# Tests Accepted by Mil-Hdbk-17

<table>
<thead>
<tr>
<th>Test Category</th>
<th>Source of Test Method</th>
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<tbody>
<tr>
<td></td>
<td>ASTM</td>
</tr>
<tr>
<td><strong>Prepreg tests</strong></td>
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</tr>
<tr>
<td>Resin content</td>
<td>D2539, C613, D5300</td>
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<tr>
<td>Volatiles content</td>
<td>D3530</td>
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<tr>
<td>Resin flow</td>
<td>D3531</td>
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<tr>
<td>Resin gel time</td>
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<tr>
<td>Fiber areal weight</td>
<td>D3776</td>
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<tr>
<td>Moisture content</td>
<td>D4019</td>
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<td>Tack</td>
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<td>HPLC</td>
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<tr>
<td>IR</td>
<td>E1252, E168</td>
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<tr>
<td>DMA (RDS)</td>
<td>D4065, D4473</td>
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<td>DSC</td>
<td>E1356</td>
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<tr>
<td><strong>Lamina physical tests</strong></td>
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</tr>
<tr>
<td>Moisture conditioning</td>
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<td>Fiber volume</td>
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<td>Void content</td>
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<tr>
<td>Cured ply thickness</td>
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<tr>
<td>Glass transition temperature (dry)</td>
<td>D4065</td>
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<tr>
<td>Glass transition temperature (wet)</td>
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<td>CTE, out-of-plane</td>
<td>E831</td>
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<tr>
<td>CTE, in-plane</td>
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<tr>
<td>Moisture diffusivity</td>
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<td>Thermal diffusivity</td>
<td>E1461</td>
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<td>ASTM D3039, SACMA RM 4, RM 9</td>
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<tr>
<td>90°/Fill tension</td>
<td>ASTM D3039, D5450, SACMA RM 4, RM 9</td>
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<tr>
<td>0°/Warp compression</td>
<td>ASTM D3410, D5467, SACMA RM 1, RM 6</td>
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<tr>
<td>90°/Fill compression</td>
<td>ASTM D3410, D5449, SACMA RM 1, RM 6</td>
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<tr>
<td>In-plane shear</td>
<td>ASTM D3518, D5448, D5379, SACMA RM 7</td>
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<tr>
<td>Interlaminar shear</td>
<td>ASTM D5379, SACMA --</td>
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<tr>
<td>Short beam shear</td>
<td>ASTM D2344, SACMA RM 8</td>
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<tr>
<td>Flexure</td>
<td>ASTM --, SACMA --</td>
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<tr>
<td>Open-Hole Compression</td>
<td>ASTM draft, SACMA RM 5</td>
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<tr>
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<td>draft</td>
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<td>Double-shear bearing</td>
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<tr>
<td>Compression after impact</td>
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<td>Mode I fracture toughness</td>
<td>D5528</td>
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<tr>
<td>Mode II fracture toughness</td>
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<tr>
<td>Tension/tension fatigue</td>
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<td>Tension/compression fatigue</td>
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<td>****</td>
<td><strong>SACMA</strong></td>
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<tr>
<td>RM 5</td>
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</table>
Laminate Testing

- ASTM D638 Tensile Properties of Plastics – dogbone specimen
Laminate Testing

- ASTM D3039 Tensile Properties of PMC Materials
  - Used for most aerospace composites
Laminate Testing

- ASTM D695 Compressive Properties of Rigid Plastics (1942)
- Uses an untabbed, dogboned, flat specimen
Laminate Testing

- Modified D695 Compression Test Method
  - Uses a straight sided specimen
  - Tabbed for strength (gage length too short to instrument using strain gages)
  - Untabbed for modulus
  - No ASTM standard governing this method
  - Defined in Boeing Specification Support Standard (BSS 7260, 1982) and SACMA Recommended Test Method (SRM 1-88, 1988)
Laminate Testing

- Modified ASTM D695 - Mil-Hdbk-17 interprets this technique to be for 0° direction properties of unidirectional coupons, and 0° and 90° properties of fabric coupons only (and then only when unit cell size of weave or braid is small.)
Laminate Testing

- ASTM D3410 Compressive Properties of PMC Materials by Shear Loading
  - Standard for high modulus carbon fiber composites (1980s)
  - 0.5” gage length for strain gage sometimes buckles.
  - Tab failure also problematic.

Celanese fixture © 2003, P. Joyce
Laminate Testing

- ASTM D3410 Compressive Properties of PMC Materials by Shear Loading
  - Standard for high modulus carbon fiber composites (1980s)
  - 0.5” gage length for strain gage sometimes buckles.
  - Tab failure also problematic.

