Designation: D4393/D4393M – 10

Standard Test Method for Strap Peel Adhesion of Reinforcing Cords or Fabrics to Rubber Compounds[1]

This standard is issued under the fixed designation D4393/D4393M; 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 determination of peel adhesion of reinforcing fabrics that are bonded to rubber compounds. It is applicable to either woven or parallel cord textile structures from both natural and manmade fibers and to parallel steel cord structures.

1.2 This test method is primarily used to evaluate tire cords and tire cord fabrics, including steel tire cords, using a suitable tire cord adhesive and a suitable rubber compound. This test method may be used to evaluate tire cord adhesives (fabric dip), metallic (usually brass) coatings on steel cord, and the process of adhesive reaction on the cord using one consistent form of tire cord or fabric and one consistent rubber compound. This test method may be used to evaluate cords and fabrics in industrial hose and belting products and other cord or fabric reinforced rubber products.

1.3 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 or reinforcing fabrics, rubber type, rubber cure, rubber thickness, and cord spacing.[2]

1.3.1 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 rubber embedment.[3]

1.4 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard..

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:*[4]

D76 Specification for Tensile Testing Machines for Textiles
D123 Terminology Relating to Textiles
D1566 Terminology Relating to Rubber
D2138 Test Methods for Rubber Property-Adhesion to Textile Cord[5]
D2229 Test Method for Adhesion Between Steel Tire Cords and Rubber
D6477 Terminology Relating to Tire Cord, 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 D6477.

3.1.1.1 The following terms are relevant to this standard: adhesion, adhesion, in tire fabrics, chafer fabric, curing, fabric dip, holland cloth, rubber, rubber compound, as used in the manufacture of rubber articles, rubberize, steel cord, steel filament, stitch, in making rubberized articles, straightness, in steel cord, tack, for rubber or rubber compounds, tire cord, tire cord fabric, vulcanization, weftless fabric.

3.1.2 For definitions of terms related to rubber, refer to Terminology D1566.

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

4. Summary of Test Method

4.1 *Strap Peel Adhesion From Single Cord*—Two pieces of weftless fabric of sufficient size to cover the curing mold cavity are generated on a rotatable drum (Fig. 1). These two fabrics are laid one against the other, with cords in the same direction, to form the pad (Fig. 2). This pad has a nonstick fabric, such as holland cloth, separating the two fabric layers at one end for a

[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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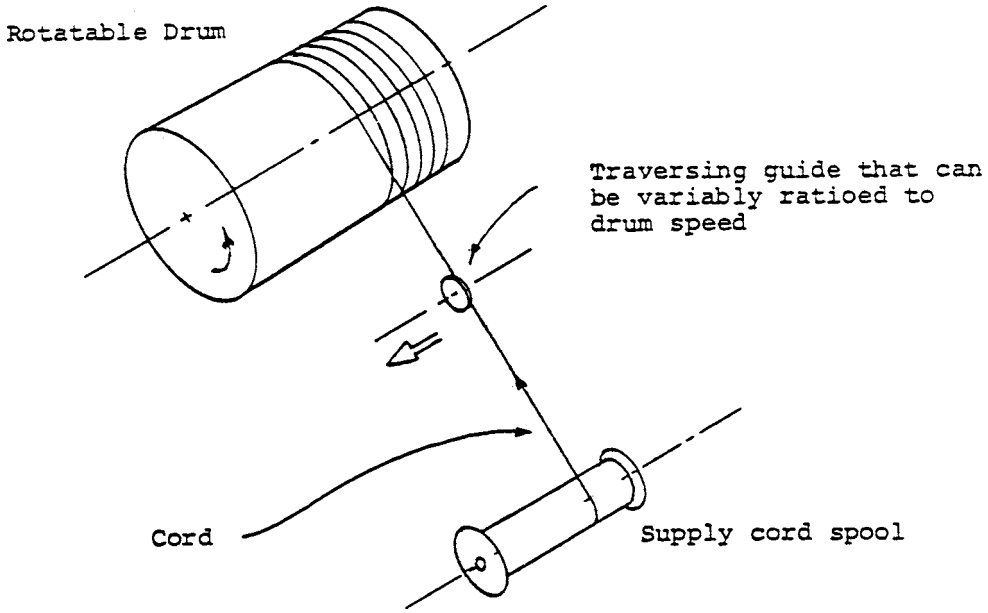
[2] Iyengar, Y., "Adhesion Behavior of Nylon Tire Cord/Adhesive/Rubber Systems," *Journal of Applied Polymer Science*, Vol 13, 1969, pp. 353–363.

