Honda’s Study & Report on the Study Commissioned by NHTSA “Mass Reduction for Light-Duty Vehicles for Model Years 2017-2025” DTNH22-11-C-00193

Presented by Chuck Thomas
PUBLIC VERSION

NHTSA Mass-Size-Safety Workshop
May 13th-14th, 2013
Honda’s Observations on LWV Study

• The EDAG/GWU Report is a good study of light weighting possibilities.

• Many of the technologies and approaches to light weighting in the report reflect Honda’s own research and direction.

• This report by Honda is an effort to share with NHTSA and others our important observations and corrections with respect to both the details of the report, and its conclusions.

• Honda believes that by sharing our thinking, we can improve NHTSA’s policy-making to reflect more realistic and practical considerations from industry.
Honda’s Observations on LWV Study

• Honda believes that the LWV design would not achieve performance parity with the 2011 Accord in the areas of:
  – Crashworthiness
  – Performance & Drivability
  – Ground Clearance

• Business conditions not considered by EDAG would result in increased weight of the LWV:
  – Platform Commonality

• Mass added to the vehicle to correct for performance and platform issues will result in a mass rebound effect that will add additional mass.
  – Power-train downsizing
Summary of LWV Mass Reduction

Total weight savings ▲22% (332 kg), cost up +$319 ($0.96 per KG)
Honda observes that the goal of the LWV design – to achieve the same level of performance as the 11M Accord – fell short in two critical areas:

- Crashworthiness
- Drivability & Performance
  - Handling
  - Ride Comfort
  - Ground Clearance

Honda finds that by solving the Crash Worthiness performance, the Drivability performance (stiffness) can be addressed.
Performance – Intention of The Study

Intention of The Study

- Fuel economy
- Acceleration
- Noise, Vibration
- Road noise, Wind noise
- Flat & Smooth ride comfort
- Handling response
- Steering feel
- Brake feel
- Safety

Crash safety

11 Accord

LWV Intention

ENG Noise, Vibration

Road noise, Wind noise

Noise

Drivability

Ride comfort
Honda’s judgment is based on study of the report, discussion with the researchers (Dec '12), and Honda’s own internal study, research, and analysis.
Crashworthiness Issues

Precondition for countermeasures

LWV; Sub-frame is designed to engage during crash event

ACCORD; Sub-frame is designed to disengage during crash event

Countermeasures is performed in the LWV sub-frame engagement system

Countermeasure is performed by change of material and thickness on the LWV BIW structure
### Frontal Crash Safety Performance

<table>
<thead>
<tr>
<th>TEST Target</th>
<th>Issues</th>
<th>Judgment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IIHS GOOD</strong></td>
<td>On the whole, dashboard, lower (firewall), pedal area intrusion and deformation – impacting lower extremities is larger on LWV than ACCORD, resulting in <strong>more injury risk to the driver</strong>.</td>
<td>MARGINAL (leg/foot, right)</td>
</tr>
</tbody>
</table>

Countermeasure Required

![LWV](image1.png)  
**LWV**

![ACCORD](image2.png)  
**ACCORD**
## Improving Frontal Crash Performance

<table>
<thead>
<tr>
<th>Area</th>
<th>COUNTERMEASURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOE BOARD (RIGHT FOOT)</td>
<td>TOE BOARD  increase strength with additional STIFFENER to prevent out-of-plane deformation</td>
</tr>
<tr>
<td>FRONT RAIL END</td>
<td>FRONT RAIL END increase strength with additional STIFFENERs</td>
</tr>
</tbody>
</table>
| WHEEL HOUSE UPPER MEMBER FR PILLAR UPR FR PILLAR LWR SIDE SILL | 1. Increase FR W/HOUSE UPR MBR strength to prevent FR W/HOUSE intruding into DA/BD LWR.  
2. Adjust the PLRs and S/SILL strength up, according to the W/HOUSE UPR MBR stiffener |
| SEAT FOOT                                  | Increase the SEAT FOOT strength to prevent seat pitching seen in LWV model     |
## Side Crash Safety Performance

<table>
<thead>
<tr>
<th>TEST Target</th>
<th>Issues</th>
<th>Judgment</th>
</tr>
</thead>
<tbody>
<tr>
<td>IIHS SICE GOOD</td>
<td>Hard to maintain integrity of the safety cage due to many predicted fractures</td>
<td>In order to maintain integrity of the safety cage from potential harmful fractures, especially considering mass production variability, this solution is not acceptable (too marginal)</td>
</tr>
</tbody>
</table>

Countermeasure Required

- **Crack**
- **Limit of elongation**
Improving Side Crash Safety Performance

Goal: Maintain integrity of the safety cage

To prevent the material fracture

1. Apply better elongation material (lower Yield strength) to the large deformation portion on LWV
2. Adjust LWV thickness equal to the ACCORD thickness
3. Adjust the cross member thickness to transfer the bigger side impact load according to the CTR PLR countermeasures

+10Kg
<table>
<thead>
<tr>
<th>TEST Target</th>
<th>Issues</th>
<th>Judgment</th>
</tr>
</thead>
<tbody>
<tr>
<td>FMVSS 301</td>
<td>Fuel pipe and the edge of Rear suspension upper arm interfere GWU did not include fuel filler pipe in their simulation. When Honda added the fuel filler pipe to the simulation, deformation occurred</td>
<td>Fuel filler pipe deformation and potential damage is unacceptable for a simulation. Countermeasure Required</td>
</tr>
</tbody>
</table>
Countermeasures to eliminate the possibility of fuel leak

Note: LWV CAE model is not equipped with fuel filler pipe. Honda merged it from ACCORD CAE model.

