



Designation: D 5041 – 98

# Standard Test Method for Fracture Strength in Cleavage of Adhesives in Bonded Joints<sup>1</sup>

This standard is issued under the fixed designation D 5041; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This test method covers the determination of fracture strength in cleavage of adhesive bonds when tested on standard reinforced plastic specimens and under specified conditions of preparation and testing (Note 1).

NOTE 1—While this test method is intended for use in reinforced plastic applications, it may be used for measuring fracture properties of adhesives using other plastic adherends, provided consideration is given to the thickness and should be of equal rigidity to the plastic adherends.

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:

D 618 Practice for Conditioning Plastics and Electrical Insulating Materials for Testing<sup>2</sup>

D 907 Terminology of Adhesives<sup>3</sup>

D 2093 Practice for Preparation of Surfaces of Plastics Prior to Adhesive Bonding<sup>3</sup>

D 5573 Practice for Classifying Failure Modes in Fiber-Reinforced-Plastic (FRP) Joints<sup>3</sup>

E 4 Practices for Force Verification of Testing Machines<sup>4</sup>

## 3. Terminology

3.1 *Definitions*—Many of the terms used in this test method are defined in Terminology D 907.

3.2 *Definitions of Terms Specific to This Standard:*

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee D-14 on Adhesives and is the direct responsibility of Subcommittee D14.40 on Adhesives for Plastics.

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<sup>2</sup> *Annual Book of ASTM Standards*, Vol 08.01.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 15.06.

<sup>4</sup> *Annual Book of ASTM Standards*, Vol 03.01.

3.2.1 *failure initiation energy,  $E_i$* —the area under the load deflection curve where the first significant load drop occurs after the start of the test, showing the onset of permanent damage to the bonded assembly (see Fig. 1).

3.2.2 *failure propagation energy,  $E_p$* —the area under the load-deflection curve beginning at the failure initiation energy and ending at the catastrophic failure of the bonded assembly. (See Fig. 1).

3.2.3 *semirigid*—indicates that the adherends shall have such dimensions and physical properties as to permit bending them through any angle of up to 30° without breaking or cracking.

3.2.4 *semirigid adherend,  $n$* —an adherend that has dimensions and physical properties that permit bending at designated test temperature through any angle up to 30° without breaking or cracking.

3.2.5 *total energy*—failure initiation energy plus failure propagation energy.

## 4. Significance and Use

4.1 This test method provides a means of measuring the cleavage forces and energies required to fail adhesively bonded reinforced flat bonded specimens. It also offers a semi-quantitative observation of failure mode.

4.2 This test method has found application in screening structural adhesives for bonding reinforced plastics where simple lap shear testing has proven to be inadequate in distinguishing differences between adhesives.

4.3 It is important to note that the test method measures performance properties of the total bonded system (for example, reinforced plastic and adhesive) but will not yield fundamental properties of the adhesive alone.

## 5. Apparatus

5.1 *Testing Machine*, any suitable testing machine capable of control of constant-rate-of-crosshead movement and comprising essentially the following:

5.1.1 *Drive Mechanism*, a mechanism for imparting to the cross-head movable member, a uniform, controlled velocity with respect to the base (fixed member); this velocity is to be regulated as specified in Section 10.

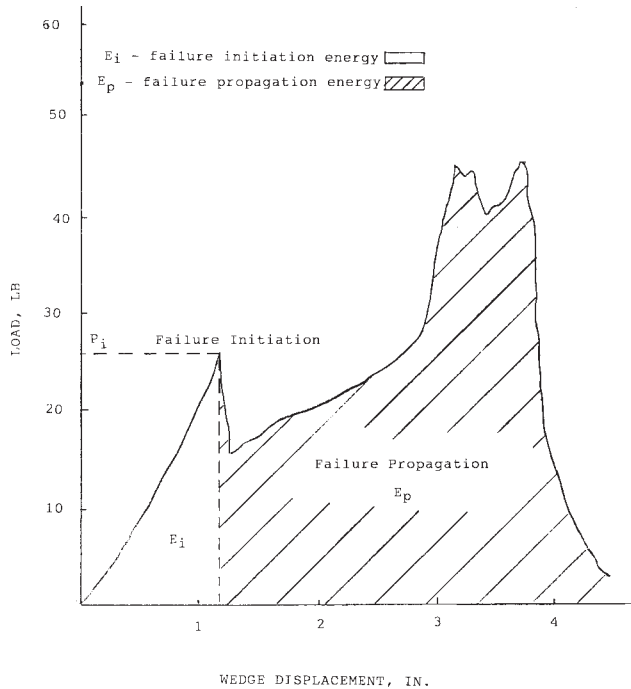


FIG. 1 A Typical Load versus Deflection Curve for Wedge Test

5.1.2 *Load Indicator*, a mechanism capable of showing the total compressive load carried by the test specimen. The mechanism is to be essentially free from inertia-lag at the specified rate of testing and indicate the load with an accuracy of  $\pm 1\%$  of the maximum indicated value of the test (load). Verify the accuracy of the testing machine at least once a year in accordance with Practices E 4.

