Standard Test Method for Climbing Drum Peel for Adhesives

This standard is issued under the fixed designation D1781; 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.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This test method covers the determination of the peel resistance of adhesive bonds between: a relatively flexible adherend and a rigid adherend; and the relatively flexible facing of a sandwich structure and its core, when tested under specified conditions.

1.2 The values stated in SI units are to be regarded as the standard. The values given in parentheses are 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:

B209 Specification for Aluminum and Aluminum-Alloy Sheet and Plate

D907 Terminology of Adhesives

E4 Practices for Force Verification of Testing Machines

2.2 ASTM Adjuncts:

Climbing Drum Peel Tester

3. Terminology

3.1 Definitions—Many of the terms used in this test method are defined in Terminology D907.

4. Summary of Test Method

4.1 Determine the peeling force of a conditioned adhesive bonded sandwich assembly by peeling a face skin around a circular drum. This is done by clamping the assembly in a universal test machine. The average peeling load is determined using a standard formula.

5. Significance and Use

5.1 This test method may be used to determine comparative rather than fundamental measurements of adhesion and is particularly suitable for process control, some examples of which are listed.

5.1.1 This test method is particularly sensitive to adherend surface preparation and is of value where the adhesive is used in conjunction with a primer.

5.1.2 When a relatively brittle adhesive is used, the peel resistance can often give an indication of the degree of cure, that is, higher values than normally realized may indicate an incomplete cure. Direct comparison of different adhesives or processes can only be made when specimen design and test conditions are identical.

6. Apparatus

6.1 Peeling Apparatus, consisting of a flanged drum, flexible loading straps or cables, and suitable clamps for holding the test specimen. The apparatus illustrated in Fig. 1 has been found to be satisfactory.

6.1.1 The outside radius of the drum is 51.00 ± 0.13 mm (2.000 ± 0.005 in.), and the radius of the flange, including one half of the thickness of the loading straps or cables, is 12.70 ± 0.13 mm (0.500 ± 0.005 in.) larger than the radius of the drum.
6.1.2 Use a suitable top clamp (Fig. 2) for supporting the specimen, and a drum clamp (Fig. 3) to hold the adherend against the face of the drum.

6.1.3 Balance the drum about the axis by the use of counterweights (as shown in Fig. 1) placed diametrically opposite the drum clamp to compensate for the weight of this clamp.

6.1.4 The drum and flanges with the drum clamp and its compensating weight weighs \( \leq 3.6 \text{ kg (8 lb)} \), a lighter weight being preferable to facilitate handling of the apparatus.\(^4\)

6.2 Testing Machine, capable of applying tensile loads under the conditions prescribed in Section 11 and with the following further requirements:

6.2.1 The rate of movement between heads of the testing machine remains essentially constant under fluctuating loads (Note 1).

6.2.2 The testing machine weighs the load to within 1 \%. The testing machine and range are selected such that the maximum load on the specimen falls between 15 and 85 \% of the full-scale capacity.

6.2.3 The use of autographic equipment to record load versus head movement is recommended.

6.2.4 Verification of the testing machine is made in accordance with the recommendations of Practices \( \text{E4} \).

NOTE 1—It is difficult to meet this requirement when loads are measured with a spring-type or pendulum-type weighing device.

7. Test Specimen

7.1 For evaluation of adhesives in laminated assemblies, a specimen of the type shown in Fig. 4 has been found to be satisfactory. The specimen is 25 mm (1 in.) wide between saw kerfs and at least 254 mm (10 in.) long. The specimen may be cut from larger bonded panels if desired.

7.2 For evaluation of adhesives in sandwich constructions, make the test specimens in conformance to the general form of the specimen shown in Fig. 1. The specimen is 76 mm (3 in.) wide by at least 305 mm (12 in.) long, including about a 25-mm (1-in.) overhang of one facing at each end. Thickness of the core is not important, except in the sense that the sandwich specimen does not bend while the facing is being peeled. For comparative evaluation of adhesives in bonding metal-faced sandwich constructions, a facing of clad aluminum alloy meeting the requirements of Specification \( \text{B209} \), Alloy 2024-T3, 0.51 mm (0.020 in.) thick with a core 12.7 mm (0.5 in.) thick, has been found to be suitable. Other metal facings of comparable flexibility may also be used. The specimens may be cut from larger bonded panels if desired.