[3] Wenghoefer, H. M., "Environmental Effects on RFL Adhesion," *Rubber Chemistry and Technology*, Vol 47, No. 5, December 1974, pp. 1066–1073.

[4] 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.

[5] *Discontinued 1990—Replaced by D4776, D4777.*



NOTE 1—Laydown of cord to a specified number of cords per metre uses the principles of thread cutting on a machining lathe.

FIG. 1 Rotatable Drum and Guide Arrangement

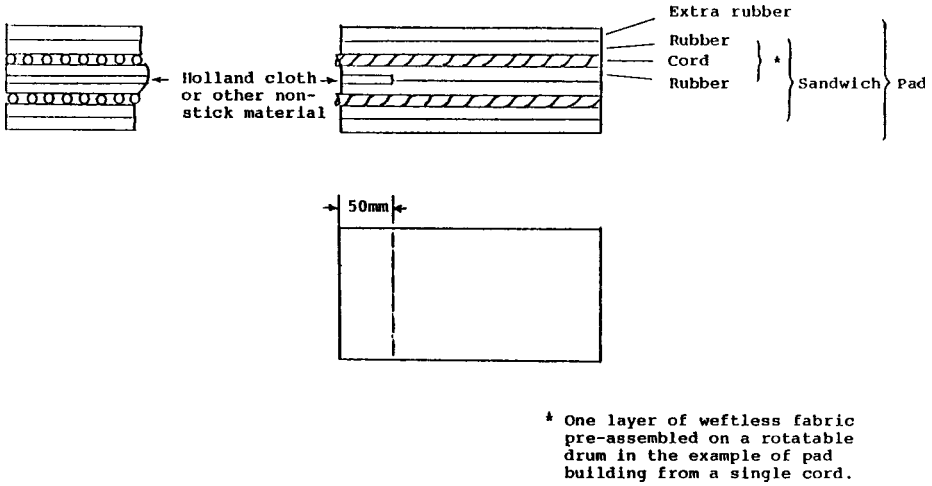


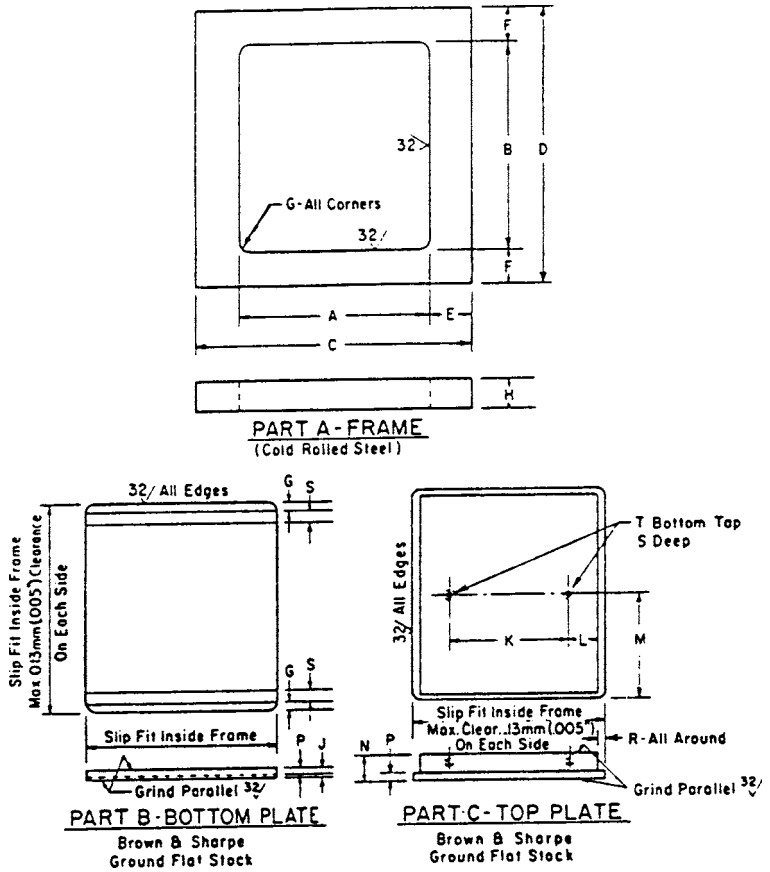
FIG. 2 Assembly of Components into a Pad from Which Seven Adhesion Specimens (Straps) May Be Cut After Curing

