Designation: D 4776 – 04

Standard Test Method for Adhesion of Tire Cords and Other Reinforcing Cords to Rubber Compounds by H-Test Procedure[1]

This standard is issued under the fixed designation D 4776; 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 covers the measurement of adhesion of reinforcing cords that are bonded to rubber compounds. This test method is applicable to textile cord structures from both natural and manmade fibers, other than steel. For adhesion testing of steel tire cords, refer to Test Method D 2229.

1.2 This test method is primarily used to evaluate tire cords, using a suitable tire cord adhesive and a suitable rubber compound. This test method is also used to evaluate (*1*) tire cord adhesives, and (*2*) the process of adhesive reaction on the cord using one consistent form of tire cord and one consistent rubber compound. This test method may be used to evaluate cords in industrial hose and belting products and other cord reinforced rubber products.

1.3 This test method is written in SI units. The inch-pound units which are provided in this test method are not necessarily exact equivalents of the SI units. Either system may be used in this test method.

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

2. Referenced Documents

2.1 *ASTM Standards:* [2]

D 76 Specification for Tensile Testing Machines for Textiles
D 123 Terminology Relating to Textiles
D 1566 Terminology Relating to Rubber
D 2229 Test Method for Adhesion Between Steel Tire Cords and Rubber
D 4393 Test Method for Strap Peel Adhesion of Reinforcing Cords or Fabrics to Rubber Compounds
D 6477 Terminology Relating to Tire Cords, Bead Wire, Hose Reinforcing Wire, and Fabrics

3. Terminology

3.1 *Definitions:*

3.1.1 For defintions of terms relating to tire cord, bead wire, hose wire, and tire cord fabrics, refer to Terminology D 6477.

3.1.1.1 The following terms are relevant to this standard: adhesion, adhesion, in tire fabrics, cord, curing, H-test adhesion, industrial yarn, reinforcing cord, rubber, rubber compound, as used in the manufacture of rubber articles, vulcanization.

3.1.2 For definitions of other terms relating to rubber, refer to Terminology D 1566.

3.1.3 For definitions of other textile terms related to textiles, refer to Terminology D 123.

4. Summary of Test Method

4.1 A cord specimen is sandwiched between two layers of rubber compound test stock in a form resembling an "H," placed in a heated mold, and cured at a specified temperature and pressure. The test specimen sandwich is then cut to create an H-test specimen consisting of a single cord with each end embedded in the center of a tab end of the rubber test block (Fig. 1). The test specimen is placed in the grips of the tensile tester, and then the grips are separated. The maximum force obtained is the H-test adhesion force.

5. Significance and Use

5.1 Test Method D 4776 for the determination of the H-test adhesion of reinforcing cords to rubber compounds may be used for the acceptance testing of commercial shipments of reinforcing cords but caution is advised since information about between-laboratory precision is incomplete. Comparative tests as directed in 5.1.1 may be advisable.

5.1.1 In cases of dispute arising from the differences in reported test results when using Test Method D 4776 for acceptance testing of commercial shipments, the purchaser and the supplier should conduct comparative tests to determine if there is statistical bias between their laboratories. Competent statistical assistance is recommended for the investigation of bias. As a minimum, the two parties should take a group of test specimens which are as homogeneous as possible and which are from a lot of material of the type in question. The test

[1] This test method is under the jurisdiction of ASTM Committee D13 on Textiles and is the direct responsibility of Subcommittee D13.19 on Tire Cord and Fabrics.
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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.

