Designation: C 794 – 93

Standard Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants[1]

This standard is issued under the fixed designation C 794; 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 a laboratory procedure for determining the strength and characteristics of the peel properties of a cured-in-place elastomeric joint sealant, single- or multicomponent, for use in building construction.

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

1.3 *This standard does not purport to address all of the safety problems, 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:*

C 33 Specification for Concrete Aggregates[2]

C 109 Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50-mm Cube Specimens)[3]

C 150 Specification for Portland Cement[3]

C 717 Terminology of Building Seals and Sealants[4]

G 23 Practice for Operating Light-Exposure Apparatus (Carbon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials[5]

3. Terminology

3.1 *Definitions*—See Terminology C 717 for applicable definitions of the following terms: cure, elastomeric, joint, primer, sealant, and substrate.

4. Summary of Test Method

4.1 This test method consists of preparing test specimens by embedding a strip of cloth in a thin layer of the sealant being tested, on several substrate materials, curing these specimens for a certain length of time under specified conditions, then placing them in a tension-testing machine in such a way that the embedded cloth is peeled back from the substrate at 180°, and measuring the force exerted as well as the nature of the separation of the sealant from the substrate.

5. Significance and Use

5.1 There are differences in opinion among those concerned with sealant technology whether or not this adhesion-in-peel test is intended to simulate the conditions encountered by a sealant in normal use. Nevertheless, since it represents a test to destruction, the value of the test denotes the ability of the cured sealant to maintain a bond to the substrate under severe conditions.

5.2 Many sealant manufacturers utilize the adhesion-in-peel test for determining the adhesive characteristics of sealant/primer combinations with unusual or proprietary substrates.

6. Apparatus and Materials

6.1 *Testing Machine* with tension grips capable of pulling at the rate of separation of 51 mm (2 in.)/min, and having a chart indicator calibrated in 0.45-kg (1-lb) units.

6.2 *Standard Substrates*:

6.2.1 *Aluminum Alloy*, Type 6063-T5 or 6061-T6, with a clear anodized finish of not less than 0.0075-mm (0.3-mil) thickness over a scale-free finish; 2 pieces, 152 by 76 by 6.3 mm (6 by 3 by ¼ in.).

6.2.2 *Mortar Slabs*, prepare two cement mortar slabs, each 152 by 76 by 9.5 mm (6 by 3 by ⅜ in.) in size, using one part of high early strength portland cement conforming to Type III of Specification C 150 for Portland Cement, to two parts by weight of clean, uniformly graded, concrete fine aggregate (sand) conforming to Specification C 33, for Concrete Aggregates. Use sufficient water to produce a flow of 100 ± 5 when tested in accordance with the procedure for the determination of consistency of cement mortar described in Test Method C 109. After curing 1 day in moist air and 6 days in saturated lime water at 23 ± 2°C (73 ± 3°F), prepare the surface of 152 by 76 mm (6 by 3 in.) of each slab by wet grinding either with a belt sander using No. 60 aluminum carbide sanding belt or using an iron lap with No. 60 silicon carbide (or aluminum oxide) grain until the aggregate is uniformly exposed. Return the slabs to saturated lime water storage until needed.

6.2.2.1 Slabs may be prepared and shipped to other locations for use. The slabs may be shipped dry and shall be returned to lime water storage on arrival until needed.

6.2.2.2 Prior to use, wet grind the previously ground surface

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[1] This test method is under the jurisdiction of ASTM Committee C-24 on Building Seals and Sealants, and is the direct responsibility of Subcommittee C24.32 on Chemically Curing Sealants.

Current edition approved Nov. 15, 1993. Published January 1994. Originally published as C 794 – 75. Last previous edition C 794 – 92.

[2] *Annual Book of ASTM Standards*, Vol 04.02.

[3] *Annual Book of ASTM Standards*, Vol 04.01.

[4] *Annual Book of ASTM Standards*, Vol 04.07.

[5] *Annual Book of ASTM Standards*, Vol 14.02.

to remove any laitance, rinse thoroughly under running tap water, and dry the slabs overnight at 105 to 110°C (220 to 230°F). Clean the slabs by vigorous brushing with a stiff-bristled fiber brush to remove any film or powder. Condition the slabs at standard conditions for not less than 1 day and not more than 7 days.

6.2.3 *Plate Glass*, polished, clear, 152 by 76 by 6.3 mm (6 by 3 by ¼ in.).

NOTE 1—Because of the fact that adhesive properties of a joint sealant are related to the nature of the substrate, it is strongly recommended that whenever possible the peel test be made with the substrates that are to be used in the building under consideration in addition to or in place of the specified substrates described in 6.2.1, 6.2.2, and 6.2.3. Such substrates include brick, marble, limestone, granite, stainless steel, plastic, quarry tile, and others. For practical reasons the specimen dimensions may be changed from the standard sizes provided the thickness of the sealant remains as specified.

