Designation: D8285/D8285M – 19

Standard Practice for Compressive Properties of Tapered and Stepped Joints of Polymer Matrix Composite Laminates by Sandwich Construction Long Beam Flexure[1]

This standard is issued under the fixed designation D8285/D8285M; 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 the procedure for determination of the compressive strength of a tapered or stepped bonded joint of polymer matrix composite materials. It is applicable to secondary bonded or co-bonded laminates with either unidirectional plies or woven fabric reinforcements. The materials to be bonded may be different systems. In the bondline, a separate adhesive material may or may not be used (example: adhesives may be used with a prepreg system or may not be used with a wet lay-up repair system). The range of acceptable test laminates and thicknesses are described in 8.2.7. The standard repair types are the same as for the tensile loading in Practice D8131/D8131M. While external patch repairs are not explicitly covered in this practice, these repairs could be tested as a non-standard specimen using this practice.

1.2 This practice supplements Test Method D7249/D7249M for compressive loading of facesheet sandwich constructions by long beam flexure. Several important test specimen parameters (for example, joint length, ply overlaps, step depth, and taper ratio) are not mandated by this practice; however, these parameters are required to be specified and reported to support repeatable results.

1.3 Unidirectional (0° ply orientation) composites as well as multi-directional composite laminates and fabric composites, can be tested.

1.4 *Units*—The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

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

1.5 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement

D883 Terminology Relating to Plastics

D3171 Test Methods for Constituent Content of Composite Materials

D3878 Terminology for Composite Materials

D5229/D5229M Test Method for Moisture Absorption Properties and Equilibrium Conditioning of Polymer Matrix Composite Materials

D7249/D7249M Test Method for Facesheet Properties of Sandwich Constructions by Long Beam Flexure

D8131/D8131M Practice for Tensile Properties of Tapered and Stepped Joints of Polymer Matrix Composite Laminates

E4 Practices for Force Verification of Testing Machines

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

[1] This practice 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.

E2533 Guide for Nondestructive Testing of Polymer Matrix Composites Used in Aerospace Applications

2.2 *SAE Document:*[3]

CMH-17 Composite Materials Handbook-17 - Volume I

3. Terminology

3.1 *Definitions*—Terminology D3878 defines terms relating to high-modulus fibers and their composites. 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 Terminology standards.

NOTE 1—If the term represents a physical quantity, its analytical dimensions are stated immediately following the term (or letter symbol) in fundamental dimension form, using the following ASTM standard symbology for fundamental dimensions, shown within square brackets: [M] for mass, [L] for length, [T] for time, [θ] for thermodynamic temperature, and [nd] for non-dimensional quantities. Use of these symbols is restricted to analytical dimensions when used with square brackets, as the symbols may have other definitions when used without the brackets.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *co-bonded (repair) facesheet, n*—the co-bonded facesheet is the facesheet that is bonded to the parent pre-cured facesheet and cured in a second cure cycle.

3.2.2 *joint compressive strength, n*—ultimate compressive force experienced by the test specimen facesheet divided by the initial width of the joint area and the nominal thickness of the parent facesheet.

3.2.3 *nominal value, n*—a value, existing in name only, assigned to a measureable property for the purpose of convenient designation.

3.2.3.1 *Discussion*—Tolerances may be applied to a nominal value to define an acceptable range for the property.

3.2.4 *parent facesheet, n*—the parent facesheet is the facesheet that is cured during the first cure cycle.

3.2.5 *secondary bonded (repair) facesheet, n*—the secondary bonded facesheet is a pre-cured laminate that is bonded to the parent pre-cured facesheet using a separate adhesive material (sometimes referred to as a pre-cured patch repair).