NOTE 2—Direct comparisons of different adhesives can be made only when specimen design and test conditions are identical.

7.3 Test at least six specimens, for example, two or more from each of three bonded panels, for each adhesive sample.

7.4 For sandwich constructions based on orthotropic cores, peel half of the specimens parallel to the length direction of the core.

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\( ^4 \) A suitable climbing drum peel apparatus is available from Custom Scientific Instruments, Inc., 13 Wing Drive, Whippany, NJ, 07981.
core and half parallel to the width direction, as determined from the configuration of the cell structure.

8. Preparation of Test Specimen

8.1 Do all preconditioning or special preparation of the adherends in accordance with the recommendations of the manufacturer of the adhesive.

8.2 Bond in accordance with the procedure and recommendations prescribed by the manufacturer of the adhesive.

NOTE 3—Other preconditioning, preparation, and bonding conditions may be used if agreeable to the supplier and the purchaser of the adhesive.

8.3 Cut specimens from the sandwich panels or laminated panels in such a way as to avoid overheating or mechanical damage to the bond.

NOTE 4—A metal-cutting bandsaw has been found suitable for aluminum-alloy specimens of the types illustrated. The kerfs in laminate assemblies may be cut with a metal-cutting circular saw or milling cutter.

8.4 Attach laminated assemblies to the backing plate in such a manner that the surface to be peeled has no projections. This is done by drilling and tapping the specimen and attaching it by means of No. 6 machine screws inserted from the back side as shown in Fig. 4. Alternatively, with thick assemblies, holes in the specimen are counterbored, and flathead machine screws are then inserted through the specimen and backing plate and held with nuts on the back surface. This permits the use of slotted holes in the backing plate to accommodate less accurately spaced holes in the specimen. In some cases, it is possible to bond the specimen to the backing plate.

9. Calibration of Test Apparatus

9.1 Determine the load to overcome the resisting torque, \( F_0 \) (12.2), of drum, clamp, and counterweight, by one of the following methods:

9.1.1 For peel resistance of adhesive with no compensation for bending of adherend, insert a strip of fabric 0.20 to 0.28 mm (0.008 to 0.011 in.) thick and having negligible stiffness in place of the specimen, and apply a load sufficient to roll the drum upward on the fabric. With the drum dimensions given in 6.1 this measured load is about four times the weight of the drum, clamp, and counterweight, if the weighing apparatus is balanced to zero at the start.

9.1.2 For peel resistance of the adhesive with compensation for bending of the adherend, substitute a piece of material of the same composition, properties, and dimensions as the adherend to be peeled in place of the thin fabric, and apply a load sufficient to roll the drum upward on the material. This method largely offsets the torque required to bend the adherend in the peel test. The forces imposed on the adherend during the peel test usually result in greater bending than is obtained in bending the unbonded adherend around the drum. More torque is required, therefore, to bend a bonded than an unbonded material; hence, this compensation is only approximate.

10. Conditioning

10.1 Condition specimens for 7 days at a relative humidity of 50 \( \pm \) 2 % and a temperature of 23 \( \pm \) 1°C (73.4 \( \pm \) 1.8°F), except when the adhesive manufacturer specifies that this conditioning period is unnecessary and that a shorter period is adequate. The manufacturer may also specify that a longer period is necessary.

10.2 Conditioning is not required for laminated assemblies containing only metal adherends, unless specified by the adhesive manufacturer as part of the bonding procedure.

11. Procedure

11.1 Clamp the test specimen securely to the drum by means of the drum clamp as shown in Fig. 3, and attach the other end of the specimen in the top clamp as shown in Fig. 1 and Fig. 2. Attach a suitable rigid backing plate to each laminate specimen. See 8.4 for suggested methods of attachment. Suspend the top clamp from the upper head of the testing machine. Balance the weighing apparatus to zero. Then pin the loading bar to the appropriate fittings on the lower head of the testing machine as shown in Fig. 1.

11.2 Apply an initial load, equal to that obtained in the calibration of the apparatus for load to overcome the resisting torque of the drum assembly, by loading the apparatus in tension. Determine the peel resistance over at least 152 mm (6