Compressive failure of unidirectional carbon fibre composites from bending tests

Dr Xun Wu
Prof. Michael Wisnom
5th of October, 2021

bristol.ac.uk/composites
Background

Compression Test Methods

Better test method, higher strength and larger design allowable!

Compression workshop
05th Oct, 2021
Background – flexural tests

- Higher and more consistent compressive measurements.
- DO NOT require high precision and complex machining.

- Premature failure under the loading noses
- Strain gradient enhancement effect
- Size effect in bending is hard to quantify.

**Challenge:** to understand and separate size and strain gradient effects and develop methods to get more reliable compressive strain allowable.
Size effect of loading noses

Average compressive strain: **1.19% (13.2%)**

Average compressive strain: **1.41% (7.5%)**

Conclusion: consistent gauge section failures and higher values in larger diameter rollers.
Sandwich beam test

- Keep gauge section dimensions the same
- Keep the thickness of the carbon fibre skins the same
- Vary depth of the beam (6mm to 38mm) to change strain gradient
- Increase support span to maintain similar applied load.
- Larger roller diameter was used.
- Core material: Ash wood – high shear strength and easy to machine in different thicknesses

Compress workshop
05th Oct, 2021
Strain gradient effects

- The compressive strain to failure decreased with the increase of core depths of the carbon/wood sandwich beams.
- Little effect of strain gradient above 10mm thickness
- Low CVs were obtained.

Conclusion: carbon fibre-wood sandwich beam with a core depth larger than 20mm is recommend for compressive measurements.

<table>
<thead>
<tr>
<th>Testing methods</th>
<th>Compressive strain (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combined Loading Compression [1]</td>
<td>0.93 (9.7%)</td>
</tr>
<tr>
<td>Dog-bone compression [2]</td>
<td>1.19 (2.8%)</td>
</tr>
<tr>
<td>Carbon/Wood sandwich [3]</td>
<td>1.36 (2.7%)</td>
</tr>
</tbody>
</table>