Designation: D430 – 06 (Reapproved 2018)

Standard Test Methods for Rubber Deterioration—Dynamic Fatigue[1]

This standard is issued under the fixed designation D430; 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 These test methods cover testing procedures that estimate the ability of soft rubber materials to resist dynamic fatigue. No exact correlation between these test results and service is given or implied. This is due to the varied nature of service conditions. These test procedures do yield data that can be used for the comparative evaluation of rubber or composite rubber-fabric materials for their ability to resist dynamic fatigue.

1.2 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.3 *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.*

1.4 *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]

D412 Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension

D1349 Practice for Rubber—Standard Conditions for Testing

D1682 Test Method for Breaking Load and Elongation of Textile Fabric (Withdrawn 1992)[3]

D3183 Practice for Rubber—Preparation of Pieces for Test Purposes from Products

D3767 Practice for Rubber—Measurement of Dimensions

D4483 Practice for Evaluating Precision for Test Method Standards in the Rubber and Carbon Black Manufacturing Industries

3. Summary of Test Methods

3.1 Three test methods are covered, using the following different types of apparatus:

3.1.1 *Method A*—Scott Flexing Machine.

3.1.2 *Method B*—DeMattia Flexing Machine.

3.1.3 *Method C*—E. I. DuPont de Nemours and Co. Flexing Machine.

3.1.4 The Scott flexing machine is used principally for tests of Type I, the DeMattia flexing machine for tests of Type II, while the DuPont apparatus is adapted to tests of either Type I or II, refer to 4.2.

4. Significance and Use

4.1 Tests for dynamic fatigue are designed to simulate the continually repeated distortions received in service by many rubber articles, such as tires, belts, footwear, and molded goods.

4.1.1 These distortions may be produced by extension, compressive, and bending forces or combinations thereof.

4.1.2 The effect of the distortions is to weaken the rubber until surface cracking or rupture occurs. Where rubber is combined with other flexible materials such as fabric, the effect may be evidenced by separation at the interface between the materials, caused either by breaking of the rubber or failure of the adhesion or both.

4.2 These tests are, therefore, of the following two types:

4.2.1 *Type I*—Tests designed to produce separation of rubber-fabric combinations by controlled bending of the specimens.

4.2.2 *Type II*—Tests designed to produce cracking on the surface of rubber by either repeated bending or extension as may occur in service.

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[1] These test methods are under the jurisdiction of ASTM Committee D11 on Rubber and Rubber-like Materials and are the direct responsibility of Subcommittee D11.15 on Degradation Tests.

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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.

5. Application

5.1 Established specifications, practices or methods of test as agreed upon between customer and supplier take precedence over those contained herein.

6. Preparation of Test Specimens

6.1 Except as may be otherwise specified herein, specimen preparation shall comply with the requirements of Practice D3183.

7. Test Temperatures and Conditioning

7.1 The standard temperature for testing shall be as described in Practice D1349 for the Standard Laboratory Atmosphere [23 ± 2°C (73.4 ± 3.6°F)].

7.2 Controlled temperatures outside the standard range are acceptable and often desirable. Notation of nonstandard test temperatures shall appear in the report.

7.3 Specimens shall be conditioned at the specified temperature for no less than 12 h prior to testing.

METHOD A: SCOTT FLEXING MACHINE[4]

8. Type of Strain

8.1 The Scott flexing machine test method is used to test for ply separation in test specimens composed of plies of fabric bonded to rubber compounds (belts, tires, etc.) by controlled bending.

9. Test Specimens from Belts

9.1 The specimens shall be 209.5 mm (8.25 in.) in length by 25 ± 2 mm (1 ± 0.08 in.) in width.

9.2 The thickness shall be measured in accordance with Practice D3767, Procedure A, recorded and reported.

9.3 Test specimens selected from samples of belts shall be cut lengthwise of the belt and their locations recorded and reported.

9.4 The seam area of a folded belt shall not be included in any of the test specimens and the folded edge shall be removed before cutting the specimens.

9.5 The specimens shall consist of four plies for routine tests, any excess plies being removed by carefully stripping so as not to weaken the remaining bonds.

