Pedestrian Safety GTR
Leg Impact Testing

42nd Session of GRSP
December 2007
Overview

★ VRTC Lower Legform Testing
  – Vehicles tested
  – Results
  – Examples of good bumper performance
TRL Lower Leg Testing

VRRTC EuroNCAP Testing (ESV 2005)
★ 5 North American passenger cars
  – 2002 Mazda Miata
  – 2000 Volvo S40
  – 2001 Ford Focus
  – 1999 VW Beetle
  – 2001 Honda Civic

2 locations: support and center

VRRTC GTR Testing (2007)
★ 2 passenger cars
  • 2002 Mazda Miata
  • 2006 VW Passat

★ 3 SUVs
  • 2005 Honda CR-V
  • 2002 Jeep Wrangler
  • 2006 Dodge Durango

★ 2 Pickup Trucks
  • 2006 Toyota Tacoma
  • 2005 Chevrolet Silverado

★ 1 Minivan
  • 2006 Toyota Sienna

★ 1 Full-size van
  • 2003 Ford E350 Van

5 locations
## Lower Bumper Reference Line (LBRL) Height Across Bumper Test Area

<table>
<thead>
<tr>
<th></th>
<th>SUVs</th>
<th>Pickup Trucks</th>
<th>Minivan</th>
<th>Van</th>
<th>Passenger cars</th>
</tr>
</thead>
<tbody>
<tr>
<td>LBRL Minimum Height (mm)</td>
<td>405</td>
<td>410</td>
<td>420</td>
<td>378</td>
<td>260</td>
</tr>
<tr>
<td>LBRL Max. Height (mm)</td>
<td>452</td>
<td>415</td>
<td>505</td>
<td>378</td>
<td>264</td>
</tr>
</tbody>
</table>

### GTR Test Rules

- **LBRL < 425 mm**: lower leg test required
- **425 mm ≤ LBRL < 500 mm**: manufacturer’s choice of lower or upper leg test
- **LBRL ≥ 500 mm**: upper leg test required
Limit 19 °:
- 84% exceeded
- Represents 19% risk of collat. lig injury

Out of alignment limits
Out of speed range
Bumper height - >50 cm
Shear Displacement (mm)

Limit 6 mm:
- 63% exceeded
- Represents 21% risk of cruciate lig injury

Prior Testing

SUVs
Pickups
Minivan Van
Pass. Cars
Pass. Cars

SUVs
Pickups
Minivan Van
Pass. Cars
Pass. Cars

Prior Testing
Tibia Acceleration (g)

Limit 170g:
- 78% exceeded
- 31% risk of fx

Limit 250g:
- 51% exceeded
- 81% risk of fx

Durango Wrangler CR-V Silverado Tacoma Sienna E-350 Passat Miata-07 Miata-05 S-40 Focus Beetle Civic

- SUVs
- Pickups
- Minivan
- Van
- Pass. Cars
- Pass. Cars Prior Testing
2005 Honda CR-V – Passed 4/5

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>Pass/ Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak bending angle (degrees)</td>
<td>9.5</td>
<td>2.8</td>
<td>1.5</td>
<td>3.6</td>
<td>31.5</td>
<td>19</td>
</tr>
<tr>
<td>Peak shear displacement (mm)</td>
<td>1.6</td>
<td>1.8</td>
<td>1.8</td>
<td>1.5</td>
<td>2.8</td>
<td>6</td>
</tr>
<tr>
<td>Peak tibia acceleration (g)</td>
<td>97</td>
<td>96</td>
<td>85</td>
<td>91</td>
<td>329</td>
<td>170/250</td>
</tr>
</tbody>
</table>

C (Pass)

E (Fail)
### 2002 Mazda Miata - Passed 1/5

<table>
<thead>
<tr>
<th></th>
<th>A</th>
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<th>D</th>
<th>E</th>
<th>Pass/ Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bending angle</strong></td>
<td>25.7</td>
<td>22.9</td>
<td>18.7</td>
<td>20.9</td>
<td>24.9</td>
<td>19</td>
</tr>
<tr>
<td><strong>Shear displacement</strong></td>
<td>8.6</td>
<td>7.8</td>
<td>4.2</td>
<td>4.9</td>
<td>7.9</td>
<td>6</td>
</tr>
<tr>
<td><strong>Tibia acceleration</strong></td>
<td>440</td>
<td>247</td>
<td>159</td>
<td>163</td>
<td>210</td>
<td>170/250</td>
</tr>
</tbody>
</table>

**Bending angle (degrees)**

**Shear displacement (mm)**

**Tibia acceleration (g)**

C (Pass)
## 2002 Jeep Wrangler - Passed 1/5

<table>
<thead>
<tr>
<th></th>
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<th>C</th>
<th>D</th>
<th>E</th>
<th>Pass/Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bending angle</strong> (degrees)</td>
<td>31.9</td>
<td>32.2</td>
<td>31.3</td>
<td>31.2</td>
<td>3.2</td>
<td>19</td>
</tr>
<tr>
<td><strong>Shear displacement</strong> (mm)</td>
<td>-7.5</td>
<td>-7.6</td>
<td>-7.8</td>
<td>-7.5</td>
<td>-0.75</td>
<td>6</td>
</tr>
<tr>
<td><strong>Tibia acceleration</strong> (g)</td>
<td>427</td>
<td>305</td>
<td>445</td>
<td>455</td>
<td>60</td>
<td>170/250</td>
</tr>
</tbody>
</table>

E (Pass)
Summary

- Lower leg test performance generally poor relative to GTR requirements
- Energy-absorption and support above/below knee appear to be key for good performance.