn.

5.3 *Comparison to Skein Testing*—The single-strand method gives a more accurate measure of breaking force present in the material than does the skein method and uses less material. The skein-breaking force is always lower than the sum of the breaking forces of the same number of ends broken individually.

5.4 *Applicability*—Most yarns can be tested by this test method. Some modification of clamping techniques may be necessary for a given yarn depending upon its structure and composition. To prevent slippage in the clamps or damage as a result of being gripped in the clamps, special clamping adaptations may be necessary with high modulus yarns made from fibers such as glass or extended chain polyolefin. Specimen clamping may be modified as required at the discretion of the individual laboratory providing a representative force-elongation curve is obtained. In any event, the procedure described in this test method for obtaining tensile properties must be maintained.

5.5 *Breaking Strength*—The breaking strength of a yarn influences the breaking strength of fabrics made from the yarn, although the breaking strength of a fabric also depends on its construction and may be affected by manufacturing operations.

5.5.1 Because breaking strength for any fiber-type is approximately proportional to linear density, strands of different sizes can be compared by converting the observed breaking strength to breaking tenacity (centinewtons per tex, grams-force per tex, or grams-force per denier).

5.6 *Elongation*—The elongation of a yarn has an influence on the manufacturing process and the products made. It provides an indication of the likely stretch behavior of garment areas such as knees, elbows, or other points of stress. It also provides design criteria for stretch behavior of yarns or cords used as reinforcement for items such as plastic products, hose, and tires.

5.7 *Force-Elongation Curve*—Force-elongation curves permit the calculation of various values, not all of which are discussed in this test method, such as elongation at break, elongation at specified force, force at specified elongation, initial elastic modulus which is resistance to stretching, compliance which is ability to yield under stress, and is the reciprocal of the elastic modulus, and area under the curve, a measure of toughness, which is proportional to the work done.

NOTE 3—Force-elongation curves can be converted to stress-strain curves if the force is converted to unit stress, such as to centinewtons per tex, or pounds per square inch, or pascals, or grams-force per tex, or