5.2 *Wedge*, made of either aluminum or steel with an included angle of  $45^\circ$ . The sides of the wedge are machined smooth with the edge having a radius not to exceed 0.02 mm (0.01 in).

NOTE 2—A stainless steel wedge is recommended, has been found to work well, and is very durable. Due to the weight of a steel wedge, the removal of excess metal, which does not adversely affect the stiffness of the wedge, is recommended.

5.3 *Removable Tip (Optional)*—In some cases, the tip of the traveling wedge will strike the adhesive before catastrophic failure. This phenomenon will lead to grossly distorted test data. Should this be a problem in some adhesively bonded assemblies, a removable tip wedge of the design shown in Fig. 2 is suggested.

5.4 *Support Fixture*, an adjustable fixture used to support and center the bonded assembly under the tip of the wedge. See Fig. 3.

5.5 *Integrator*, a mechanical or electronic device or computer for the determination of failure energies.

5.6 *Bond Fixture*, any suitable fixture with temperature- and pressure-controlled platens, capable of bonding test assemblies in accordance with the adhesive manufacturer's recommendations.

6. Test Assemblies

6.1 *Flat Adherend*, unless otherwise specified in material specifications, make the test adherends in conformance to the

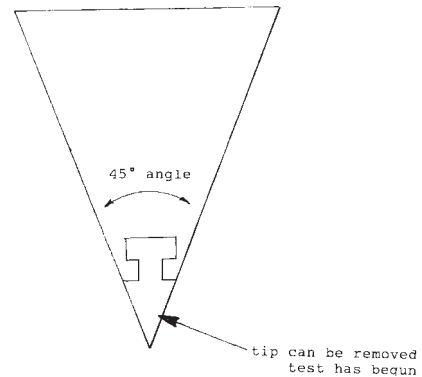


FIG. 2 Wedge with Removable Tip

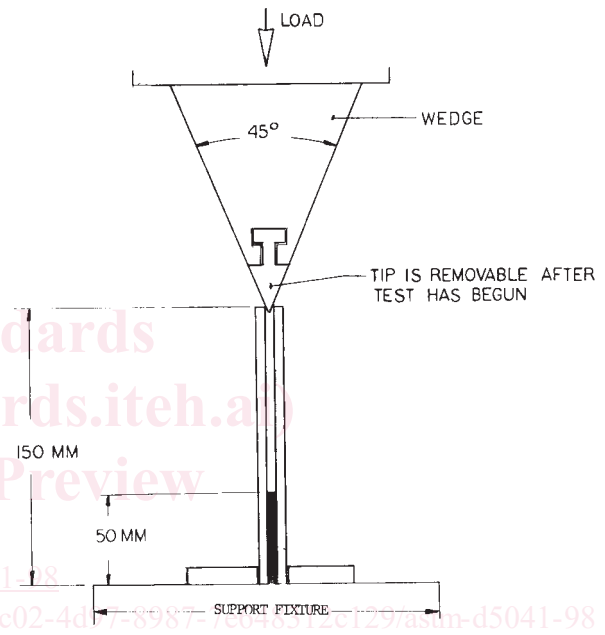


FIG. 3 Test Setup

form and dimensions shown in Fig. 4. Cut them from flat semirigid plastic panels having a nominal thickness of 2.54 mm (0.1 in.)  $\pm 0.5\%$ . Cut adherends into sections, 150 by 150 mm (6 by 6 in.),  $\pm 0.5\%$ . (See appendix for optional specimen sizes.)

7. Preparation

7.1 Laminated test assemblies (Fig. 5) consist of two adherends of similar stiffness properly prepared and bonded together.

NOTE 3—If the bonded test assembly is constructed with adherends of different stiffness, the result is a peel rather than a cleavage test. (For example, higher stiffness promotes cleavage; lower stiffness, peel.)

7.2 Prepare the surface of the substrate prior to bonding in accordance with the adhesive suppliers' recommendations. Typical surface preparations include solvent scrubbing, application of primers and, in some cases, only a dry rag wipe.

NOTE 4—It is important to be aware of potential substrate surface differences. Frequently reinforced plastics have a preferred bonding side. Contact the substrate supplier if there is any doubt.