Standard Guide for
Use of Adhesive-Bonded Single Lap-Joint Specimen Test Results[1]

INTRODUCTION

The true strength of an adhesive is a material property independent of the joint geometry, adherend properties, and load, and is a good starting point for determining an allowable design stress. Allowable stresses in shear and tension are needed to design safe, efficient, adhesively bonded joints and structures. The true shear strength, however, cannot be easily determined using single-lap specimens.

Many factors affect the apparent shear strength of an adhesive when measured with a small laboratory specimen, and in particular, with a single-lap specimen. For example, the failure of a typical single-lap specimen, is usually controlled by the tensile stress in the adhesive, and not by the shear stress. The factors that control the tensile stress in lap-joint specimen, and thus, the apparent shear strength are the size and shape of the specimen, the properties of the adherends, the presence of internal stresses or flaws, and the changes that take place in the specimen due to adhesive cure and the environment. Similarly these factors affect the apparent tensile strength of an adhesive in butt-joint test specimens.

Due to the effects of these factors, the apparent shear strength obtained through measurements on small laboratory specimens may vary widely from the true shear- or tensile-strength values needed to determine allowable shear and tension design stresses.

The objectives of this guide are: to develop an appreciation of the factors that influence strength and other stress measurements that are made with small laboratory test specimens; to foster the acceptable uses of the widely used thin-adherend single-lap-joint test; and, specifically, to prevent misuse of the test results.

1. Scope

1.1 This guide is directed toward the safe and appropriate use of strength values obtained from test methods using single-lap adhesive joint specimens.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 The discussion focuses on shear strength as measured with small thin-adherend, single-lap specimens. Many factors, however, apply to shear modulus, tensile strength, and tensile modulus measured by small laboratory specimens in general. This discussion is limited to single-lap specimens and shear strength only for simplification.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D896 Practice for Resistance of Adhesive Bonds to Chemical Reagents

D906 Test Method for Strength Properties of Adhesives in Plywood Type Construction in Shear by Tension Loading

D907 Terminology of Adhesives

D1002 Test Method for Apparent Shear Strength of Single-Lap-Joint Adhesively Bonded Metal Specimens by Tension Loading (Metal-to-Metal)

D1144 Practice for Determining Strength Development of Adhesive Bonds

D1151 Practice for Effect of Moisture and Temperature on Adhesive Bonds

D1183 Practices for Resistance of Adhesives to Cyclic

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3. Terminology

3.1 *Definitions:*

3.1.1 The following terms are defined in accordance with Terminologies D907 and E6.

3.2 *creep*—the time-dependent increase in strain in a solid resulting from force.

3.3 *shear strength*—the maximum shear stress which a material is capable of sustaining. Shear strength is calculated from the maximum load during a shear or torsion test and is based on the original dimensions of the cross section of the specimen. (See *apparent* and *true shear strength*).

3.4 *strain*—the unit change due to force, in the size or shape of a body referred to its original size or shape. Strain is a nondimensional quantity, but is frequently expressed in inches per inch, centimeters per centimeter, etc. (Refer to Terminology E6 for specific notes.)

3.4.1 *linear (tensile or compressive) strain*—the change per unit length due to force in an original linear dimension.

3.4.2 *shear strain*—the tangent of the angular change, due to force, between two lines originally perpendicular to each other through a point in a body.

3.5 *stress*—the intensity at a point in a body of the internal forces or components of force that act on a given plane through the point. Stress is expressed as force per unit of area (pounds-force per square inch, newtons per square millimetre, etc.).

NOTE 1—As used in tension, compression, or shear tests prescribed in product specifications, stress is calculated on the basis of the original dimensions of the cross section of the specimen.

3.5.1 *normal stress*—the stress component perpendicular to the plane on which the forces act. Normal stress may be either:

3.5.1.1 *compressive stress*—normal stress due to forces directed toward the plane on which they act, or

3.5.1.2 *tensile stress*—normal stress due to forces directed away from the plane on which they act.

3.5.1.2.1 *Discussion*—In single-lap specimen testing, the plane on which the forces act is the bondline. Tensile stress is sometimes used interchangeably, although incorrectly, with peel or cleavage stress. Peel and cleavage involve complex tensile, compressive, and shear stress distributions, not just tensile stress.

3.5.2 *shear stress*—the stress component tangential to the plane on which the forces act.

3.6 *Definitions of Terms Specific to This Standard:*

3.6.1 *allowable design stress*—a stress to which a material can be subjected under service conditions with low probability of mechanical failure within the design lifetime.

3.6.1.1 *Discussion*—Allowable design stress is obtained usually by multiplying the true shear strength of the material (or close approximation thereof) by various adjustment factors for manufacturing quality control, load and environmental effects, and safety.

3.6.2 *apparent shear strength*—(in testing a single-lap specimen) the nominal shear stress at failure without regard for the effects of geometric and material effects on the nominal shear stress. Often called the *lap-shear* or *tensile-shear strength*.

3.6.3 *average stress*—(in adhesive testing) the stress calculated by simple elastic theory as the load applied to the joint divided by the bond area without taking into account the effects on the stress produced by geometric discontinuities such as holes, fillets, grooves, inclusions, etc.

3.6.3.1 *Discussion*—The average shear and tensile stresses are denoted by τ_{avg} and σ_{avg} respectively. (See 5.3.1.) (*Average stress* is the same as the preferred but less common term, *nominal stress*, as defined in Terminology E6.)

3.6.4 *cleavage stress*—(in adhesive testing) a term used to describe the complex distribution of normal and shear stresses

[3] The last approved version of this historical standard is referenced on www.astm.org.

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