



Standard Test Method for Durability Assessment of Adhesive Joints Stressed in Peel¹

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INTRODUCTION

The combination of stress and moisture decreases the durability of most adhesive joints. Stresses in the presence of water or water vapor may cause some adhesive joints to fail at some fraction of the stress required to break the dry joint. The time to failure for a given adhesive joint tested under moist conditions generally decreases with increasing stress, temperature, and relative humidity.

1. Scope

1.1 This test method provides data for assessing the durabilities of adhesive joints by means of T-peel type specimens stressed in contact with air, air in equilibrium with certain solutions, water, aqueous solutions, or other environments at various temperatures.

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:

B 209 Specification for Aluminum and Aluminum-Alloy Sheet and Plate²

D 907 Terminology of Adhesives³

D 1828 Practice for Atmospheric Exposure of Adhesive-Bonded Joints and Structures³

D 1876 Test Method for Peel Resistance of Adhesives (T-Peel Test)³

D 2651 Guide for Preparation of Metal Surfaces for Adhesive Bonding³

E 104 Practice for Maintaining Constant Relative Humidity by Means of Aqueous Solutions⁴

3. Terminology

3.1 *Definitions*—Many terms in this practice are defined in Terminology D 907.

4. Significance and Use

4.1 The combination of stress and moisture decreases the durability of most adhesive joints. Stresses in the presence of water or water vapor may cause some adhesive joints to fail at some small fraction of the stress required to break the dry joint. The time to failure for a given adhesive joint generally decreases with increasing stress, temperature, and relative humidity.

4.2 This test method may be used as an accelerated screening test for assessing the durability of adhesive joints. It may be used to measure durability of adhesive joints exposed outdoors or to environmental conditions experienced by adhesive joints in service. It may also be used to determine the effects of various surface preparations or substrates on durabilities of adhesive joints.

4.3 The durability performance of various adhesives may be compared by using this test method under uniform sets of conditions. To assess the overall durability of a given adhesive, T-peel joints should be tested under a range of stress, relative humidity, and temperature. For a specific end use it may be possible to obtain the needed durability data using only one set of test conditions.

5. Apparatus

5.1 For outdoor exposure the test location should be in an area free of or protected from high winds. Standard outdoor weathering racks are suggested (Practice D 1828), but any stable frame may be used (for example galvanized pipe or painted steel channel). No other special apparatus is required for outdoor tests.

5.2 For exposure in environmental cabinets or chambers no additional special apparatus is necessary. Constant-temperature

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² *Annual Book of ASTM Standards*, Vol 02.02.

³ *Annual Book of ASTM Standards*, Vol 15.06.

⁴ *Annual Book of ASTM Standards*, Vol 11.03.

baths may also be used.

5.3 For exposure to distilled or deionized water in the laboratory it may be convenient to use the apparatus shown in Fig. 1.

5.4 For exposure to constant relative humidities, the specimen may be placed in an apparatus similar to that shown in Fig. 1. A saturated salt solution may be placed in the bottom of the glass tube to provide a constant relative humidity (see Practice E 104); a stopper having a small glass tube packed with grease may be used to seal the upper end of the large glass tube.

6. Test Specimens

6.1 The successful use of the following test method depends on preparing good quality T-peel joint specimens. Prepare the

test panels carefully according to the adhesive manufacturer's directions or according to some other specified set of conditions agreed upon between the manufacturer and the purchaser.

6.2 Use the test-panel construction and the test specimen described in Test Method D 1876. To adapt to differing test conditions and constraints due to size or configuration of various test environments and apparatus, dimensions of the specimen may be varied as long as they are identical when making direct comparisons of different adhesives.

NOTE 1—For example, test specimens may be cut to 12.7 mm (1 in.) wide to fit more readily into a glass tube as shown in Fig. 1.