IITRI fixture
Laminate Testing

- ASTM D6641 Compressive Properties using CLC Fixture (2001)
  - Evolved out of WTF ELSS fixture
  - Uses straight sided, untabbed specimen
  - Not recommended for unidirectional composites
Laminate Testing

- ASTM D2344 Short-Beam Strength of PMC Materials
  - Low cost QC test
  - Material screening

\[ t = 0.060 - 0.090 \text{ in.} \]
\[ w = 0.250 \text{ in.} \]
\[ L = 1.0 \text{ in.} \]
\[ S = (4 \pm 0.1) t \]
Laminate Testing

- ASTM D5379 Shear Properties of Composite Materials by the V Notched Beam Method (Iosipescu)
Laminate Testing
(Iosipescu method)

Front

Nominal Specimen Dimensions

- $d_1 = 20.0$ mm [0.75 in.]
- $d_2 = 4.0$ mm [0.15 in.]
- $h = \text{as required}$
- $L = 76.0$ mm [3.0 in.]
- $r = 1.3$ mm [0.05 in.]
- $w = 12.0$ mm [0.45 in.]

Side
Laminate Testing

- ASTM D3518 In-plane Shear (IPS)
  - Uses ±45° laminate to extract shear properties.
  - Strictly a shear design allowable
  - Not used for QC
Laminate Testing

- ASTM D790 Flexural Properties of Un-Reinforced and Reinforced Plastics
Laminate Testing

- ASTM D6484 Open Hole Compressive Strength of PMC Laminates (1999)

- After Boeing Specification Support Standard BSS 7260, also described in SACMA Recommended Method SRM 3-88.
Laminate Testing

- ASTM D6742 Filled Hole Tensile/Compressive Strength of PMC Laminates (2002)

Tension: (Left:) Tensile failure with minimal delamination and splitting present. (Right:) Tensile failure with extensive delamination, +/-45 degree ply splitting.

Compression: (Left:) Compressive failure across center of fastener hole. (Right:) Compressive failure offset from center of fastener hole.
Laminate Testing

- Creep testing
  - Creep is defined as the change in a property over time when subjected to a constant forcing function.
  - Creep should be considered if the end use involves high stress in the matrix dominated direction
  - high temperature
  - or exposure to a harsh chemical environment
Laminate Testing

- Creep is especially important in composites with a thermoplastic matrix, particularly as $T_s \rightarrow T_g$
- Creep is expected to be small in thermoset matrix composites, due to cross-linking.
- Creep testing is not used to provide primary design data, rather designs should be checked for creep deformation.
Testing Fabric-Reinforced “Textile” Composites

- Refer to ASTM D 6856 Standard Guide for . . .
- Discusses special testing considerations for textile composites.
Adhesives Testing

- ASTM D1002 Single Lap Shear is the most common & industry standard test for:
  - QC in-process inspection to verify mixing, cure, and surface preparation.
  - Screening for materials selection.

“five finger” Al specimens

Specimens machined from composite laminate

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Adhesives Testing

- ASTM D3528 Double Lap Shear minimizes peel, results in higher, more consistent shear strength.

![Diagram of ASTM D3528 Double Lap Shear specimen](image)

- $T_1 = 1.6$ mm
- $T_2 = 3.2$ mm
- $A = $ Test gluelines
- $B = $ Area in test grips
- $C = $ Shear areas

$25.4$ mm
Adhesives Testing

- ASTM D3165 Notched Lap Shear
  - QC for large laminated assemblies (voids)
  - Compatibility of different resin systems
Adhesives Testing

- ASTM D1780 Adhesive Creep
  - Apply constant load and measure deflection of scribe marks.
Adhesives Testing

- ASTM D1876 Tee Peel
- Requires two flexible adherends (Al)
Adhesives Testing

- ASTM D3167 Floating Roller (Bell) Peel
- One rigid, one flexible adherend
Sandwich Testing

- ASTM C297 Flatwise Tensile Strength of Sandwich Constructions (used as workmanship verification, unless very reliable NDE being used.)

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Sandwich Testing

- ASTM C393 “Long Beam” Flexure
  - 4 point bending produces uniform bending moment in the center section.
  - Specimen is sized to induce compression failure in upper skin, not core shear.
  - Also demonstrates that skin to core strength is adequate to achieve designed facesheet compression stress.

Paste Photo Here
Sandwich Testing

- ASTM C393 Beam Flexure
  - Performed in addition to FWT on co-cured sandwich if rigorous structural requirement.
  - Accounts for any knockdown from wrinkling/dimpling.
  - Usually yields lower strength & modulus than solid facesheet tension or compression test.
Sandwich Testing

- **Mil-Std 401B Core Shear**
  - Used to verify core splice performance.
  - Can also be used to compare different surface preparations.
  - Standard configuration uses
    - 0.062” Al facesheets
    - 8.1 pcf Al core
Sandwich Testing

- ASTM D1781 Climbing Drum Peel
  - Used for characterization of adhesives for Al facesheet construction
  - Workmanship test
References

- Mil-Hdbk-17 Composite Materials Handbook
- Mil-Hdbk-23A Structural Sandwich Composites
- Wyoming Test Fixtures, Product Catalog No. 106 (2000)
- ASTM Annual Book of Standards (2001)