9.5.1 When another number of plies are used in nonroutine tests, the number of plies shall be recorded and reported.

10. Test Specimens from Tires

10.1 Test specimens from tires shall be cut to the dimensions indicated in 10.2.3.1. If suitable test specimens cannot be cut from tires it is necessary to prepare special flexing pad samples as described in 10.2.1 – 10.2.3 from the cord fabric and rubber compounds that are to be tested.

10.2 Specimen thickness measurements shall be determined in accordance with Practice D3767, Procedure A.

10.2.1 *Preparing Unvulcanized Flex Specimen Pads:*

10.2.1.1 Solution coated, frictioned, or bare cord fabric shall be calendered with the rubber compound to a total thickness of 1.25 mm (0.050 in.).

10.2.1.2 Six plies of this material shall be assembled using a hand roller so that the plies run in alternate directions. The first, third, and fifth plies shall have the cords lengthwise and the second, fourth, and sixth plies crosswise of the pad.

10.2.1.3 Care shall be taken that the same calendered side of each piece is facing up and that each alternate ply crosses at right angles.

10.2.1.4 The pad, which shall have a thickness of 7.6 mm (0.300 in.) shall be cut by means of a template and knife to dimensions of 125 × 202 mm (4.94 × 7.94 in.). The long edge of the template shall be held parallel with the lengthwise cords in the specimen pad.

10.2.2 *Vulcanization of Flexing Pad Specimens:*

10.2.2.1 The specimen pad shall be vulcanized in a steel mold having single, or multiple, cavities measuring 125 × 203 × 8.25 mm (5 × 8 × 0.325 in.).

10.2.2.2 Uniform compression shall be applied over the entire top surface of the specimen pad. This compression, together with slight stretching produced by the unvulcanized pad being cut slightly smaller than the cavity, ensures straight cords in the cured specimen pad.

10.2.2.3 In order to obtain uniform compression, it is necessary to make up the difference between the specimen pad thickness and the mold depth by means of filler layers of Holland cloth or aluminum foil placed on top of the specimen pad.

10.2.2.4 These filler layers shall be added until the total thickness of the assembly is 7.75 mm (0.305 in.).

10.2.2.5 A sheet of rubber compound containing curing ingredients and measuring 152 × 228 × 0.5 mm (6 × 9 × 0.02 in.) shall be placed on top of the specimen pad and filler layers over the cavity of the mold before the mold cover is placed in position.

10.2.2.6 The purpose of the top rubber layer is to fill the overflow space and seal the mold. In placing the specimen pad in the mold, care shall be taken to keep uppermost that side of the specimen pad having the cords running crosswise.

10.2.2.7 The total thickness of the material in the mold is then 8.25 mm (0.325 in.) and expansion will produce an undistorted specimen pad.

10.2.2.8 The mold shall be placed in a press under the conditions of pressure, temperature, and time to achieve vulcanization of the material.

10.2.2.9 After curing, the filler layers shall be removed and the specimen pad allowed to equilibrate at an ambient temperature of between 21 and 32°C (70 and 90°F) for no less than 36 h before being tested.

10.2.2.10 Specimen pads made in this manner shall be 203 × 127 × 7.0–7.1 mm (8 × 5 × 0.275–0.280 in.).

[4] Method A was originated by General Laboratories, U.S. Rubber Co. For further information concerning this test see Gibbons, W. A.,“ Flexing Test for Tire Carcass Stocks,” *Industrial and Engineering Chemistry*, Analytical Edition, Vol 2, No. 1, Jan. 15, 1930, p. 99; also Sturtevant, W. L., “Rubber Power Transmission Belting, Part III—Flexing Machine and Dynamometers for Testing Belting Quality,” *India Rubber World*, Vol 83, No. 3, 1930, p. 67.

