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# Standard Test Methods for Testing Tire Cords, Tire Cord Fabrics, and Industrial Yarns Made From Glass Filaments[1]

This standard is issued under the fixed designation D2970/D2970M; 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 These test methods cover the testing of industrial yarns made of glass filaments, cords twisted from such yarns, and fabric woven from such cords—products that are made specifically for use in the manufacture of pneumatic tires. By agreement, these test methods may be applied to similar glass yarns and cords used for reinforcing other rubber goods and for other industrial applications. The yarn or cord may be wound on cones, tubes, bobbins, spools, or beams, woven into fabric, or in other forms. These test methods include testing procedures only. These test methods do not include specifications or tolerances.

1.2 No procedure is included for the determination of fatigue resistance of cords, but several articles relating to the measurement of fatigue resistance of cords made from man-made filaments and cured in rubber were published in the bibliography of Test Methods D885.

1.3 The following sections are included:



1.4 These test methods show the values in both SI units and in inch-pound units. "SI units" is the technically correct name for the system of metric units known as the International System of Units. "Inch-pound units" is the technically correct name for the customary units used in the United States. The values stated in either acceptable metric units or other units shall be regarded separately as standard. The values expressed in each system may not be exact equivalents; therefore, each system must be used independently of each other without combining values in any way.

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]

D76 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
D1423 Test Method for Twist in Yarns by Direct-Counting
D2258 Practice for Sampling Yarn for Testing
D4393 Test Method for Strap Peel Adhesion of Reinforcing Cords or Fabrics to Rubber Compounds
D4848 Terminology Related to Force, Deformation and Related Properties of Textiles
D6477 Terminology Relating to Tire Cord, Bead Wire, Hose Reinforcing Wire, and Fabrics

## 3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms related to tire cord, bead wire, hose wire, and tire cord fabrics, refer to Terminology D6477.

[1] These test methods are under the jurisdiction of ASTM Committee D13 on Textiles and are the direct responsibility of Subcommittee D13.19 on Industrial Fibers and Metallic Reinforcements.

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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.

3.1.1.1 The following terms are relevant to this standard" catenary length, cord twist, dip, dip pickup, in textile cord or fabric, industrial yarn, standard atmosphere for testing textiles, tabby sample, tire cord, and tire cord fabric.

3.1.2 For definitions of terms related to force and deformation in textiles, refer to Terminology D4848.

3.1.2.1 The following terms are relevant to this standard: breaking force, breaking tenacity, initial modulus, tensile strength.

3.1.3 For definitions of other terms related to textiles, refer to Terminology D123.

3.1.3.1 The following terms are relevant to this standard: fabric

3.2 *Abbreviations:*

3.2.1 *CRE*—constant-rate-of-extension

## 4. Summary of Test Methods, General

4.1 A summary of the directions prescribed for the determination of specific properties is stated in the appropriate sections of specific test methods or the referenced standard.

## 5. Significance and Use

5.1 The procedures in these test methods may be used for the acceptance testing of commercial shipments, but caution is advised because technicians may fail to get good agreement between results on certain yarns, cords, or fabrics. Comparative tests as directed in Section 5.1.1 may be advisable.

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, test samples should be used that are as homogeneous as possible, that are drawn from the material from which the disparate test results were obtained, and that are randomly assigned in equal numbers to each laboratory for testing. Other materials with established test values may be used for this purpose. 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.

5.2 The significance and use of particular properties are discussed in the appropriate sections of the specific test methods.

## SAMPLING AND CONDITIONING

## 6. Sampling of Yarn and Cord

6.1 *Lot Sample*—As a lot sample for acceptance testing, take at random the number of shipping cases or beams directed in an applicable material specification or Practice D2258. Consider shipping cases to be the primary sampling unit.

6.2 *Laboratory Sample:*

6.2.1 *Yarn or Cord in Cases*—As a laboratory sample for acceptance testing, select packages at random from each shipping case in the lot sample. Take the number of packages for the laboratory sample as directed in an applicable material specification or Practice D2258. Preferably, the same number of packages should be taken from each shipping case in the lot sample. If differing numbers of packages are to be taken from shipping cases in the lot sample, the cases from which a specific number of packages are to be drawn should be determined at random.

6.2.2 *Yarn on Beams*—As a laboratory sample for acceptance testing, select ends at random from each beam in the lot sample. Take the number of ends for the laboratory sample as directed in an applicable material specification or Practice D2258. Wind the laboratory samples on a tube or spool using a winder with a tension of 5 ± 1 mN/tex [0.05 ± 0.01 gf/den] using the general technique directed in Practice D2258.

6.2.2.1 Take laboratory samples from the outside of the beams unless there is a question or disagreement about a shipment. In that case, take laboratory samples after removing a radial depth of 6 mm [¼ in.] or more to minimize the effects of handling and atmospheric changes that occurred during shipment or storage. Place the laboratory samples in a moisture resistant container to protect them from atmospheric changes until the yarn is conditioned in the atmosphere for testing tire cords and industrial yarns.

6.3 *Test Specimens*—Take the number of specimens from each laboratory sampling unit as directed in each test method.

6.3.1 *Preparation of Specimens*—Unwind and discard at least six layers of yarn or cord from the package to eliminate ultraviolet and physically damaged material (except from beams). If specimens are not taken directly from the original package, it is advisable to wind the sample on a tube or spool by means of a winder using a tension of 5 ± 1 mN/tex [0.05 ± 0.01 gf/den]. If the specimen is collected as a loosely wound package, or in the form of a skein, report that the observed results were determined on a relaxed sample. Use care in handling the specimen. Discard any specimen subjected to any change of twist, kinking or making any bend with a diameter less than 6 mm [¼ in.]. Place the specimen in a moisture resistant polyethylene bag or other moisture resistant container to protect it from atmospheric changes until ready to condition in the atmosphere for testing industrial yarns and tire cords.

