JMLIT Compatibility Research

GRSP, May 2004

JMLIT
JMLIT Compatibility Research

• Development of test procedures
  – Accident analysis
  – Crash tests

• Cooperation with IHRA

• The research are conducted in JMLIT Compatibility WG
Vehicle Fleet in Japan

Vehicle registrations (*1000)

Year

Minicar
Small car
Large car
Minicar
Medium car
MPV
Wagon
SUV
Key Factors of Compatibility

- Structural interaction
- Force matching
- Compartment strength
1. Full-Width Tests for Structural Interaction Evaluation
Full-Width Crash Tests

- Full-width rigid barrier crash tests have already been in the regulations of Japan, US and Australia as a high-acceleration test for restraint systems.
- Barrier force distributions are measured for structural interaction evaluation.
- Full-width tests are agreed as phase I in IHRA compatibility WG.
Full-Width Tests in Japan

- 125 x 125 mm load cells
- 44 rigid barrier tests (42 JNCAP + 2 additional tests)
- 6 (TRL) deformable barrier tests

**Rigid barrier**

**Deformable barrier**
Force Distributions in Full-Width Rigid Barrier Tests

AHOF = average height of force

\[ F = \sum F_i \]

Honda Accord
AHOF: 410 mm

Nissan Liberty
AHOF: 434 mm

Honda Stepwgn
AHOF: 487 mm
Car-to-MPV - Similar AHOF -

Nissan Liberty
AHOF: 434 mm
Kerb mass: 1516 kg

Honda Accord
AHOF: 410 mm
Kerb mass: 1441 kg

AHOF difference is 24 mm
Car-to-MPV - Different AHOF -

Honda Stepwgn
AHOF: 487 mm
Kerb mass: 1528 kg

Honda Accord
AHOF: 410mm
Kerb mass: 1440 kg

AHOF difference is 77 mm

AHOF can be an effective parameter to predict override/underride in car-to-car crashes.
Full-Width Deformable Barrier Tests

- Structural forces are seen clearly without engine footprint.
- Forces from lower cross member can be seen?
- Relative homogeneity assessment has been proposed in deformable barrier tests.

Relative Homogeneity Assessment
Variability of peak load (Individual cells, each row and each column)

<table>
<thead>
<tr>
<th>Force from lower cross member or force dispersion by honeycomb?</th>
<th>Wagon R</th>
<th>Vitz</th>
<th>Legacy</th>
<th>Forester</th>
<th>STEPWGN</th>
<th>SURF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Force (kN)</td>
<td>0.13</td>
<td>0.02</td>
<td>0.08</td>
<td>0.10</td>
<td>0.20</td>
<td>0.32</td>
</tr>
<tr>
<td></td>
<td>0.28</td>
<td>0.32</td>
<td>0.24</td>
<td>0.21</td>
<td>0.45</td>
<td>0.90</td>
</tr>
</tbody>
</table>
**Force Distributions by Load Cell Alignment**

**Ground height 125 mm**

**Ground height 50 mm**

Target load = 6.8 kN

Relative homogeneity assessment

Target load = 7.1 kN

Load cell ground height

<table>
<thead>
<tr>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground level</td>
<td>125 mm</td>
<td>50 mm</td>
<td></td>
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</table>

Unit: kN
Unrealistic Deformation by Deformable Barrier

Large cross-section of front-end, which will be useful for structural interaction, can be disadvantageous in full-width deformable barrier tests.
Injury Criteria of Driver Dummy in Full-Width Rigid and Deformable Barrier Tests

- Injury criteria are comparable between rigid and deformable barrier tests.
- Due to crash sensing time differences, injury criteria in deformable barrier tests can be higher than rigid barrier tests, especially for high-acceleration cars.
AHOF in Full-Width Rigid and Deformable Barrier Tests

![Graph showing the relationship between AHOF in rigid and TRL barrier tests.]
Full-Width Deformable Barrier Tests

- Forces from structures can be seen clearly.
- It is still not clear if the footprint of cross members can be seen in deformable barrier tests.
- AHOF is comparable between rigid and deformable barrier.
- Load cell alignments affect force distribution measurements and relative homogeneity assessments.
- Unrealistic deformation can occur.
- Deformable barrier tests can be used as high deceleration tests for restraint system evaluation.
Full-Width Tests for Structural Interaction Evaluation

- AHOF is a useful criterion to evaluate underride/override.
- To determine the AHOF, the force distributions measured in either rigid or deformable barrier tests can be used.
- Further research is necessary for deformable barrier and homogeneity assessment criteria.
2. Compartment Strength Effectiveness and its Evaluation
Car-to-Car Tests (50 km/h)

Vitz(Echo) 2001 Australia test

Vitz 2003
Overload Tests (80 km/h)

2002 Vitz

2003 Vitz
Compartment Strength Criteria

- **Maximum structural force**
- **End of crash force**
  Barrier force at the time when the difference between engine inertia force and barrier force is maximal
- **Rebound force**
  Barrier force at the time when car starts to rebound
Overload and Car-to-Car Tests

![Graph showing the relationship between rebound force in overload tests (kN) and firewall intrusion of small car in a crash into a large car (mm). The graph includes data points for: Vitz 2003 (vs. Legacy), Civic 1999 (vs. Crown), Wagon R 2001 (vs. Crown), Move 2000 (vs. Crown), Vitz 2000 (vs. Legacy), vs. Crown (55 km/h), and vs. Legacy (50 km/h).]
Rebound Force in 80 and 64 km/h Tests

![Graph showing rebound force in 80 km/h tests and 64 km/h tests for different models: Vitz 2002, Vitz 2003, Move 2000, Wagon R 2001, Civic 1997, Vitz 2002.](image-url)
Summary – Compartment Strength

1. It was demonstrated that a strong compartment is effective in improving the self-protection.
2. Overload tests are useful for predicting the compartment strength.
3. Some criteria have been examined to evaluate the compartment strength.
4. Compartment strength may be evaluated in ODB 64 km/h tests.
<table>
<thead>
<tr>
<th>Test procedures</th>
<th>Key factors</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full-width test (Rigid barrier or deformable barrier)</td>
<td>• Structural interaction</td>
<td>• AHOF</td>
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<td>• Initial stiffness</td>
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<td>• Relative homogeneity assessment</td>
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<tr>
<td>ODB 64 km/h (Overload 80 km/h?)</td>
<td>• Compartment strength</td>
<td>• Rebound force?</td>
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<tr>
<td>ODB 64 km/h</td>
<td>• Force matching</td>
<td>• Barrier force?</td>
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