3.3 *Symbols:*

c—core thickness

CV—sample coefficient of variation, in percent

d—sandwich total thickness

E_b^f—effective backskin (tension side) facesheet chord modulus

E_r^f—effective repair (compressive side) facesheet chord modulus

F_r^{cu}—ultimate compressive strength, based on repair laminate thickness

h_b—specimen nominal backskin side laminate facesheet thickness as specified by the test requestor (nominal ply thickness may be available from the relevant material specification)

h_p—specimen nominal compressive side parent laminate facesheet thickness as specified by the test requestor (nominal ply thickness may be available from the relevant material specification)

h_r—specimen nominal compressive side repair laminate facesheet thickness as specified by the test requestor (nominal ply thickness may be available from the relevant material specification)

L—length of loading span

S—length of support span

N_f—ultimate joint running force per ply

n—number of specimens

n_r—number of repair laminate plies

P_f—maximum force carried by test specimen at failure

s_{n-1}—standard deviation statistic of a sample population for a given property

w—specimen width

xi —test result for an individual coupon from the sample population for a given property

$\bar{x}$—mean or average (estimate of mean) of a sample population for a given property

4. Summary of Practice

4.1 *Tapered or Stepped Joint Compressive Strength*—In accordance with Test Method D7249/D7249M, but using a tapered or stepped joint facesheet configured specimen (Fig. 1 or Fig. 2), subjecting a long beam of sandwich construction to a bending moment normal to the plane of the sandwich, using a 4-point loading fixture. Deflection and strain versus force measurements are recorded.

4.2 The only acceptable failure modes for sandwich facesheet compressive strength are those which are internal to the compressive loaded facesheet. Failure of the sandwich core, the core-to-facesheet bond preceding failure of the facesheet, or the tension side facesheet are not acceptable failure modes. Careful post-test inspection of the specimen is required as facesheet failure occurring in proximity to the loading points can be caused by local through-thickness compression or shear failure of the core that precedes failure of the facesheet.

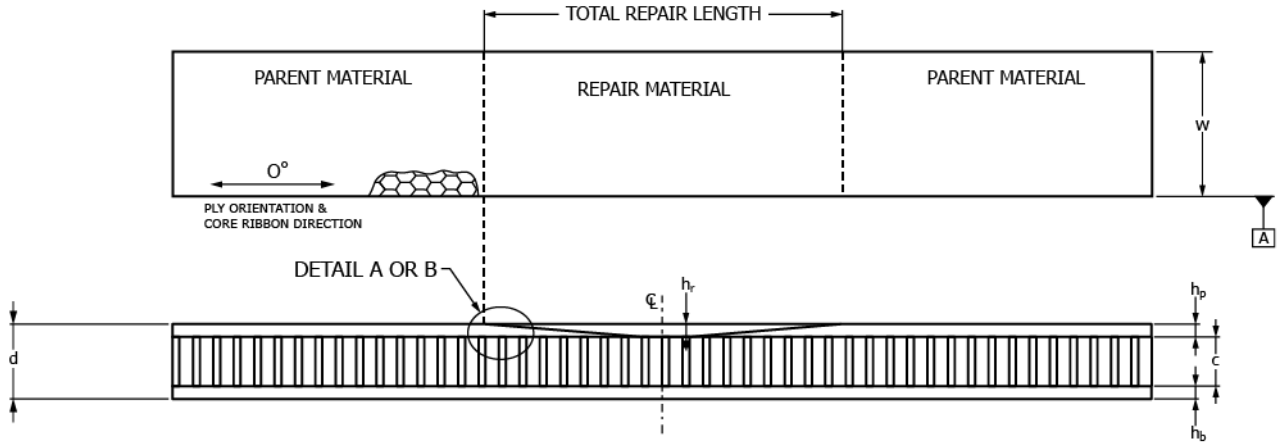
5. Significance and Use

5.1 Flexure tests on flat sandwich panel construction may be conducted to determine facesheet scarf or step joint compressive strength.

5.2 This practice is limited to obtaining the compressive strength of the sandwich panel scarf and step joint facesheets. Due to the curvature of the flexural test specimen when loaded, facesheet compression strength from this test may not be equivalent to the facesheet compression strength of sandwich structures subjected to pure edgewise (in-plane) compression.

