Designation: D7956/D7956M – 16

Standard Practice for Compressive Testing of Thin Damaged Laminates Using a Sandwich Long Beam Flexure Specimen[1]

This standard is issued under the fixed designation D7956/D7956M; 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 practice covers an approach for compressive testing thin damaged multidirectional polymer matrix composite laminates reinforced by high-modulus fibers using a sandwich long beam flexure specimen. It provides a test configuration in which the core does not constrain any protruding back side damage. It is limited to testing of monolithic solid laminates which are too thin to be tested using typical anti-buckling fixtures. It does not cover compressive testing of damaged sandwich panel facings. The composite material forms are limited to continuous-fiber or discontinuous-fiber (tape or fabric, or both) reinforced composites in which the laminate is balanced and symmetric with respect to the test direction

1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.2.1 Within the text the inch-pound units are shown in brackets.

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:*[2]

D883 Terminology Relating to Plastics
D3878 Terminology for Composite Materials
D3410 Test Method for Compressive Properties of Polymer Matrix Composite Materials with Unsupported Gage Section by Shear Loading
D6264/D6264M Test Method for Measuring the Damage Resistance of a Fiber-Reinforced Polymer-Matrix Composite to a Concentrated Quasi-Static Indentation Force
D7136/D7136M Test Method for Measuring the Damage Resistance of a Fiber-Reinforced Polymer Matrix Composite to a Drop-Weight Impact Event
D7137/D7137M Test Method for Compressive Residual Strength Properties of Damaged Polymer Matrix Composite Plates
D7249/D7249M Test Method for Facing Properties of Sandwich Constructions by Long Beam Flexure
E6 Terminology Relating to Methods of Mechanical Testing
E122 Practice for Calculating Sample Size to Estimate, With Specified Precision, the Average for a Characteristic of a Lot or Process
E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods
E456 Terminology Relating to Quality and Statistics

3. Terminology

3.1 *Definitions*—Terminology D3878 defines terms relating to high-modulus fibers and their composites, as well as terms relating to sandwich constructions. Terminology D883 defines terms relating to plastics. Terminology E6 defines terms relating to mechanical testing. Terminology E456 and Practice E177 define terms relating to statistics. In the event of a conflict between terms, Terminology D3878 shall have precedence over the other terminologies.

4. Summary of Practice

4.1 This practice consists of fabricating a composite laminate, damaging the laminate using either Test Method D6264/D6264M or Test Method D7136/D7136M, bonding the impacted or indented side of the laminate onto core and a back side facing to form a sandwich panel, and testing the damaged laminate in compression using Test Method D7249/D7249M.

5. Significance and Use

5.1 This practice provides a standard method of testing damaged composite laminates which are too thin to be tested

[1] This test method is under the jurisdiction of ASTM Committee D30 on Composite Materials and is the direct responsibility of Subcommittee D30.09 on Sandwich Construction.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

using typical anti-buckling fixtures, such as those used in Test Method D7137/D7137M. The laminate is first impacted or indented in order to produce a damage state representative of actual monolithic solid laminate structure. Impacting or static indentation is not performed on an assembled sandwich panel, as the damage state is altered by energy absorption in the core and by support of the core during the impact or indentation event. After damaging, the laminate is bonded onto the core with the impacted or indentation side of the laminate against the core, and with a localized un-bonded area encompassing the damage site. Fig. 1 illustrates the adhesive removal to avoid the damaged area and the assembly of the sandwich specimen with the impacted damaged laminate flipped over from the impacting or indentation orientation. The final assembled sandwich specimen is then tested using a long beam flexure setup with the damaged laminate being on the compression side. The sandwich panel configuration is used as a form of anti-buckling support for the thin damaged laminate.

5.2 Susceptibility to damage from concentrated out-of-plane forces is one of the major design concerns of many structures made of advanced composite laminates. Knowledge of the damage resistance and damage tolerance properties of a laminated composite plate is useful for product development and material selection.

5.3 The residual strength data obtained using this test method is used in research and development activities as well as for design allowables; however the results are specific to the geometry and physical conditions tested and are generally not scalable to other configurations.

