Recent NHTSA Compatibility Research

Repeatability evaluation for recent compatibility test procedures

2005 SAE Government / Industry Meeting
LC Barrier Repeatability

• 4 56 kph rigid barrier tests with comparable vehicles

• 2004 Honda Accord
  – Belted 50th into 8 x 16 LC barrier
  – Belted 5th into 8 x 16 LC barrier
  – Belted 95th into NCAP 4 by 9 LC barrier

• 2003 Accord
  – Belted 50th into MGA 2 by 3 LC barrier
## Test Comparison

<table>
<thead>
<tr>
<th>Test</th>
<th>Lab</th>
<th>Driver</th>
<th>Year</th>
<th>Make</th>
<th>Model</th>
<th>Weight</th>
<th>Speed</th>
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<tbody>
<tr>
<td>4485</td>
<td>MGA</td>
<td>50th</td>
<td>2003</td>
<td>HONDA</td>
<td>ACCORD</td>
<td>1571</td>
<td>55.8</td>
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<tr>
<td>5145</td>
<td>TRC</td>
<td>5th</td>
<td>2004</td>
<td>HONDA</td>
<td>ACCORD</td>
<td>1654</td>
<td>56.5</td>
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<tr>
<td>5062</td>
<td>TRC</td>
<td>50th</td>
<td>2004</td>
<td>HONDA</td>
<td>ACCORD</td>
<td>1624</td>
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<td>5139</td>
<td>KAR</td>
<td>95th</td>
<td>2004</td>
<td>HONDA</td>
<td>ACCORD</td>
<td>1834</td>
<td>56.52</td>
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</table>

The belted 95th test is considerably heavier than the other 3 tests.

<table>
<thead>
<tr>
<th>Test</th>
<th>Load cells</th>
<th>AHOF</th>
<th>Initial Stiffness</th>
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<tbody>
<tr>
<td>4485</td>
<td>6</td>
<td>443.8</td>
<td>1467.6</td>
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<tr>
<td>5145</td>
<td>134</td>
<td>436.3</td>
<td>1598.7</td>
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<tr>
<td>5062</td>
<td>134</td>
<td>414.5</td>
<td>1593.1</td>
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<tr>
<td>5139</td>
<td>36</td>
<td>410.7</td>
<td>1527.0</td>
</tr>
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</table>

Generally tests with the 2x3 barrier are not used for AHOF estimates.
Only around 60 ms do the heavier and lighter vehicles differ...
Honda Accord Initial Stiffness

- $5062 = 1593.1 \text{ N/mm}$, from 0 to 287 mm, $R^2 = 0.951$
- $5145 = 1598.7 \text{ N/mm}$, from 0 to 289 mm, $R^2 = 0.952$
- $4485 = 1467.6 \text{ N/mm}$, from 0 to 305 mm, $R^2 = 0.952$

The slope for the Force-deflection profiles repeated well.
Acceleration profiles are similar, but not as consistent as total force.
8 by 16 barriers are initially similar, but diverge after 50 ms.

4 by 9 barrier has different HOF(t).

MGA 2 Row barrier was not evaluated for HOF(t).
Honda Accord – Row Forces

Test 5062, Note the strong impact on Row 1

Test 5145, Note force on Row 3 has increased and Row 1 has decreased
Deformation and Intrusion

Only TRC tests had matching measurements

External Deformation matches well except for C6 (right side)

The right side IP measured additional intrusion in test 5062
Repeatability - Observations

- HR tests did not repeat AHOF as well as hoped
  - Engine impact strongly influenced AHOF
  - FWDB could reduce this effect
- 4x9 row resolution affected HOF(t)
- Initial Stiffness repeated well
  - Total force was not affected by LC differences between 4x9, 2x3, and 8x16 barriers.
- Need to measure impact accuracy
  - European tests have shown impact location can vary up to 20 mm
  - Did impact accuracy affect the force distributions?
• IHRA researchers has been monitoring the repeatability / accuracy of vehicle impact point
  – Pre test vehicle to barrier alignment is recorded using a sticker on barrier
  – Pin on vehicle puts a hole in sticker and the X and Y offset is recorded
  – Up to 35 mm deviation has been recorded
• NHTSA has just begun to record impact accuracy
  – Working to incorporate into standardized testing
Impact Accuracy