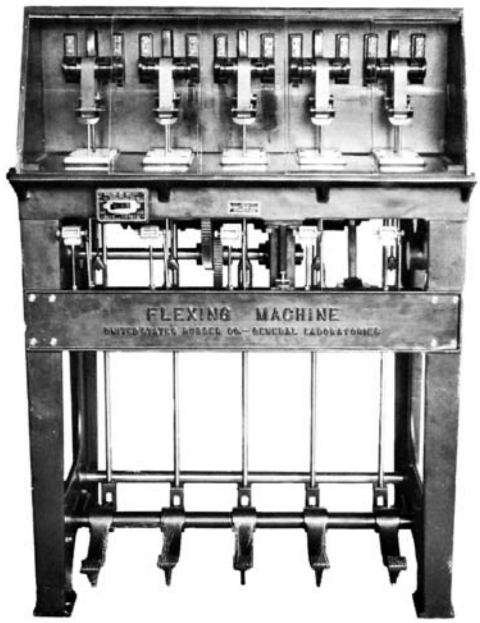

FIG. 1 Scott Flexing Machine with Five Hubs

10.2.2.11 Any pads having distorted cords shall not be tested.

10.2.3 *Cutting the Tire Test Specimens from the Pad:*

10.2.3.1 Four strips, each 203 × 25 mm (8 × 1 in.) shall be cut from the tire specimen pad.

10.2.3.2 First cut a strip 6.3 to 12.5 mm (0.250 to 0.50 in.) in width from one longitudinal edge of the specimen. Remove and discard this piece.

10.2.3.3 Beginning from the first cut, remove four additional strips, taking care to cut the strips straight with smooth edges. It is recommended to use a template as a cutting guide.

10.2.3.4 In cutting the specimens, there should not be more than five or six cut longitudinal threads exposed on the two edges of a six ply specimen. A number of cut threads beyond five or six is excessive and indicates that many of the threads of alternate plies are not parallel.

11. Number of Test Specimens

11.1 At least five specimens from each belt sample or tire and no less than four specimens from each tire specimen pad shall be tested and the results averaged as indicated in Section 16. Precision may be increased by testing a greater number of specimens.

12. Scott Flexing Machine

12.1 The essential features of the apparatus, illustrated in Fig. 1, are as follows:

12.1.1 The Scott flexing machine has five hubs and is capable of testing up to five specimens at one time. Each hub rotates on a double row, radial type, ball bearing of the grease sealed type with double shields.

12.1.2 The test specimens shall be bent around the hubs having an arc of contact of approximately 165°, and the ends shall be gripped by clamps that are oscillated, up and down, by rocker arms driven through a chain of gears by a 190 W (0.25 hp) 1750 rpm motor.

12.1.3 The action on the specimen is a flexing, back and forth, over the hub while held in tension by the loading lever and weight.

12.1.4 The specimen has a travel in one direction of 66.5 mm (2.62 in.) and a full cycle travel of 132.0 mm (5.2 in.). The speed of operation is approximately 2.7 Hz (160 cpm) with the number of cycles in each test being recorded by a counter affixed to each rocker arm.

13. Hub Size and Flexing Force

13.1 Specimens from belts shall be tested using hubs 31.7 mm (1.250 in.) in diameter with a 445 N (100 lbf) flexing force.

13.2 Specimens from tires or tire specimen pads shall be tested using hubs 14.3 mm (0.563 in.) in diameter with a 445 N (100 lbf) flexing force.

14. Procedure for Belt Specimens

14.1 Bend the belt test specimens around the hubs with the pulley side of the belt against the metal and the ends clamped in the grips.

14.2 Carefully apply the flexing load without shock, set the counter to zero, and start the machine. Allow it to run until some fine particles, dislodged by friction, may be seen on the white plate beneath the hub, which indicates that separation of the plies has started.

14.3 Frequent inspection of the specimens undergoing test is imperative if reliable results are to be expected.

14.4 When the first indication of ply separation appears, note and record the counter reading. Thereafter watch the specimen more closely and increase the frequency of the inspection to ensure proper determination of the end point.

14.5 When there is a clear separation across the width of the specimen it shall be considered to have failed. Record the minimum counter reading for this failure as the end point. Also record the location of the separation.

14.6 When a test is started, continue to completion without interruption. However, for the purpose of examining the specimen, each hub may be released momentarily from its force by means of the foot lever provided.

15. Procedure for Tire Specimens

15.1 Mount the tire test specimens with the lengthwise outer ply cords against the hub of the machine and test in a manner similar to the procedure for belts (Section 14).

15.2 After the tire specimen has been run about 10 min, but before separation begins, brush a thick coat of molten carnauba wax on the outer side of the specimen at the flexing region.

15.3 As soon as separation begins, the temperature of the flexing region increases very rapidly and the wax melts. The melting of the wax starts with a small area and gradually spreads as separation increases. This serves as a warning that complete separation will occur shortly thereafter. The interval