5.4 The properties obtained using this test method can provide guidance in regard to the anticipated damage tolerance capability of composite structures of similar material, thickness, stacking sequence, and so forth. However, it must be understood that the damage tolerance of a composite structure is highly dependent upon several factors including geometry, stiffness, support conditions, and so forth. Significant differences in the relationships between the existent damage state and the residual compressive strength can result due to differences in these parameters. For example, residual strength and stiffness properties obtained using this test method would more likely reflect the damage tolerance characteristics of an un-stiffened monolithic skin or web than that of a skin attached to substructure which resists out-of-plane deformation.

5.5 The reporting section requires items that tend to influence residual compressive strength to be reported; these include the following: material, methods of material fabrication, accuracy of lay-up orientation, laminate stacking sequence and overall thickness, specimen geometry, specimen preparation, specimen conditioning, environment of testing, void content, volume percent reinforcement, type, size and location of damage (including method of non-destructive inspection (NDI)), fixture geometry, time at temperature, and speed of testing.

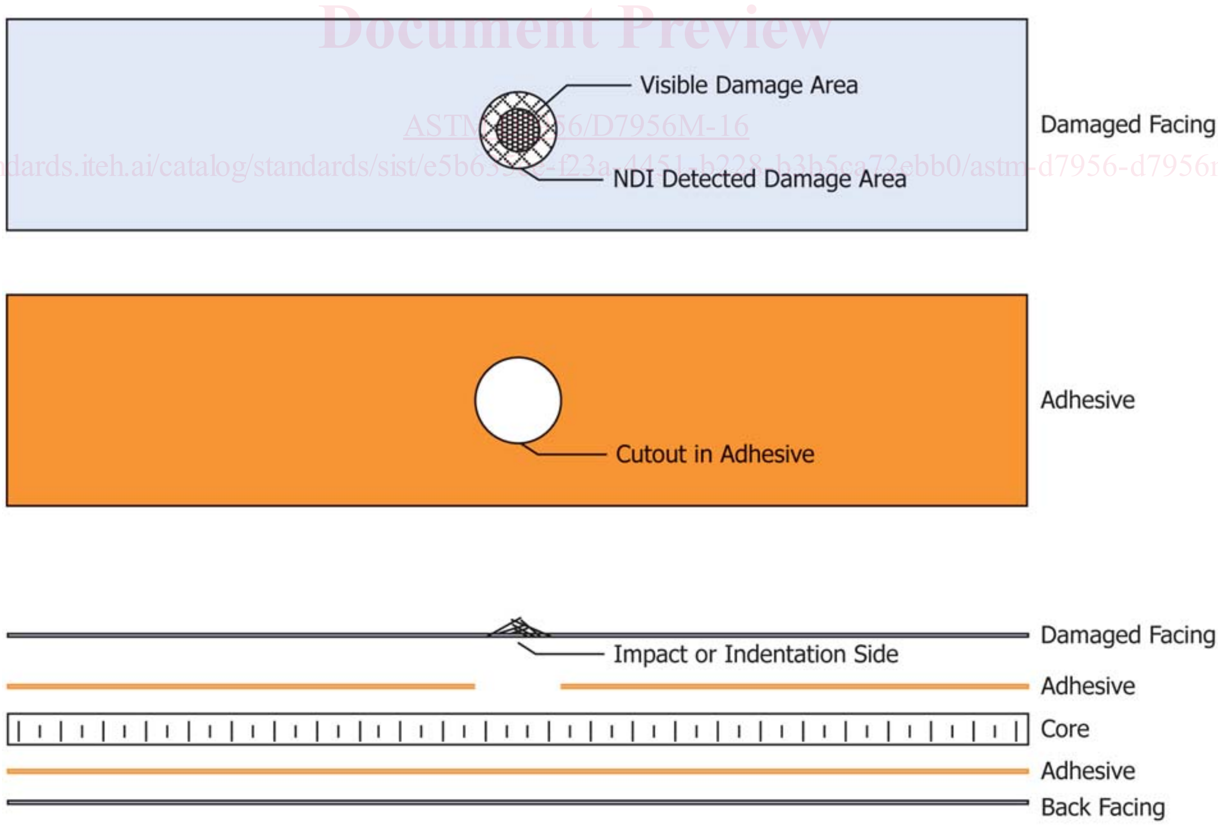

FIG. 1 Sandwich Specimen Assembly