Investigation of the compressive behaviour of carbon/glass fibre hybrid composites with 4-point flexural test

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Outline of the presentation

• Aims of the study
• Specimen configurations and experiment setup
• Result summary
• Conclusion of hybrid composites result under 4-point flexural test
• Future works
Aims of the study

- Investigate the compressive failure strain of the glass/high modulus and glass/standard modulus carbon fibre hybrid composites
- Investigate the failure mechanism of hybrid composites with different absolute carbon fibre thicknesses.
Specimen configurations and experiment setup

<table>
<thead>
<tr>
<th>Sandwich beam configurations</th>
<th>Carbon fibre thickness (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>[SG₁/M55₁/SG₁]/Ash wood 18 mm/[IM7/8552₄]</td>
<td>0.03</td>
</tr>
<tr>
<td>[SG₁/M55₂/SG₁]/Ash wood 18 mm/[IM7/8552₅]</td>
<td>0.06</td>
</tr>
<tr>
<td>[SG₁/M55₁₆/SG₁]/Ash wood 18 mm/[IM7/8552₁₀]</td>
<td>0.48</td>
</tr>
<tr>
<td>[SG₁/TC33₁/SG₁]/PMMA 20 mm/[IM7/8552₄]</td>
<td>0.03</td>
</tr>
<tr>
<td>[SG₁/TC33₂/SG₁]/PMMA 20 mm/[IM7/8552₃]</td>
<td>0.06</td>
</tr>
<tr>
<td>[SG₁/TC33₁₆/SG₁]/PMMA 20 mm/[IM7/8552₆]</td>
<td>0.48</td>
</tr>
</tbody>
</table>

Experiment setup

- 4-point bending fixture with Instron universal testing machine
  - The larger roller diameter can prevent roller failure from loading noses
- Attach strain gauges on top and bottom skin to measure compressive and tensile strains
Result summary: $SG_1/M55_n/SG_1$

Compressive load-compressive strain response of $SG_1/M55_1/SG_1$ hybrid composite

Compressive force-compressive strain response of $SG_1/M55_2/SG_1$ hybrid composite

Failure is shifted from small carbon fragmentations to single crack with kink band.
Result summary: $SG_1/M55_n/SG_1$

<table>
<thead>
<tr>
<th>Specimen configuration</th>
<th>Knee-point compressive strain (%)</th>
<th>Failure compressive strain (%)</th>
<th>Failure compressive force (N)</th>
<th>Failure mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>SG/M55$_1$/SG</td>
<td>0.484 (3)</td>
<td>-</td>
<td>1800 (10)</td>
<td>Small carbon fragmentation</td>
</tr>
<tr>
<td>SG/M55$_2$/SG</td>
<td>-</td>
<td>0.431 (2)</td>
<td>1135 (3)</td>
<td>Limited carbon fragmentation</td>
</tr>
<tr>
<td>SG/M55$_{16}$/SG</td>
<td>-</td>
<td>0.314 (3)</td>
<td>1859 (5)</td>
<td>Single angled crack and delamination</td>
</tr>
</tbody>
</table>

Remark: number in the bracket represented to the coefficient of variation (CV)

- Single ply case created small carbon fragmentation which is similar to previous study$^{[1]}$
- Double ply case shows limited carbon fragmentation, followed by a single fracture.
- 16 ply case shows single fracture with similar compressive strain compared to previous study$^{[2]}$
Result summary: SG₁/TC33ₙ/SG₁

Overall failure is kink band with slightly non-linear load-strain response.
• Compressive behaviour and failure strain are affected by the thickness of low strain fibre material or the ratio to the thickness of high strain fibre material including fibre types.
• The proper high strain/low strain hybrid system could increase the compressive performance.
Future works

• Study the compressive failure characteristics of carbon-carbon fibre hybrid composites.
• Develop an understanding of the compressive failure of hybrid composites.
• Create damage mode maps under compressive loading
References


Thank you for your attention
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