sufficient distance to eventually permit adjacent ends of each fabric layer to be separated after curing and grasped separately in the jaws of a tensile testing machine. The pad is cured in a plunger-type mold (Fig. 3) and cut into straps in the long direction, parallel to that of the cords. The force to peel one fabric layer from the other is determined in a recording tensile testing machine.

4.2 *Strap Peel Adhesion From Tire Cord Fabric*—Two pieces, approximately 100 mm [4 in.] square, are cut from woven fabric. These pieces are assembled on a clean flat surface with sheeted rubber compound and a separating material to accomplish a structure like that of Fig. 2. The assembled test pad is cured between heated platens rather than in the plunger-type mold of Fig. 3. Straps are cut from the cured pad in its long direction parallel to the cords, and the force to peel one fabric layer from the other is determined in a recording tensile test machine.

4.3 *Strap Peel Adhesion From Tire Chafer Fabric, Conveyor Belt Duck, Multi-warp Conveyor Belt, and Other Adhesive Treated Fabrics Other Than Tire Cord Fabric*—Test pads are prepared as in 4.2. Straps may be prepared and cut to accomplish a peel force in either the warp direction or 90° to (across) the warp direction, as agreed between buyer and seller. Separate straps are prepared for warp and across-warp direction except in special cases (see 10.4).

4.4 *Strap Peel Adhesion Simulating Composites Cut From Cross-ply Tires*—Four layers of weftless or woven fabric are assembled with each adjacent cord layer insulated by rubber and assembled to provide cord direction in each layer 90° to each adjacent layer. Straps are cut to provide peeling between the two middle cord layers with peel force direction 45° to the longitudinal axis of the cords.



Dimension	mm	in.	Dimension	mm	in.
A	200	8	J	8	⅜
B	225	9	K	130	5
C	300	12	L	35	1½
D	300	12	M	115	4½
E	50	2	N	25	1
F	325	1½	P	5	¼
G	10	⅜	R	3	⅛
H	30	1¼	S	15	½
			T		

FIG. 3 Strap Peel Adhesion Testing Specimen Mold

5. Significance and Use

5.1 *Single Test Cord*— Adhesive treating of cords singly or adhesive treating individual ends simultaneously (referred to as "multi-cord treating" as opposed to "fabric treating") and winding the cords as single ends is the most common laboratory method of preparing reinforcement materials for evaluation in reinforced rubber articles such as tires, belts, and hoses. This system of adhesive treating facilitates the study of a large number of adhesion variables at minimum cost. This test method provides a good comparison of variables on adhesion because it produces both an average numerical value of peel force over several linear centimetres of cord and provides convenient specimens for assessing appearance (see 11.3) of the peeled area as well. It may be used for purchase specification requirements for adhesive treated cords, steel tire cord, adhesives, rubber compounds, or manufacturing control of such products.

5.1.1 Preparation of weftless fabric from single cord is not recommended for acceptance testing of commercial shipments of tire cord fabric because single cords of long length cannot be conveniently obtained from fabric for drumwinding. See 5.2.2.

5.1.2 This test method is usually not preferred for acceptance testing of commercial shipments of adhesive treated cord, such as single end cord for hose. The more usual and convenient method for acceptance testing of such single cords is to prepare from a shipment a test piece or article in the same manner as the commercial article to be produced and to test cord-adhesion characteristics in this piece in a manner that compares its adhesion characteristics against a previously established, acceptable control. "H" and" U" tests (Test Methods D2138) provide convenient and rapid adhesion results for acceptance testing of textile cords if needed. For steel cord, Test Method D2229 provides convenient and rapid adhesion results.