Damage Control in Skin-Stiffened Structures

Rafael Luterbacher-Mus

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Damage in Composites

No damage growth

- Safety margins
- NDT
- Repair

Tolerate damage

- Weight savings
- SHM
- Self-healing

Damage control in skin-stiffened structures
Luterbacher, Bond, Trask

IABG (2014)
B.J. Blaiszik et al. (2010)
Katnam et al. (2013)

H. Speckmann et al. (2003)
S. White et al. (2001)
C. Norris et al. (2011)
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Skin-stiffened structures

Efficient structural solution,
But through thickness stresses arise
at flange tip

Skin stiffener debond specimens

Stringer or stiffening element

Failure initiation
Loading case

Flange

Bondline
Tip of flange
Skin

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Application to structural features

Adapt self-healing feature to damage pattern

Adapt damage pattern to self-healing feature

• Type of feature

• Damage Redirection
  - Tolerate and manage damage propagation into self-healing feature
Damage redirection mechanisms

- Tested in skin-stiffener debond specimens
- Static and fatigue testing
Transverse vasculues act similar to drill holes thereby redirecting delaminations.

Norris et al. (2011)
Damage redirection mechanisms

Main Results:
- Creation of damage free areas in the specimen
- No difference in global mechanical properties
- Connectivity of vascular network with damage
Summary

- Interleaves and vasculuses do not alter global mechanical performance under static and fatigue loading.
- Successful steering of damage with the help of the interleaves, vasculuses and ply structure into a self-healing feature:
  - Damage visualisation
  - Healing
- Fatigue damage successful “healed” and global mechanical properties recovered.

<table>
<thead>
<tr>
<th></th>
<th>Control through Interleaves</th>
<th>Control through Vasculuses</th>
<th>Control through Ply Structure</th>
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<tbody>
<tr>
<td>No knock down on static properties</td>
<td>✓</td>
<td>✓</td>
<td>❌</td>
</tr>
<tr>
<td>No knock down on fatigue properties</td>
<td>✓</td>
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<td>❌</td>
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<tr>
<td>Damage visualisation</td>
<td>✓</td>
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</tbody>
</table>
Current challenge

Challenge for healing resin:

Trade off between:

Mechanical properties vs. Injectability
Acknowledgments

- Ian Bond
- Richard Trask
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Thank you for your attention!

Questions?

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