6.3 *Spacer Strips*, four, of hard wood, metal, or glass as follows: two 152 by 76 by 6.3 mm (6 by 3 by ¼ in.) for preparing the test specimens on aluminum and glass, and two of the same length and width but 9.3 mm (⅜ in.) thick for preparing the test specimens on mortar.

6.4 *Glass Rod*, about 12.7 mm (½ in.) in diameter and about 305 mm (12 in.) long.

6.5 *Stainless Steel or Brass Rods*, two, 1.6 mm (1⁄16 in.) in diameter, about 305 mm (12 in.) long.

6.6 *Masking Tape*, paper, roll, 25.4 mm (1 in.) wide.

6.7 *Airplane*[6]*/Wire*[7] *Cloth* Grade A, desized, 4.28 oz/yd, 80/84 count, 6 pieces at least 178 mm (7 in.) long and 76 mm (3 in.) wide, or suitable wire cloth,[7] 30-mesh, 0.254-mm (10-mil) thickness.

6.8 *Putty Knife*, stiff, about 38 mm (1½ in.) wide.

6.9 *Knife*, with sharp razor-type blade.

7. Test Specimens

7.1 Two test specimens shall be prepared on aluminum, two on cement mortar, two on glass, and two on each of any other substrate materials specified, using the following procedures:

7.1.1 Condition not less than 250 g of sealant (and portion of catalyst, if a multicomponent) in a closed container for 24 h at 23 ± 2°C (73.4 ± 3.6°F) and 50 ± 5 % relative humidity.

7.1.2 Clean the test surfaces of all metal and glass substrates with methyl ethyl ketone or similar solvent followed by a thorough cleaning with a detergent solution (Note 2), a final rinse with distilled or deionized water, and air dry. Clean masonry surfaces with a dry stiff fiber bristle brush.

7.1.3 Apply primer to the clean dry test surfaces only when specified and supplied by the sealant manufacturer and agreed upon by the purchaser.

7.1.4 Place a strip of masking tape 25 mm (1 in.) wide across the test surface of the substrate so that the lower edge of the tape is parallel and at least 76.2 mm (3 in.) from the lower short edge of the substrate (Fig. 1*A*).

7.1.5 Spread a portion of the conditioned compound, after being mixed thoroughly for 5 min (if multicomponent), over the 102 by 76-mm (4 by 3-in.) area, which includes the masking tape, to a depth slightly more than 1.6 mm (1⁄16 in.), as shown in Fig. 1*B*.

7.1.6 Smear one piece of cloth with the compound at one end over an area of 102 by 76 mm (4 by 3 in.), forcing it into both sides of the cloth with a putty knife until the sealant has thoroughly penetrated the cloth.

7.1.7 Lay the impregnated cloth over the layer of compound and place the spacer bars of proper thickness (see 6.3) on each side of the specimen.

7.1.8 Place a 1.6-mm (1⁄16-in.) metal rod lengthwise on top of each spacer strip and squeegee the compound to 1.6 mm (1⁄16 in.) thick by rolling the glass rod over the metal rods (starting from the taped end), and simultaneously pressing on the cloth and sealant beneath it. Trim off the excess amount that is squeezed out (Fig. 1*C*).

7.1.9 Cure the specimens containing multicomponent compounds 14 days at 23 ± 2°C (73.4 ± 3.6°F). Cure those containing single component compounds 21 days as follows (Note 3): 7 days at 23 ± 2°C (73 ± 3.6°F), 50 ± 5 % relative humidity; 7 days at 37.8 ± 2°C (100 ± 3.6°F) and 95 ± 5 % relative humidity; and finally 7 days at 23 ± 2°C (73 ± 3.6°F) and 50 ± 5 % relative humidity.

7.1.10 After the specimen has cured for about 7 days, coat the cloth with a layer of the compound about 1.6 mm (1⁄16 in.) thick to help minimize cloth failure (Fig. 1*D*).

7.1.11 Immediately following the full curing period, make four cuts with a sharp blade lengthwise of the specimen, cutting completely through to the substrate surface, and remove excess material so as to leave two 25.4-mm (1-in.) wide strips of cloth-covered sealant separated by a space about 9.5 mm (⅜ in.) wide (Fig. 1*E*) (7.1.12). **Caution**—Extreme caution should be taken in removing the excess material so that the sealant/substrate bond in the test strips is not disturbed.

7.1.12 If peel adhesion is to be tested on glass substrate specimens after ultraviolet exposure through glass, after completing step 7.1.11 and before proceeding with 7.1.13, place such specimens with the sealant surface facing away from the light source on the drum of an accelerated weathering machine as specified in Practice G 23 (see description of Type D apparatus). Expose the specimens to the ultraviolet radiation for 200 h without water spray and continue as stated in 7.1.13.

7.1.13 Immediately following step 7.1.11 (except as explained in 7.1.12), completely immerse the specimen in distilled or deionized water for 7 days. Mortar specimens are placed in a separate container from the glass and aluminum specimens, because the highly alkali conditions generated could have an effect on the glass and aluminum.