6.3 The adherend surfaces may be either etched (see Guide D 2651), solvent wiped, degreased, or treated by some other

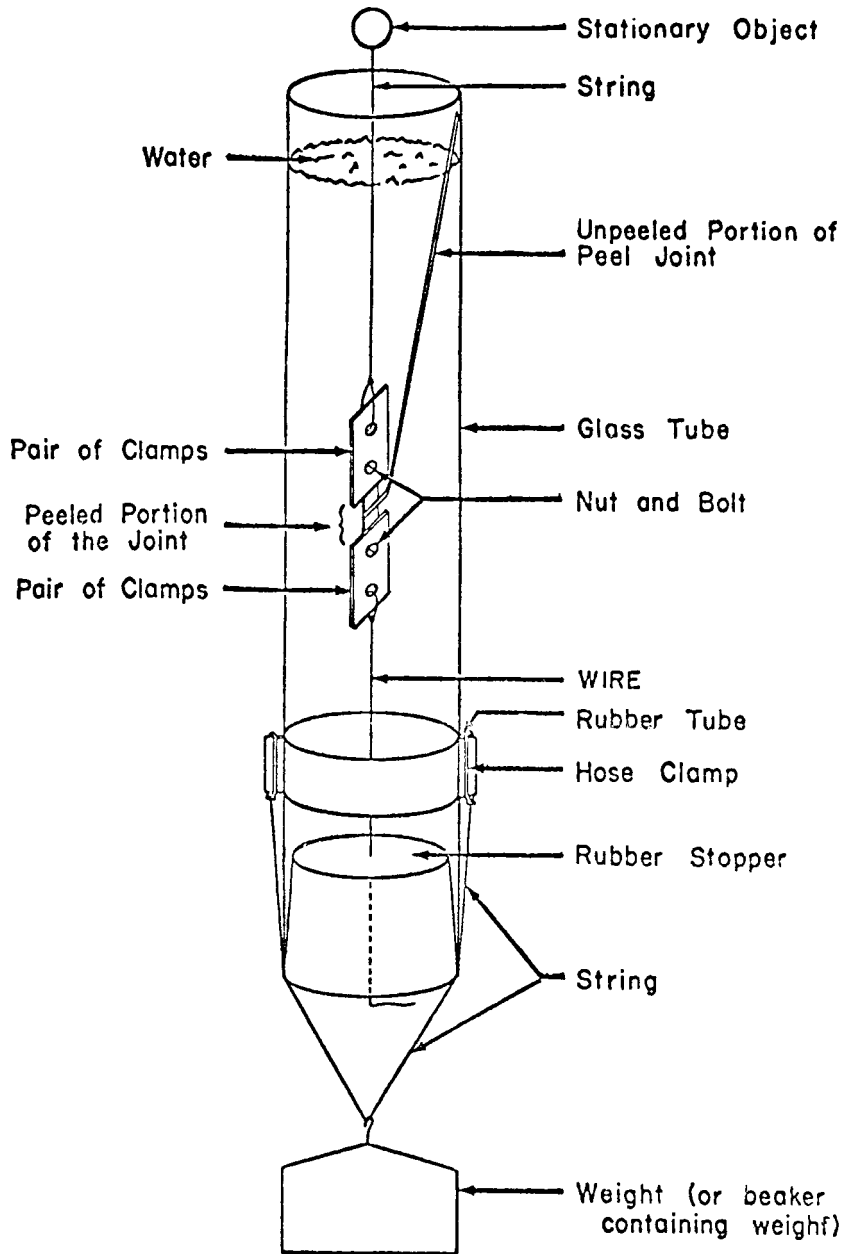


FIG. 1 Apparatus for Measuring Adhesive Peel Rates in Water

specified method of surface preparation.

7. Conditioning

7.1 Condition the peel specimens while either stressed or unstressed in the environment of the specific test for a minimum of one day before beginning measurements. Carry this out by discounting measurements made during the first day.

8. Procedure

8.1 Clamp one end of the nonbonded part of the T-peel test specimen as shown in Fig. 1 and attach to a stationary frame or object relatively free of vibrations. Clamp the other end of the panel and attach the desired weight (if the apparatus shown in Fig. 1 is used, the total force on the adhesive joint is equal to the sum of the weights of the water, the wet-peel apparatus, and the applied weight. To avoid possible breaking of the glass tube when a joint fails it is useful to attach a light-weight string from the hose clamp or wire around the upper part of the glass tube to the fixed point of support. If this apparatus is not used, the peel joints may be tested in series by bolting several joints together and attaching the weight at the bottom). The force exerted on the adhesive joint being tested should be a multiple of 450 g (1.0 lb). Expose the stressed specimen to one of the standard test environments, and then measure the length of the unpeeled portion of the specimen. Record this length hourly, daily, or weekly depending on the rate of peel of the specimen until the specimen has peeled to failure. Make at least six measurements for each specimen. Test a minimum of three specimens under each set of conditions (test environment and stress). Suggested stress levels are 25, 50, and 75 % of the normal T-peel strength as measured by Test Method D 1876.

9. Calculation

9.1 Plot the distance peeled (distance peeled equals initial length of unpeeled portion minus length of unpeeled portion at time t) versus time. The slope of the curve at any point is the peel rate at the corresponding time t . Divide the curve into six equal parts. If the peel rate varies less than a factor of two over all six parts of the curve, then obtain an average peel rate (slope of the curve) for the specimen. In order to assess durability, compare the peel rates under different levels of stress and activities of water (for example, three stresses each for test environments 1 and 3) by plotting the log of peel rate versus stress.

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10. Report

10.1 Report the following information:

10.1.1 Complete identification of the adhesive tested, including type, form, source, and manufacturer's code number.

10.1.2 Complete identification of the adherends used, including composition, thickness, and the temper for metals.

NOTE 2—The two adherends need not be identical; for example, a thin adherend may be bonded to a thick adherend with peeling occurring at 180°.

10.1.3 Method of preparing the test panel (both adhesive and adherends) and conditioning treatment.

10.1.4 Method of testing (weight in grams per millimetre (pounds per inch); test environment number from Table 1, including a complete description of any special test environments; location of outdoor test site and time of year, high, low, average temperatures, and sun exposure; angle of peel).

10.1.5 Number of specimens tested, average bond line thickness, initial peel strength of specimens from the same test panel, average peel rate (or curves of distance peeled versus time) for each specimen, and plot of log of peel rate versus stress when available.

11. Keywords

11.1 adhesive; durability; exposure; joint; moisture; stressed; T-peel

TABLE 1 Standard Test Environments

Test Environment Number	Temperature ^A	Moisture Conditions ^B
1	23°C (73.4°F)	immersed in distilled or deionized water
2	23°C (73.4°F)	50 % RH (relative humidity)
3	23°C (73.4°F)	15 % RH
4	35°C (95°F)	90 % RH
5	35°C (95°F)	100 % RH
6	50°C (122°F)	90 % RH
7	50°C (122°F)	100 % RH
8	35°C (95°F)	5 % salt fog
9	ambient (outdoors)	ambient (outdoors)
10	other (specify)	other, including aqueous solutions or nonaqueous liquids (specify)

^A The tolerance for test temperature shall be $\pm 1^\circ\text{C}$ (1.8°F) for environments 1 to 8.

^B The moisture condition may be provided by controlling the relative humidity of a box, room, or other chamber by any convenient means.