**Fuel pipe and the edge of Rear Suspension upper arm interfere**

**Cross section**

Before test

During test

- Initial clearance: 22mm
- Suspension upper ARM is pushed forward 56mm maximum

**Countermeasure**

- Reduce the deformation between Fr and Rr sub frame brackets
- Adjust the REAR FRAME and SUB FRAME lateral member strength 1.4 times to the compared to LWV

**Mechanism**

- RR FRM collapsed
- RR SUB FRM collapsed

**Countermeasure to eliminate the possibility of fuel leak**

+15Kg
Honda observes that the goal of the LWV design – to achieve the same level of performance as the 11M Accord – fell short in two critical areas:

- Crashworthiness
- Drivability & Performance
  - Handling
  - Ride Comfort
  - Ground Clearance

Honda finds that by solving the Crash Worthiness performance, the Drivability performance (stiffness) can be addressed.
Drivability & Performance: Handling

Handling Performance

Response

CHASSIS subframe rigidity (ground clearance C/M)

BODY torsional stiffness

Stability

Recovery from Steering Maneuver

Steering Response (turn-in)
Drivability: Torsional Stiffness

1. LWV physical test of Torsional stiffness values for ACCORD are significantly low compared to Honda’s internal data.

<table>
<thead>
<tr>
<th>Torsional Stiffness [kNm/deg]</th>
<th>Physical test</th>
<th>CAE result</th>
</tr>
</thead>
<tbody>
<tr>
<td>LWV</td>
<td>12.33</td>
<td>16.25</td>
</tr>
</tbody>
</table>

2. DEFIANCE’s rear support locations for their physical test are unusual.
LWV body torsional stiffness is more than 25% lower than ACCORD. The Safety-Countermeasures (50kg) already address this issue.
Ride Comfort: Noise

**Noise Quality**
- Excellent
- Quiet
- Good
- Fair

**ROAD NOISE – Rough Surface**
(typically tire & wheel)

**CRUSING NOISE – Flat Surface**
(Acoustic Insulation)

- 13M NEW Accord LX
- MID SDN. TREND ZONE
- 11M Accord (LX)
- LWV (Honda’s Estimate)

- Comp A
- Comp B
- Comp C
## Ride Comfort: Noise

<table>
<thead>
<tr>
<th>Chassis</th>
<th>LWV proposal</th>
<th>Concerns</th>
<th>C/M</th>
<th>Additional wt.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reducing thickness of Wheel Rim</td>
<td>Uncompetitive road noise vs. 11 Accord</td>
<td>Return to original thickness</td>
<td>+4.6Kg</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Insulation</th>
<th>LWV proposal</th>
<th>Concerns</th>
<th>C/M</th>
<th>Additional wt.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum Outer/Inner Door panel</td>
<td>Uncompetitive cruising noise vs. 11 Accord</td>
<td>Add insulation materials</td>
<td>+1.2Kg</td>
<td></td>
</tr>
</tbody>
</table>

Additional +5.8kg is necessary for C/M of Noise.
## Ground Clearance

<table>
<thead>
<tr>
<th>FR SUS SYS</th>
<th>LWV Proposal</th>
<th>Honda Design</th>
<th>C/M</th>
<th>C/M Wt.</th>
</tr>
</thead>
<tbody>
<tr>
<td>LWV</td>
<td>11Accord</td>
<td>SUB/F thickness up &amp; Change lower arm connecting structure</td>
<td></td>
<td>8.55Kg</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Section area reduction by escaping exhaust pipe line</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

LWV Design is lighter and stiffer, but results in lower exhaust pipe (due to straight cross member), and taller side member – both of which contribute towards lower ground clearance. **Inadequate ground clearance can result in hitting objects, suspension damage, etc.**

Honda’s countermeasure for the LWV design is a bit heavier in order to recover the ground clearance.
LWV Adjustments: 75 Kg

Crash Worthiness
- Drivability & Performance:
  - Handling
  - Ride comfort
  - Ground Clearance
- Other - Incorrect Baseline Weight:
  - WHEEL +1.4
  - TEMPER TIRE/WHL +0.8
  - FR BRK DISK +3.3
  - FR CALIPER +1.9

1480
1148
1223

units: kg
LWV Weight Adjustments

- 11M baseline: 1480 units (kg)
- LWV Adjusted Weight: 1223 units (kg)
- LWV verified weight: ?

