Designation: D8387/D8387M – 23

Standard Test Method for High Bypass – Low Bearing Interaction Response of Polymer Matrix Composite Laminates[1]

This standard is issued under the fixed designation D8387/D8387M; 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 test method determines the uniaxial high bypass - low bearing interaction response of multi-directional polymer matrix composite laminates reinforced by high-modulus fibers using a two-fastener hard point joint specimen. The scope of this test method is limited to net section (bypass) failure modes. Standard specimen configurations using fixed values of test parameters are described for this procedure. A number of test parameters may be varied within the scope of the standard, provided that the parameters are fully documented in the test report. The composite material forms are limited to continuous-fiber or discontinuous-fiber (tape or fabric, or both) reinforced composites for which the laminate is balanced and symmetric with respect to the test direction. The range of acceptable test laminates and thicknesses are described in 8.2.1. This test method was previously published under Test Method D7248/D7248M-17 Procedure C.

1.2 This test method is consistent with the recommendations of Composite Materials Handbook, CMH-17, which describes the desirable attributes of a bearing/bypass interaction response test method.

1.3 The two-fastener test configurations described in this test method are intended to provide data in the relatively high bypass, low bearing part of the composite bolted joint bearing-bypass interaction diagram. This data complements the data from filled hole tension and compression (Practice D6742/D6742M), bearing (Test Method D5961/D5961M), and low bypass/high bearing interaction (Test Method D7248/D7248M) tests.

1.4 This test method requires careful specimen design, instrumentation, data measurement, and data analysis. The use of this test method requires close coordination between the test requestor and the test lab personnel. Test requestors need to be familiar with the data analysis procedures of this test method and should not expect test labs who are unfamiliar with this test method to be able to produce acceptable results without close coordination.

1.5 *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.

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

1.6 *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.*

1.7 *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

D2584 Test Method for Ignition Loss of Cured Reinforced Resins

D2734 Test Methods for Void Content of Reinforced 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

[1] This test method is under the jurisdiction of ASTM Committee D30 on Composite Materials and is the direct responsibility of Subcommittee D30.05 on Structural Test Methods.

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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.

D5687/D5687M Guide for Preparation of Flat Composite Panels with Processing Guidelines for Specimen Preparation
D5766/D5766M Test Method for Open-Hole Tensile Strength of Polymer Matrix Composite Laminates
D5961/D5961M Test Method for Bearing Response of Polymer Matrix Composite Laminates
D6484/D6484M Test Method for Open-Hole Compressive Strength of Polymer Matrix Composite Laminates
D6742/D6742M Practice for Filled-Hole Tension and Compression Testing of Polymer Matrix Composite Laminates
D7248/D7248M Test Method for High Bearing - Low Bypass Interaction Response of Polymer Matrix Composite Laminates Using 2-Fastener Specimens
D8509 Guide for Test Method Selection and Test Specimen Design for Bolted Joint Related Properties
E4 Practices for Force Calibration and Verification of Testing Machines
E6 Terminology Relating to Methods of Mechanical Testing
E83 Practice for Verification and Classification of Extensometer Systems
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
E251 Test Methods for Performance Characteristics of Metallic Bonded Resistance Strain Gages
E456 Terminology Relating to Quality and Statistics
E1237 Guide for Installing Bonded Resistance Strain Gages

2.2 *Other Document:*[3]
CMH-17 Composite Materials Handbook-17, Polymer Matrix Composites, Vol 1, Section 7

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 documents.

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*—Refer to Guide D8509.

