



Standard Test Method for Measuring the Relative Stiffness of Leather by Means of a Torsional Wire Apparatus¹

This standard is issued under the fixed designation D 2821; 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 test method describes the use of a torsional apparatus for measuring the relative stiffness of gloving leathers. This test method does not apply to wet blue.

1.2 The values stated in SI units are to be regarded as the standard. The values shown in parentheses are provided 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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

D 1053 Test Method for Rubber Property-Stiffening at Low Temperatures: Flexible Polymers and Coated Fabrics²

D 1610 Practice for Conditioning Leather and Leather Products for Testing³

3. Significance and Use

3.1 This test method is designed to measure the apparent torsional modulus of a leather specimen. Experience has shown that the torsion modulus of leather is directly related to the characteristic known as stiffness when felt in a glove.⁴

¹ This test method is under the jurisdiction of ASTM Committee D31 on Leather and is the direct responsibility of Subcommittee D31.04 on Apparel and Upholstery. This test method was developed in cooperation with the American Leather Chemists Assn.

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² *Annual Book of ASTM Standards*, Vol 09.01.

³ *Annual Book of ASTM Standards*, Vol 15.04.

⁴ Gloves were made from the neck and butt areas of cattlehide work-glove leather selected for 3° of softness varying from soft to firm. These were ranked from softest to firmest by 20 individuals. Since there was some overlapping of rank as assigned by individual observers, the final rank was assigned according to highest number of selections. Specimens of leather cut from the sides in the area from which each glove was cut were tested for stiffness according to this test method. At 90° of twist, the stiffness values gave a ranking similar to that obtained by feel. Specimens cut parallel to the backbone gave more consistent ranking than specimens cut perpendicular to the backbone. This undoubtedly reflects the fact that work gloves are cut from a side with the fingers parallel to the backbone. A report of these experiments and data used for calculation of precision and accuracy are on file at ASTM Headquarters.

4. Apparatus

4.1 *Torsion Apparatus*⁵—The torsional apparatus, Fig. 1, shall consist of a torsion head, *A*, capable of being turned through a complete circle in a plane normal to the torsion wire. The torsion head is equipped with an upper dial or protractor, *K*, graduated from 0 to 360° in increments not greater than 5°, and a fixed index pointer, *L*. The protractor is attached to the torsion head by means of a friction bearing to permit movement for adjusting the zero point. The top of the torsion wire is attached to the torsion head at knob *H* by set screw *B* and passes through the center of a loosely fitting sleeve gripped by the friction bearing. The torsion head support carries a split bearing which can be activated by knob *G*, thus locking the sleeve carrying the wire and permitting adjustment of the zero point of the protractor without disturbing the position of the torsion wire. The bottom of the wire shall be fastened to the test specimen clamp, *C*, by means of a set screw connector, *D*. A pointer, *I*, mounted above a fixed dial, *J*, shall be provided to indicate the twist applied to the specimen. Torsion is applied by manually turning knob *H* or the remote control knob *M*.

4.2 *Stand*—The torsion apparatus shall be mounted on a rigid supporting stand.

4.3 *Torsion Wires*⁶—Torsion wires shall be made of tempered spring wire 315 mm (12.5 in.) long, with each end firmly affixed within a rod measuring 5 mm ($\frac{3}{16}$ in.) in diameter and 12.5 mm ($\frac{1}{2}$ in.) long so as to give a free length between the

⁵ The method is similar to Test Method D 1053. The original apparatus was described by Williamson, I., *British Plastics*, Vol 23, 1950, pp. 87–90, 102; and typical examples of the results of its use on leather were given in a paper by Witnauer, L. PA, and Palm, W. E., *Journal*, American Leather Chemist's Assn., JALCA, Vol 59, 1964, pp. 246–258. Working drawings for construction of the apparatus are available at nominal cost from ASTM Headquarters, 100 Barr Harbor Drive, W. Conshohocken, PA 19428-2959. Request Adjunct ADJD282102. There is no known source of supply of the equipment. The former producer, Fulton County Machine and Supply Co., Inc. is no longer in business. If you are aware of alternative suppliers, please provide this information to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend.

⁶ Lengths of the standard wire can be obtained at nominal cost from ASTM, 100 Barr Harbor Drive, W. Conshohocken, PA 19428-2959. Request Adjunct ADJD282101. A stainless steel rocket wire, Type NS-302, 0.010 \pm 0.0025 in. (0.025 \pm 0.06 mm) in diameter, bright finish, with chemical composition of 0.08 to 0.12 % carbon, 8 to 10 % nickel, and 17 to 19 % chromium, available from National Standard Co., 1618-T Terminal Road, Niles, MI 49120; telephone: (616) 683-8100; fax: (616) 683-6249; has proved satisfactory. If other wire is used, it should be calibrated as described in Test Method D 1053 and have a constant of 0.0182 g-cm/deg.



FIG. 1 Torsion Apparatus

rods of 290 ± 2.5 mm (11.5 ± 0.1 in.).

4.4 *Specimen Clamps*—Two clamps shall be provided for holding each test specimen. The top clamp, *C*, shall be mounted at the bottom of the torsion wire. The bottom clamp, *E*, shall be fashioned to move up and down without binding within guides, *F*, mounted in the base. The weight of bottom clamp *E* shall be 15 ± 0.01 g.

5. Test Specimens

5.1 Unless otherwise specified in the detailed specification, cut the specimen using a sharp die measuring 12.70 ± 0.03 mm (0.500 ± 0.001 in.) wide and 114 ± 2 mm (4.5 ± 0.1 in.) long. When known the direction to the backbone shall be indicated. It is good practice, however, to include a control specimen with known twist characteristics.