NOTE 2—At the request of the sealant manufacturer the detergent cleaning step shall be omitted from the specified cleaning procedure.

NOTE 3—The manufacturer can suggest other curing conditions for the single-component sealants that may be used provided: (*a*) the curing time does not exceed 21 days, and (*b*) the temperature does not exceed 50°C (122°F).

8. Procedure

8.1 Immediately following the 7 days' immersion, prepare

[6] Available from Reeves Brothers, Inc., 1271 Ave. of Americas, New York, NY 10020.

[7] Available from Tetko Inc., 333 South Highland Ave., Briarcliff Manor, NY 10510. Also available from McMaster Carr Supply Co., P.O. Box 4355, Chicago, IL 60680.

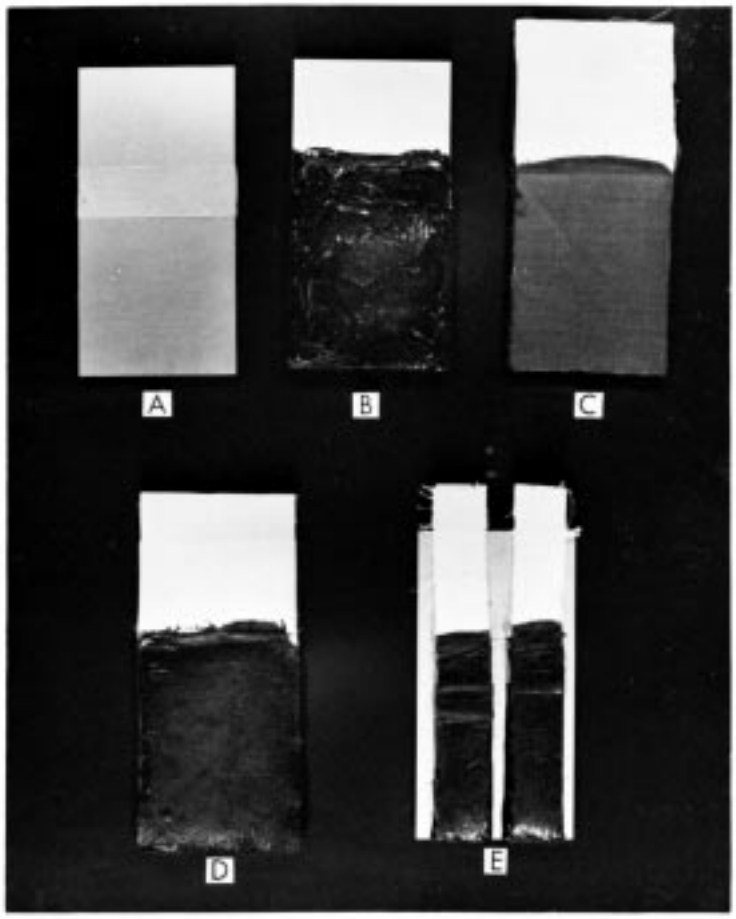

FIG. 1 Stages in the Preparation of the Adhesion-in-Peel Test Specimen

the specimen for testing by wiping it dry, releasing the sealant from the tape undercutting the sealant 12.7 mm (½ in.) and leaving a 63.5-mm (2½-in.) length adhered to the substrate.

8.2 Place the specimen in the testing machine and peel the cloth back at an angle of 180° at a rate of separation of 50.8 mm (2 in.)/min (Fig. 2). Peel the sealant for about 1 min and record the average force in newtons (or pounds-force) indicated by the dial or recording chart of the machine. If the cloth peels clean from the sealant, disregard the values. In such instances, undercut the compound with a sharp blade to produce separation at the interface to the test surface and continue the test.

8.3 Test four strips for each of the substrate materials specified.

9. Report

9.1 Report the following information for each sample tested:

9.1.1 Identification of sample.

9.1.2 Identification of the type of sealant, such as single- or multicomponent, color, etc.

9.1.3 Average peel strength in newtons (or pounds-force) for the four strips tested on each substrate.

9.1.4 The percentage loss in bond and cohesion for each strip tested.

9.1.5 Any indication of cloth failure.

9.1.6 Variation, if any, from the specified test procedure.

10. Precision and Bias

10.1 Round-robin studies of the peel test conducted by members of ASTM Committee C-24 as well as by individual members of the sealant industry indicate that peel tests made on one sealant sample with a specified substrate by a single operator in a single laboratory may yield a range of values that vary by ±10 to ±20 % from the mean value.

10.2 The range of values that can be encountered when peel tests are performed by several laboratories on the same sealant sample with the same substrate is commonly ±60 % from the mean value and is often ±100 %. The reason for this interlaboratory variation has not yet been determined.

11. Keywords

11.1 adhesion-in-peel; elastomeric joint sealant; ultraviolet exposure; water immersion

FIG. 2 Extension Machine Used in the Adhesion-in-Peel Test