3.3 *Symbols:*

A = gross cross-sectional area (disregarding hole) mm^2 [in.^{2}]
C_F = fastener flexibility (Ref **1**)[4]
C_P = plate (specimen) flexibility
C_S = doubler plate flexibility
CV = sample coefficient of variation, %
d = fastener diameter, mm [in.]
D = hole diameter, mm [in.]
e/D = actual edge distance ratio
E_F = fastener modulus, MPa [psi]
E_{xP} = test specimen laminate modulus, MPa [psi]
E_{xS} = doubler plate modulus in axial (x) direction, MPa [psi]
$F_x^{gr\_byp\_t}$ = ultimate tensile gross bypass strength, MPa [psi].
$F_x^{net\_byp\_t}$ = ultimate tensile net bypass strength, MPa [psi]
$F_x^{gr\_byp\_c}$ = ultimate compressive gross bypass strength, MPa [psi]
$F_x^{net\_byp\_c}$ = ultimate compressive net bypass strength, MPa [psi]
F^{br_byp} = bearing stress at ultimate bypass strength, MPa [psi]
g = distance from hole edge to specimen end, mm [in.]
h = specimen thickness near hole (nominal or actual, as specified), mm [in.]
k_D = proportion of total force transferred through doubler plates
k_E = estimate of proportion of total force transferred through fasteners to doubler plates
k_S = proportion of total force transferred through specimen
L = distance between fastener centerlines, mm [in.]
n = number of strain gages on the doubler plate
n = number of tested specimens
P = total force applied to specimen, N [lbf]
P_{D1}, P_{D2} = force in doubler plates, N [lbf]
P_i = force at i-th data point, N [lbf]
P_{max} = maximum force prior to failure, N [lbf]
P_S = force in specimen between fasteners, N [lbf]
s_{n-1} = sample standard deviation
t_P = test specimen laminate thickness, mm [in.]
t_S = doubler plate thickness, mm [in.]
v_F = fastener Poisson's ratio
w = width of specimen across hole, mm [in.]
w_P = test specimen width, mm [in.]
w_S = doubler plate width, mm [in.]
$\bar{X}$ = sample mean (average)
x_i = measured or derived property
δ_{1i} = extensometer-1 displacement at i-th data point, mm [in.]
δ_{2i} = extensometer-2 displacement at i-th data point, mm [in.]
ε_i^{br} = bearing strain, microstrain
σ_i^{br} = bearing stress at i-th data point, MPa [psi]

4. Summary of Test Method

4.1 Refer to Guide D8509 for discussion of bearing/bypass test procedures.

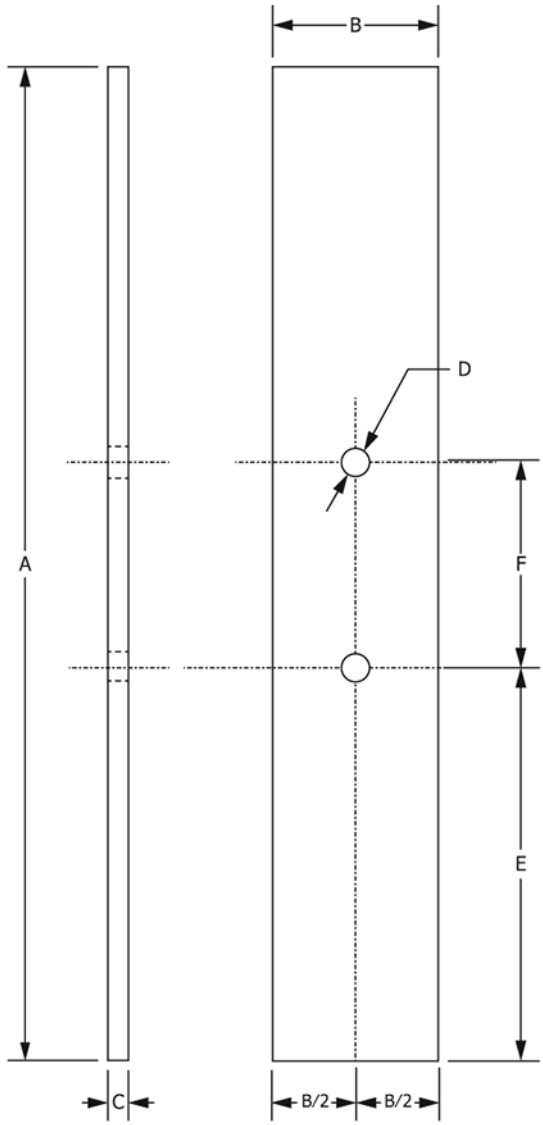
4.2 *High Bypass/Low Bearing Double Shear:*

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

[4] The boldface numbers in parentheses refer to the list of references at the end of this standard.

4.2.1 A flat, constant rectangular cross-section test specimen with two centerline holes located in the middle of the specimen, as shown in the test specimen drawing of Fig. 1, is axially loaded. Two doubler plates, Fig. 2, are attached to the specimen as shown in Fig. 3 to act as a "hardpoint" which induces bearing forces in the test specimen and plates. The ends of the test specimen are gripped in the jaws of a test machine and loaded in tension or compression.

4.2.1.1 *Unstabilized Configuration (No Support Fixture)*—The ends of the test specimen are gripped in the jaws of a test machine and loaded in tension.



	A	B	C	D	E	F
mm	344	36	2 - 5	6.00	147	50
inch	13.50	1.50	0.08 - 0.20	0.250	5.75	2.00

Tolerances:
mm: X ± 1 ; D + 0.08 / –0.00
inch: X.XX ± 0.03 ; D + 0.003 / –0.000

FIG. 1 Double-Shear, 2-Fastener Hardpoint Test Specimen Drawing