Moulding the Future of Composite Crash Structures

D J Marler, J Rowe
Lotus Engineering, Potash Lane, Hethel, Norfolk, England

M Wacker, J Russ
Jacob Composites GmbH, Bergstraße 31-35, D-91489, Wilhelmsdorf, Germany
Material Characterisation
- 4m Drop test rig - up to 8m/s and 19kJ

- Esprit and Elite Composites
- Crash Development 1975 -->
- Material Characterisation
Crash Structure Development

Lotus Elise
Elise Crash Structure

- Energy dissipation of up to 75kJ
Elise Crash Structure

- FE Simulation
Crash Structure Development

AML
Vanquish

Lotus
Elise

Lotus Engineering
AML Vanquish Crash Structure

- Rails and Bumper Beam Assembly
- $0^\circ$ Rigid 1200kg 34.3mph = 141.2kJ
- Federal and European Markets

FE Simulation
Crash Structure Development

AML
Vanquish

Lotus Elise

BMW M3
BMW M3 Bumper Beams

- Up to 60% weight reduction
- Fulfilled Requirements for AZT, Pendulum, Barrier, Towing
- Same component for all markets
- Benefit from lower insurance premiums
Crash Structure Development

AML
Vanquish

ECOLITE Front
End Structure

Crash Structure Development


Lotus Elise

BMW M3

Lotus Engineering
Ecolite Front End Module - Thermoplastic

Lotus Elise

Thermoset Composite

High speed crash management

AML Vanquish

Thermoset Composite

High speed crash management for world car requirements.

BMW M3

Thermoplastic Composite

Low speed crash management. Recyclable solution

Ecolite Structure

Complete integration of low and high speed crash management, in a single recyclable module for world car requirements

Thermoplastic Composite
Comparison - Thermoset v Thermoplastic

Thermoplastic performance comparable with Thermoset
## Composite Components in High Speed Impact

<table>
<thead>
<tr>
<th>Component</th>
<th>Process</th>
<th>Section</th>
<th>SEA (J/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminium 6063 T7</td>
<td>Extrusion</td>
<td>Tube</td>
<td>15 – 20</td>
</tr>
<tr>
<td>Glass / Polyester</td>
<td>RTM</td>
<td>Rail</td>
<td>25 – 40</td>
</tr>
<tr>
<td>Carbon / Epoxy</td>
<td>RTM</td>
<td>Rail</td>
<td>35 – 80</td>
</tr>
<tr>
<td>Glass / Polyamide 6</td>
<td>Thermoformed</td>
<td>Rail</td>
<td>25 - 55</td>
</tr>
</tbody>
</table>
Ecolite Front End Structure

Baseline Metallic Structure = 22.5kg
Ecolite Front End Structure

Ecolite Thermoplastic/Glass Structure = 16kg
Ecolite Front End Structure

- Stable tuneable crush
- High and low speed
- Federal and European
- High Specific Energy Absorption
- Low residual crush length - package benefits
- Improved Thatcham / Danner rating
- 30% saving in weight versus the steel equivalent structure
- Part integration / Reduces complexity
- 50% reduction in tooling investment
- Competitive piece cost allowing realistic business cases at 30,000 units per year
- Recyclable