5.2 Condition the specimen as specified in Practice D 1610.

6. Preparation of Apparatus

6.1 Clamp the specimen in the testing apparatus as described below so that 89 ± 2 mm (3.5 ± 0.1 in.) of the specimen is free between the clamps. It is advisable to mark this distance on the specimen using a bench marker.

6.2 Insert the specimen into the jaws of the bottom clamp, *E*, until the edge of the clamp meets the bench mark, and tighten the two set screws using finger tip pressure. Be sure the specimen is perpendicular to the jaws of the clamp.

6.3 Insert the other end of the specimen into the jaws of the upper clamp, up to the bench mark and tighten the two set screws using finger tip pressure. Be sure the specimen is perpendicular to clamp.

6.4 Insert the bottom clamp into the clamp guide, *F*.

6.5 Unlock the top dial by turning knob *G* counterclockwise about $\frac{1}{4}$ turn.

6.6 Bring both clamps into parallel position by turning knob *H*, or knob *M*, either clockwise or counterclockwise so there is no twist to the specimen. When the clamps are parallel adjust the top clamp indicator, *I*, so it is over the “0” mark on the lower dial, *J*, by holding the clamp parallel in one hand and turning the indicator. The indicator is attached to the upper clamp by a friction clasp.

6.7 Lock the top dial, *K*, by turning knob *G* clockwise until tight.

6.8 Set the top dial by actually turning dial *K* to read 270° (top dial is tension fitted).

NOTE 1—By setting the dial to 270° , the 90° twist of the specimen will be subtracted out automatically, and the readings obtained will be that of the wire to give the desired 90° twist of the specimen.

NOTE 2—When setting top dial care should be taken not to twist the wire, causing the top clamp indicator to move. Movement of the indicator means that knob *G* was not tightened sufficiently. If this happens repeat operations 6.5-6.8 as may be necessary.

NOTE 3—Dial *K* is attached to knob *H* through a friction bearing, thus permitting dial *K* to be adjusted while the wire, which is attached to knob *H*, is in a locked position when knob *G* is tight. Loosening knob *G* permits knob *H* and dial *K* to be turned freely as a unit.

NOTE 4—The procedure outlined here is for testing of specimens at 90° twist. If in the detailed specification, other degrees of angular twist are specified, then the preflexing cycles and the final measurement shall be made at the specified degree of twist. The zero shall be adjusted to read 360° minus the specified degrees of angular twist, and the torsion values will become corrected for the new value.

7. Procedure

7.1 Preflex the specimen by applying the same degree of angular twist as specified for the test through a minimum of two cycles as detailed below.

7.2 Loosen knob *G* and turn the top dial, *K*, using knob *H* or knob *M*, slowly in a counterclockwise direction until the upper clamp indicator, *I*, shows that the specimen has been twisted 90° (see Note 4). (Try to keep a uniform rate that will take about 4 to 5 s/ 90° . The use of the remote control knob *M* is recommended as it permits a more uniform application of twist.)

7.3 Reverse rotation to the clockwise direction and continue rotating slowly until the specimen clamp indicator *I* has passed the original reference line indicated on the lower dial *J* by approximately 45° . Reverse the direction of rotation again and slowly realign the specimen clamp indicator *I* with the original reference line indicated on lower dial *J*.

7.4 If the upper dial does not read 270° (see Note 4), tighten knob *G* and bring the upper dial to 270° by actually turning dial *K*.

7.5 Repeat steps 7.2-7.4 for one more cycle. This completes the preflexing operation.

7.6 Loosen knob *G* and again turn upper dial *K* using knob *H* or knob *M*, slowly and in a counterclockwise direction, until the specimen clamp indicator, *I*, shows a 90° twist (see Note 4).

7.7 Read from the upper dial, *K*, the angle of torsion and record this value to the nearest 5° .

NOTE 5—Torsion values can be obtained at several increments of angular twist on the same specimen without removing it from the apparatus. If torsion measurements are to be made at more than one increment of angular twist, it is advisable to make the first torsion measurement at the lowest degree of twist and proceed with the increasing

increments in consecutive order. When this is done it is essential that the specimen be preflexed for two cycles at each increment of angular twist.

NOTE 6—Excessively high values may be due to either (a) overshooting the end point from turning the dial too rapidly; (b) the specimen is not perpendicular to clamp jaws and causes bottom clamp to bind; or (c) neglecting to reset zero point between the second preflexing cycle and the final reading.

NOTE 7—Excessively low values, especially at higher degrees of twist may be caused by inadvertently stopping the specimen at 90° instead of going to the higher order.

7.8 Release the specimen from the top clamp by loosening the two set screws.

7.9 Remove the bottom clamp from the guide and release the specimen by loosening the two set screws.

8. Report

8.1 The report shall include the following:

8.1.1 Complete identification of the material tested including type, source, manufacturer's code designation, form, date made, etc.

8.1.2 Direction to backbone.

8.1.3 Dimensions of test specimen, details of conditioning of specimens prior to test, and torsional constant of torsion wire used.

8.2 Report torsion to the nearest 5°, and indicate the angular twist applied to the specimen.

9. Precision and Bias

9.1 The precision of the test method is largely limited by the specimen to specimen variation in such a complex material as leather.

9.1.1 At the 95 % confidence level, repeat determinations on a single specimen made singly by the same operator on different days should not differ by more than 13 % of the lowest value.

9.1.2 At the 95 % confidence level, single determinations made at different laboratories on the same specimen should not differ by more than 23 % of the lowest value.

10. Keywords

10.1 glove leather; stiffness

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