Camry Test, Center of 75 mm target was aligned with the pin pre-test

Accord Test
Full Width Deformable Barrier Tests

Comparison of Plascore and Cellbond Barrier Faces
1996 Chrysler Concorde

<table>
<thead>
<tr>
<th>test</th>
<th>weight</th>
<th>speed</th>
<th>Barrier</th>
<th>AHOF</th>
<th>Vertical Accuracy</th>
<th>Corrected AHOF</th>
<th>Interval (ms)</th>
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<tbody>
<tr>
<td>4963</td>
<td>1788</td>
<td>56.4</td>
<td>Rigid</td>
<td>435.1</td>
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<td>5-114</td>
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<tr>
<td>5251</td>
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<td>56.4</td>
<td>Cellbond</td>
<td>449.6</td>
<td>20</td>
<td>429.6</td>
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<td>5252</td>
<td>1788</td>
<td>56.2</td>
<td>Plascore</td>
<td>434.2</td>
<td>1</td>
<td>433.2</td>
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</tr>
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</table>

- Plascore was low bidder
- Cellbond was manufacturer for FWDB development tests
- FWDB’s were 1000 mm high
- FWDB was mounted 125 mm above the ground
- AHOF was corrected by subtracting the vertical offset.
- Impact accuracy was not measured for the rigid barrier test
The FWDB tests had similar total force measurements.
Acceleration profiles are noisy, which is common for older vehicles.
The HOF(t) are similar after correcting for impact accuracy
Row Forces (Uncorrected)

<table>
<thead>
<tr>
<th>Force by Rows</th>
</tr>
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<tbody>
<tr>
<td>Test 5252, 1996 CHRYSLER CONCORDE, Rows numbered from Ground</td>
</tr>
</tbody>
</table>

**Plascore Barrier**

<table>
<thead>
<tr>
<th>Time (Seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
</tr>
</tbody>
</table>

-250K -200K -150K -100K -50K 0 0.00 0.02 0.04 0.06 0.08 0.10 0.12 0.14

**Cellbond Barrier**

(19 mm higher impact), Increase force in row 4 Less in rows 1 and 2
The force distribution for the rigid barrier test is much different than either of the FWDB tests.
Vehicle-to-Vehicle Repeatability

Full Frontal Collinear
Dodge Ram 1500 into
Honda Accord
NHTSA conducted a collinear frontal vehicle-to-vehicle test in which a driver air bag failure occurred in the Accord.

Honda repeated the Ram/Accord frontal test, providing an opportunity to examine the repeatability for this vehicle-to-vehicle test series.

<table>
<thead>
<tr>
<th>Test Year</th>
<th>Make</th>
<th>Model</th>
<th>Speed</th>
<th>Weight</th>
<th>Width</th>
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<td>RAM1500</td>
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<td>HONDA</td>
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<td>1623</td>
<td>1821</td>
</tr>
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</table>

MGA ran both tests under identical conditions. Stationary Accord impacted full frontal collinear. Both vehicle centerlines were aligned.
Accord Post Test

V5247

V5041
Acceleration

Comparison of Honda Acceleration

Honda Accord
(CF = 0.96)

Dodge Ram 1500
(CF = 0.95)
Honda Driver injury measures not compared

<table>
<thead>
<tr>
<th>tstno</th>
<th>Striking Vehicle</th>
<th>15 ms HIC</th>
<th>Max Nij</th>
<th>Chest Acceleration</th>
<th>Chest Deflection</th>
<th>Left Femur</th>
<th>Right Femur</th>
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<tbody>
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</table>
Bullet Vehicle Deformation

Ram 1500 Top of Bumper

Ram 1500 Bottom of Bumper

Ram 1500 Center Grill

Ram 1500 Front of Hood
Observations

- Vehicle measurements repeated very well
- Injury measures for Honda passenger and Ram driver repeated well
- Ram Passenger injury measures did not repeat
  - No clear explanation for the difference in Ram passenger femur or neck loads
- External deformation measurements repeated well
  - The repeat test did not measure toe pan intrusions