Optimal V-Notched Shear Testing of Composite Laminae and Laminates

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Shear Strength Workshop
March 7, 2022
Optimal Shear Test of Composites:
What attributes come to mind?

**Within the “test section”:**

- Uniform state of shear stress
- “Pure shear” - no other stress components
- Higher magnitude of shear stress than other regions of the specimen
- Shear failure produced in test section
Comparison of V-Notched Shear Tests: Test Fixtures and Specimens

- **V-Notched Beam**
  - "Iosipescu" Shear
  - ASTM D5379

- **V-Notched Rail Shear**
  - ASTM D7078

- **Combined Loading Shear**
Iosipescu (V-Notched Beam) Shear Test: ASTM D5379

- 76 mm long x 19 mm wide specimen
- Opposing 90° machined V-notchess
- Asymmetrical four-point flexure loading
- In-plane and interlaminar shear testing
V-Notched Rail Shear Test: ASTM D7078

- Standardized in 2005 by ASTM
- 76 mm x 56 mm notched specimen
- Same notch configuration as Iosipescu specimen
- Increased gage section (compared to Iosipescu)
- Face-loading allows testing of higher shear strength laminates
Combined Loading Shear Test
(In Process of ASTM Standardization)

- Retains face loading of current D7078 V-notched rail shear test
- Introduce edge loading similar to D5379 Iosipescu shear test
- Specimen length increased to 127 mm
- Allow shear testing of thicker, higher shear strength composite laminates
Shear Stress Distribution in Test Section Area:

V-Notched Shear Tests

Results from finite element simulation, AS4/3501-6 carbon/epoxy
Comparison of Loading Capabilities: V-Notched Rail Shear Tests

Shear load capability increased significantly using Combined Loading Shear (CLS) test method

<table>
<thead>
<tr>
<th>Ave. Max Load (lb)</th>
<th>[0/90]s</th>
<th>[0/90]2s</th>
<th>[0/90]3s</th>
<th>[0/90]4s</th>
<th>[0/±45/90]s</th>
<th>[0/±45/90]2s</th>
<th>[0/±45/90]3s</th>
<th>[0/±45/90]4s</th>
<th>[±45/0]3s</th>
<th>[±45/0]4s</th>
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<td>0</td>
<td>22</td>
<td>44</td>
<td>66</td>
<td>88</td>
<td>110</td>
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<td>CLS, 3 in. (67 mm)</td>
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<td>CLS, 5 in. (127 mm)</td>
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~100 kN
Shear Failure of Quasi-Isotropic Combined Loading Shear (CLS) Test Specimen

IM7/8552 carbon/epoxy, ~10 mm specimen thickness