5.3 Factors that influence the compressive response and should therefore be reported include the following: materials (laminate facesheet, core, and adhesive); methods of material fabrication; methods of material preparation, including surface preparation prior to bonding, lay-up, specimen facesheet stacking sequence, and overall thickness; core geometry (cell size); core density; adhesive thickness; joint taper ratio or step

[3] Available from SAE International (SAE), 400 Commonwealth Dr., Warrendale, PA 15096, http://www.sae.org.



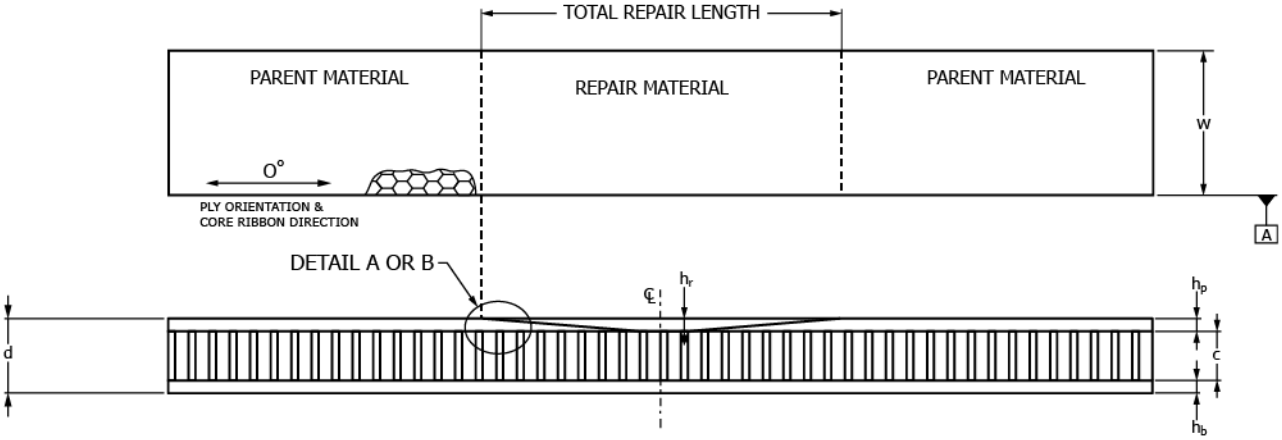
DRAWING NOTES:

1. INTERPRET DRAWING IN ACCORDANCE WITH ANSI Y14.5M-1982, SUBJECT TO THE FOLLOWING:
2. ALL DIMENSIONS IN MILLIMETERS WITH DECIMAL TOLERANCES AS FOLLOWS:

NO DECIMAL	.X	.XX
± 0.1	± 0.03	± 0.01

3. PLY ORIENTATION DIRECTION TOLERANCE RELATIVE TO -A- WITHIN ± 0.5°.
4. FINISH ON MACHINE EDGES NOT TO EXCEED 64√ (SYMBOLOGY IN ACCORDANCE WITH ASA B46.1, WITH ROUGHNESS HEIGHT IN MICROINCHES.)
5. REFER TO TABLES 1 AND 2 FOR ADDITIONAL STANDARD SPECIMEN GEOMETRY DEFINITIONS.
6. REFER TO FIGS. 5 AND 6 FOR DETAILS A AND B.
7. CORE RIBBON DIRECTION PARALLEL TO 0° DIRECTION.

FIG. 1 Compressive Sandwich Beam Tapered and Stepped Joint Specimen – Overall Geometry (SI)



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7. CORE RIBBON DIRECTION PARALLEL TO 0° DIRECTION.

FIG. 2 Compressive Sandwich Beam Tapered and Stepped Joint Specimen – Overall Geometry (Inch-Pound)

length; ply overlap length; relative thickness and stiffness of parent and repair laminates; adhesive bond stiffness; specimen preparation; specimen conditioning; environment of testing; specimen alignment; speed of testing; time at temperature; void content; and volume percent reinforcement. Properties, in the test direction, which may be obtained from this practice, include the following:

5.3.1 Ultimate compressive strength (based on the nominal repair material thickness), (F_r^{cu}).

5.3.2 Ultimate running load per ply, (N_j).