Business Considerations & Mass Rebound Effect
Automaker’s Business Condition

We OEMs must pay attention to provide products at an affordable price;

→ Taking advantage of platform commonality

Vehicle weight

Honda Accord L4/V6
1448~1614kg

Honda Crosstour
1660~1820kg

Acura TL
1690~1815kg

Area: sales volume

When using a common platform it is necessary to consider heaviest vehicle
Estimated weight impact is approx. 40kg.
LWV Weight Adjustments: 40 Kg

Performance Parity:
- LWV baseline: 1480 kg
- 11M: ~1148 kg

Business Considerations:
- LWV Adjusted Weight: 1263 kg
- 40 kg adjustment

Mass Rebound Effect:
- ?

Units: kg

Note: The diagram represents weight adjustments and performance parity comparisons for LWV and 11M, with an adjustment of 40 kg leading to the adjusted weight of 1263 kg.
Mass Rebound Effect

These items are based on 332kg mass reduction

<table>
<thead>
<tr>
<th>System</th>
<th>baseline wt.</th>
<th>LWV wt.</th>
<th>mass reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>PT</td>
<td>169.9</td>
<td>141.3</td>
<td>28.6</td>
</tr>
<tr>
<td>TMISS</td>
<td>96.7</td>
<td>68.8</td>
<td>27.9</td>
</tr>
<tr>
<td>DR/SH</td>
<td>15.2</td>
<td>11.7</td>
<td>3.5</td>
</tr>
<tr>
<td>STRG</td>
<td>STRG SH+</td>
<td>17.3</td>
<td>4.4</td>
</tr>
<tr>
<td>P/S UNIT</td>
<td>5.5</td>
<td>4.7</td>
<td>0.9</td>
</tr>
<tr>
<td>BRK</td>
<td>FR DISK</td>
<td>16.0</td>
<td>5.9</td>
</tr>
<tr>
<td></td>
<td>ABS</td>
<td>3.1</td>
<td>1.2</td>
</tr>
<tr>
<td></td>
<td>FR PAD</td>
<td>1.8</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td>Vacuum Pump</td>
<td>1.0</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td>RR PAD</td>
<td>0.9</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td>RR DISK.</td>
<td>8.2</td>
<td>3.0</td>
</tr>
<tr>
<td>EXH</td>
<td>EXPI+CAT+SLNCR+H/B</td>
<td>20.8</td>
<td>19.0</td>
</tr>
<tr>
<td>COOLING</td>
<td>Expansion bottle</td>
<td>1.1</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>RAD support</td>
<td>0.4</td>
<td>0.03</td>
</tr>
<tr>
<td></td>
<td>HOSE</td>
<td>1.8</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td>RAD</td>
<td>4.4</td>
<td>0.4</td>
</tr>
<tr>
<td></td>
<td>FAN</td>
<td>7.1</td>
<td>1.1</td>
</tr>
<tr>
<td>ELEC</td>
<td>BATT</td>
<td>12.4</td>
<td>1.1</td>
</tr>
<tr>
<td>FUEL</td>
<td>F/Tank</td>
<td>12</td>
<td>1.7</td>
</tr>
<tr>
<td></td>
<td>Gas</td>
<td>50.9</td>
<td>7.4</td>
</tr>
</tbody>
</table>

90kg

contribute to...

Acceleration Performance

Vehicle mass
Available downsize items are ▲48kg(+42kg).
LWV Weight Adjustments: 82 Kg

- 11M baseline
- LWV

Performance Parity:
- 1480 kg
- 1148 kg
- Adjusted Weight: 1223 kg (40 kg reduction)

Business Considerations:
- 1263 kg (42 kg adjustment)

Mass Rebound Effect:
- LWV Adjusted Weight: 1305 kg

units: kg
LWV Weight Total Adjustments: 157 Kg

- **11M baseline**
- **LWV** Adjusted Weight: 1223 + 75 kg = 1305 kg
- **Business Considerations And Mass Rebound Effect**
- **LWV Adjusted Weight**: 1305 kg
- **Honda LWV Weight**: 1305 kg

units: kg
Conclusion

- In order to achieve true performance parity with the 2011 Accord several adjustments to the LWV are needed:
  - Crashworthiness, Drivability, NVH Performance, and Others.

- Considering performance and business issues impact on weight, the true achievement of the LWV scenario is closer to 175 kg reduction not the 332 kg reduction predicted in the report.

- In addition manufacturers must consider increasing demands for performance in upcoming design cycles (Safety, drivability, etc.) These factors over the two lifecycle timeline of the LWV were not considered.
  - These factors will impact the amount of achievable mass reduction over this period.

- Honda recognizes many of the technologies highlighted in the EDAG report have excellent weight reduction potential and Honda is already moving aggressively to introduce these materials and design ideas into our vehicles.
  - AHSS, Hot-Stamped Steels, Aluminum body and chassis parts, cast magnesium structures, reinforced plastics and composites, and other weight reduction technologies.
End