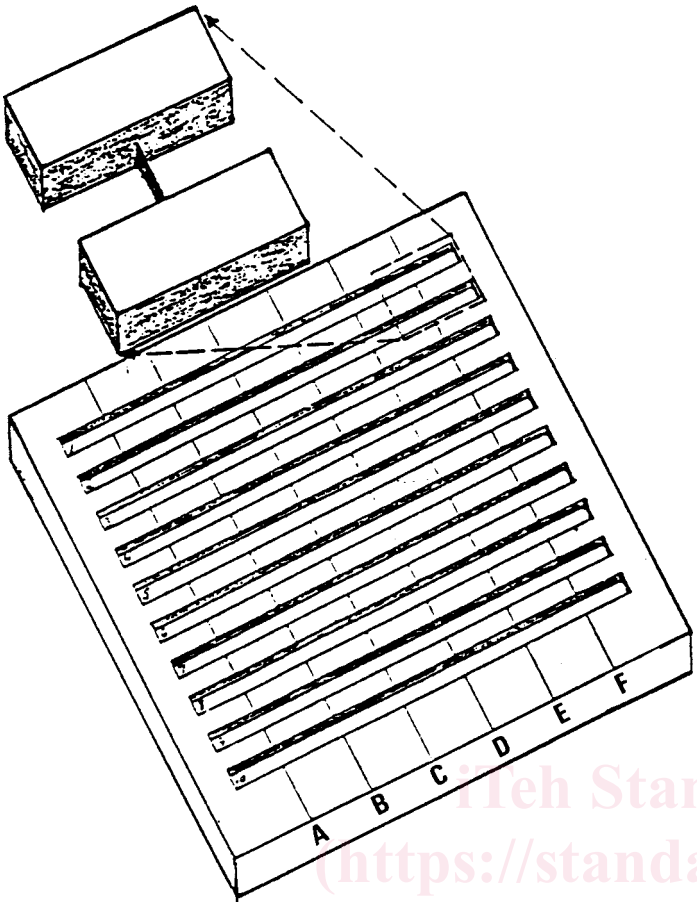

FIG. 1 H-Test Specimen

specimens should then be randomly assigned in equal numbers to each laboratory for testing. The average results from the two laboratories should be compared using Student's *t*-test for unpaired data and an acceptable probability level chosen by the two parties before testing begins. If a bias is found, either its cause must be found and corrected or the purchaser and the supplier must agree to interpret future test results in light of the known bias.

5.2 This test method is used to measure the force required to extract the cord from a rubber compound test block.

5.3 This test method is designed to test the adhesion of textiles that are bonded to rubber compounds. Variables that may contribute to differences in results of this test method include adhesive type, adhesive application procedure, adhesive cure, fiber type, construction of cords, rubber type, rubber cure, and rubber thickness.

5.3.1 The deleterious effect of ozone in combination with atmospheric moisture on the ability of adhesives to bond with rubber requires assiduous protection of cords prior to embedment.

5.4 The expected range of values which characterize acceptable adhesion can be determined in any cord-rubber combination with experience. For this reason, the purchaser normally establishes a minimum level of adhesion to be obtained by the supplier in either the supplier's laboratory or the purchaser's laboratory using either the supplier's standard rubber compound or the purchaser's rubber compound.

5.5 Another procedure for testing adhesion of cords to rubber compounds is Test Methods D 4393 . This procedure has been used extensively in the trade for acceptance testing. Results obtained by this method cannot be used interchangeably since there is no overall correlation between them.

6. Apparatus and Materials

6.1 *Tensile Testing Machine*—Although a constant-rate-of-extension (CRE) tensile testing machine is preferred, a constant-rate-of-traverse (CRT type, pendulum type) may be used. The specification and methods of calibration and verification of these machines shall conform to Specification D 76. The testing machine shall be equipped with an autographic recorder (rectilinear coordinates preferred) or an interface computer. There is a distinct difference between the CRE and CRT type testing machines. Consequently, they cannot be used interchangeably unless a mathematical correlation has been established and agreed upon by the purchaser and supplier.

6.2 *Curing Press*, capable of maintaining a minimum pressure of 3.5 MPa (500 psi) over the total area of the mold surface, equipped with 300 by 300 mm (12 by 12 in.) platens or larger, and capable of a platen temperature control within ±3°C (±5°F) of the temperature specified for curing the rubber compound.

6.3 *Molds*—The design of the molds shall be as shown in Fig. 2. The dimensions of the test specimen are controlled by the specifications and tolerances of the mold. The dimensions of the mold (6.40 mm [0.250 in.] embedment) in Fig. 2a shall be used for cords with a dtex of 1100/2 or less. The dimensions of the mold (9.52 mm [0.375 in.] embedment) in Fig. 2b shall be used for cords with a dtex larger than 1100/2. The slot size for each mold shall be 1.17 mm ± 0.13 mm (0.46 in. ± 0.005 in.).

6.4 *Specimen Grips*—The design of the specimen grips shall be as shown in Fig. 3. Two grips are required.

6.5 *Tensioning Masses*—The masses may be of the hook type, or designed in such a manner that they can be clamped to the cord. In any event, the total mass shall be 50 g.

6.6 *Sheeted Rubber Compound*, (sometimes called skim stock), supported on a non hygroscopic backing, such as a plasticizer-free plastic material. Polyethylene film has been found to be satisfactory. The thickness of the rubber stock required to fill the mold properly shall be determined by experience. As a guide, the thickness of the rubber stock should be not less than 8 % greater than one-half of the mold cavity depth. In any event, the thickness is agreed upon between the purchaser and supplier.

6.6.1 Rubber stock properties are best maintained by storage in a cool, dry atmosphere. Excessive rubber stock moisture may lower adhesion of some fiber/rubber composites.

6.6.2 Rubber compounds exhibit wide variations in shelf life (properties suitable for good adhesion results) dependent upon both composition and storage condition. Rubber compounds are usually replaced after three months; however, some may require replacement within a few weeks. In any event, storage conditions and shelf life should be specified by the supplier of the rubber compound.

6.7 *Timers*, having 60 min capacity, ½ min intervals.