6.3.2 If the yarn or cord has been treated with a resorcinol-formaldehyde-latex (RFL) type adhesive, samples should be protected against exposure to ultraviolet light, high humidity (over 60 % relative humidity) and high temperature (over 38°C [100°F]).

## 7. Sampling of Tire Cord Fabric

7.1 *Lot Sample*—As a lot to be sampled for acceptance testing, take tire cord fabric produced on only one loom creel. As a primary sampling unit, select one roll of fabric from the lot and prepare tabby sample to yield the laboratory sampling units as directed in Section 7.2.

7.2 *Preparation of Laboratory Sample*—Take a sample equal to the length of cord between the regular tabby woven at the end of the roll and a special tabby woven a short distance from the end when the roll of fabric is manufactured. For rolls that do not have a special woven tabby, improvise a tabby by the use of gummed tape or strips of cemented fabric applied across a section of the cord fabric. The length of the tabby

sample shall be as agreed upon by the purchaser and the supplier. The recommended minimum is 0.5 m [18 in.]. The width of the sample shall be at least one tenth of the roll width. Cut the warp cords of the fabric along the center line of the special tabby across for a distance equal to the width of the required sample. If this distance is less than the full width of the fabric, cut the filling yarns of the sample and of the special and regular tabbies in the direction parallel with the warp cords. The resulting section of cord fabric is the tabby sample. Attach the tabby sample to a piece of cardboard or fiber board, the length of which shall be equal to at least the length of the cord warp between tabbies. Fold the tabby portions of the sample over each end of the board, and secure the sample to the board with pressure-sensitive tape or staples. Use care to avoid contact of tape or staples with the area to be tested. Handle the sample carefully and hold it under sufficient tension in the warp direction to prevent the cords from kinking. The board with the sample may be folded lengthwise and parallel with the warp for convenience. Place the board with the fabric sample in a polyethylene bag, or wrap it with several layers of polyethylene film to protect the sample from changes in atmospheric moisture content until ready to condition in the atmosphere for testing industrial yarns and tire cords. Use care during subsequent handling of the sample to prevent any change in the cord twist and to avoid kinking of the cords in the area to be tested.

7.3 *Test Specimens*—Take the number of specimens at random from each laboratory sampling unit as directed in each of the specific test methods.

## 8. Conditioning

8.1 Bring all specimens of yarn, cord, and fabric to moisture equilibrium for testing in the atmosphere for testing industrial yarns and tire cords.

## TENSILE PROPERTIES OF YARNS AND CORDS

## 9. Scope

9.1 These tests are used to determine the tensile properties of yarns and cords.

## 10. Summary of Test Method

10.1 A continually increasing force is applied longitudinally to a conditioned specimen of yarn or cord placed in the clamps of a tensile testing machine until broken. The breaking force and elongation are observed depending upon the option employed. Two clamping options are provided: Option 1, drum clamp; and Option 2, pneumatically-operated clamps having fixed snubbing surfaces that are integral with one of the clamping surfaces. Elongation and modulus are calculated from the force-extension curve when using Option 2. Breaking tenacity is calculated using yarn number.

## 11. Significance and Use

11.1 In some laboratories, the output of the CRE-type of tensile testing machine may be connected with electronic recording and computing equipment that may be programmed to calculate and print the results of tests for each required property. Because of the variety of electronic equipment available, and the various possibilities for recording test data, use of this type of equipment is not covered in this test method.

11.2 The levels of tensile properties obtained when testing industrial yarns and tire cords are dependent to a certain extent on the age and history of the sample and on the specific conditions used during the test. Among these conditions are rate of tensioning, type of clamps, gage length of specimen, temperature and humidity of the atmosphere, rate of airflow across the specimen, and temperature and moisture content of the specimen. Testing conditions accordingly are specified precisely to give reproducible test results on a specific sample.

11.3 Because the load-bearing ability of a reinforced rubber product is related to the strength of the yarn or cord used as a reinforcing material, breaking strength is used in engineering calculations when designing various types of textile reinforced rubber products. When intrinsic strength characteristics of yarns and cords of different sizes or different types of fiber are to be compared, breaking tenacity is very useful, because for most types of fiber, breaking force is approximately proportional to linear density.

11.4 The drum clamp option gives a more accurate measure of strength since it minimizes the effect of clamping and is recommended when strength only is required. Elongation and modulus are not readily measured by this option.

11.5 The pneumatic-type clamp option provides for the measurement of strength, elongation, and modulus. However, the strength of the yarn or cord may be lower and subject to greater variation due to the effect of clamping.

11.6 Elongation of yarn or cord is taken into consideration in the design and engineering of reinforced rubber products because of its effect on uniformity of the finished product and its dimensional stability during service.

11.7 Modulus is a measure of the resistance of yarn or cord to extension as a force is applied. It is useful for estimating the response of a textile-reinforced structure to the application of varying force and its rate. Although modulus may be determined at any specified force, initial modulus is the value most commonly used.

11.8 It should be emphasized that, although the preceding parameters are related to the performance of a textile-reinforced product, the actual configuration of the product is significant. Shape, size, and internal construction also can have appreciable effect on product performance. It is not possible, therefore, to evaluate the performance of a textile reinforced product in terms of the reinforcing material alone.

## 12. Apparatus

12.1 *Tensile Testing Machine*—A single-strand CRE-type tensile testing machine. The specifications and methods of calibration and verification of this machine shall conform to Specification D76. The testing machine shall be suitable for operation at a rate of crosshead travel not to exceed response of the read-out device to follow force and speed changes. The machine shall be equipped with an autographic recorder (rectilinear coordinates preferred) or digital read-out.