



Designation: D 4776 – 98

Standard Test Method for Adhesion of Tire Cords and Other Reinforcing Cords to Rubber Compounds by H-Test Procedure¹

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 2229D 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:

- D 76 Specification for Tensile Testing Machines for Textiles²
- D 123 Terminology Relating to Textiles²
- D 1566 Terminology Relating to Rubber³
- D 2138 Test Methods for Rubber Property—Adhesion to Textile Cord⁴
- D 2229 Test Method for Adhesion Between Steel Tire Cords and Rubber²

D 4393 Test Method for Strap Peel Adhesion of Reinforcing Cords or Fabrics to Rubber Compounds⁵

3. Terminology

3.1 Definitions:

3.1.1 *adhesion, n*—the property denoting the ability of a material to resist delamination or separation into two or more layers.

3.1.2 *adhesion, n—in tire fabrics*, the force required to separate a textile material from rubber or other elastomer by a definite prescribed method.

3.1.3 *curing, n*—see the preferred term *vulcanization*.

3.1.4 *industrial yarn, n*—a yarn composed of continuous filaments, usually of high breaking tenacity, produced with or without twist, and intended for applications in which functional properties are of primary importance; for example, in reinforcing material in elastomeric products (tires, hose, belting), in protective coverings, and in cordage and webbing, etc.

3.1.4.1 *Discussion*—For example, in reinforcing material in elastomeric products (tires, hose, belting), in protective coverings, and in cordage and webbing, etc.

3.1.5 *reinforcing cord, n*—a cord made from industrial yarns and used to provide added support to other materials, such as tires, hose, belting, protective coverings, webbings, etc.

3.1.6 *rubber, n*—a material that is capable of recovering from large deformations quickly and forcibly, and can be, or already is, modified to a state in which it is essentially insoluble (but can swell) in boiling solvent, such as benzene, methylethyl ketone, and ethanol-toluene azeotrope.

3.1.7 *rubber compound, n—as used in the manufacture of rubber articles*, an intimate mixture of elastomer(s) with all the materials necessary for the finished article.

3.1.8 *cord, n*—a twisted or formed structure composed of one or more single or plied filaments, strands, or yarns of organic polymer or inorganic materials.

3.1.8.1 *Discussion*—For the manufacture of pneumatic tires or other industrial fabrics, the direction of twist used to combine the single or plied yarn elements into a cord construction is in the direction opposite to that used in the yarns.

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² *Annual Book of ASTM Standards*, Vol 07.01.

³ *Annual Book of ASTM Standards*, Vol 09.01.

⁴ *Discontinued 1990—Replaced by D 4776, D 4777.*

⁵ *Annual Book of ASTM Standards*, Vol 07.02.

Frequently, tire and other reinforcing cords consist of a single yarn strand having little or no twist. These cords as well as single monofilaments, are used synonymously with twisted and plied cords in this test method.

3.1.9 *vulcanization, n*—an irreversible process, usually accomplished through the application of heat, during which a rubber compound through a change in its chemical structure (for example, cross-linking) becomes less plastic and more resistant to swelling by organic liquids, and elastic properties are conferred, improved, or extended over a greater range of temperature.

3.1.10 For definitions of other textile terms used in this standard, refer to Terminology D 123D 123. For definitions of other terms relating to rubber, refer to Terminology D 1566D 1566.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *H-test adhesion*—as used in this test method, the force to extract either end of a textile cord structure that is embedded in a rubber compound under specified conditions.

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 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.

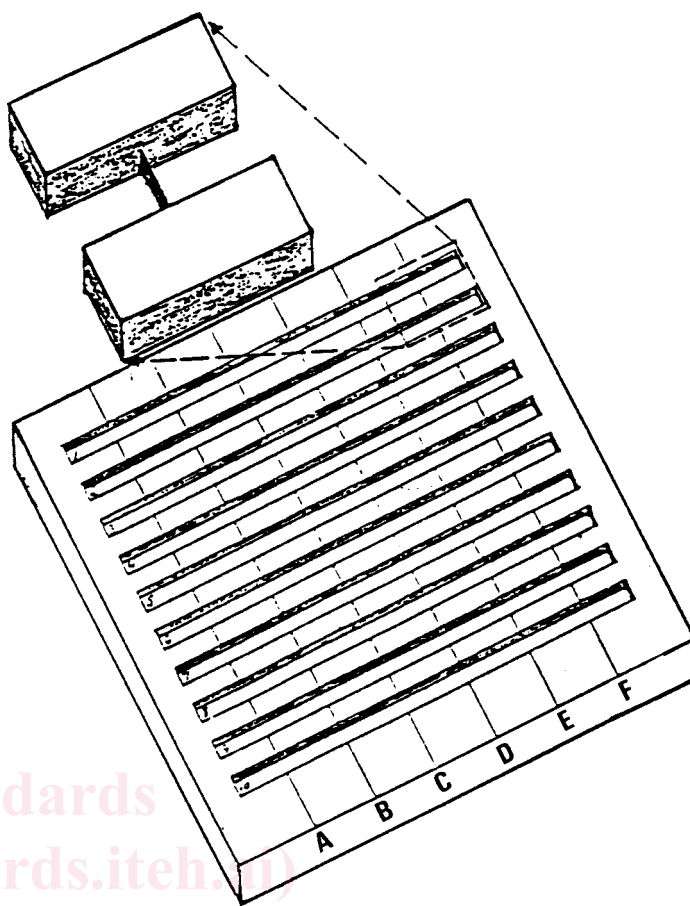


FIG. 1 H-Test Specimen

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 Other procedures for testing adhesion of cords to rubber compounds are available, such as Test Methods D 4393 or D 2138D 4393D 2138. These procedures have been used extensively in the trade for acceptance testing. The decision on which test procedure to use is determined by agreement between the purchaser and supplier based on historical data and experience of the contractual parties. Results obtained by any of these methods cannot be used interchangeably since there is no overall correlation between them.