IIHS Side Impact 2.0 Barrier Development

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IIHS side impact crashworthiness test

50 km/h perpendicular impact
Began in 2003

Vehicle Ratings
- Good
- Acceptable
- Marginal
- Poor

Vehicle ratings based on dummy injury measures, restraints/dummy kinematics and structural performance
Side crash fatalities in the United States

- **PV occupant deaths in side impacts**
- **Side impact driver death rate in 1-3 year old vehicles**

The chart shows a decrease in both PV occupant deaths in side impacts and side impact driver death rate from 2000 to 2020.
Side impact ratings: crash tests and field data

- Fatal crash analysis - 2011
  - Fatality risk in side impact crashes 70 percent lower in ‘good’ rated vehicles versus ‘poor’

- Remaining Fatal/Serious Injury case review - 2015
  - Predominantly involve more severe crashes: higher impact speed and heavier striking vehicles

- Modified crash configuration - 2017
  - Laboratory crash test configuration to best promote vehicle-design improvements
    - Higher Speed
    - Vehicle-to-vehicle
    - Heavier crash partner (LTV)

Real-world Side Crashes
Body Regions Injured
Side impact 2.0 test conditions

Increase MDB striking speed from 50 km/h to 60 km/h

Increase MDB mass from 1,500 kg to 1,900 kg

Average IIHS side crash Delta V

Average IIHS side crash 2.0 Delta V

Cumulative weighted percent

Lateral delta V (km/h)

0 10 20 30 40 50 60 70

Vehicle Mass (kg)


Vehicle Year

IIHS MDB

IIHS MDB 2.0

Fatal

MAIS2+

MAIS3+

Pickups

SUVs

Cars
Vehicle-to-vehicle tests indicate need for updating IIHS barrier

Comparison testing revealed differences

- Vehicle motion characteristics
- Damage pattern and amount of deformation
- Dummy injury pattern
Vehicle-to-vehicle tests indicate need for updating IIHS barrier

Laboratory test of vehicle struck by an SUV

- Vehicle rolls toward crash partner
- “M” shape localized deformation
- Primarily pelvic/femur injuries

Laboratory test of vehicle struck by IIHS barrier

- Vehicle rolls away from crash partner
- Uniform loading across vehicle side
- Primarily head and chest injuries
Criteria for updating the IIHS side impact honeycomb barrier design

Goals for new barrier design

- Vehicle motion characteristics
- Damage pattern
- Dummy injury pattern
- Avoid test artifacts and barrier bottoming
Methodology for honeycomb barrier development

26 modern LTV dimensions

Material properties and dynamic performance from industry-used barrier tests

Evaluate a vehicle model with LTV and IIHS MDB striking vehicle test results

IIHS modified, AE-MDB, AE-MDB modified, Showa-prototype

Modern LTV dimensions

Initial Prototype Design

Taper angle, Upper Stiffness, Bumper Stiffness

Prototype design
Cellbond B

Fine tuning of prototype design

Best prototype chosen
Cellbond B4

Test multiple vehicle models with prototype design

Final Design

IIHS barrier 2.0
Redefining the barrier shape based on current SUVs and Pickups
Vehicle profiles from 23 SUVs and 3 pickups
Redefining the barrier shape based on current SUV and Pickups

Lateral properties

- Stiffer rail section
- Flat front section expanded to accommodate stiffer rail sections while still representing shape of vehicles
Characteristics of industry-used barriers and other prototypes

<table>
<thead>
<tr>
<th>Characteristics compared to standard IIHS MDB</th>
<th>MDB mod</th>
<th>AE-MDB</th>
<th>AE-MDB mod</th>
<th>Showa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
<td>-</td>
</tr>
<tr>
<td>Width</td>
<td>↓</td>
<td>-</td>
<td>↓</td>
<td>↓</td>
</tr>
<tr>
<td>Stiffness (upper)</td>
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<td>↓</td>
<td>↓</td>
<td>↓</td>
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<tr>
<td>Stiffness (lower center)</td>
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<td>↓</td>
<td>↓</td>
<td>↓</td>
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<tr>
<td>Stiffness (lower outside)</td>
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<td>↑</td>
<td>↑</td>
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<tr>
<td>Taper</td>
<td>-</td>
<td>↑</td>
<td>↓</td>
<td>↓</td>
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</tbody>
</table>

2018 Toyota Camry struck vehicle
## Performance of industry-used barriers and other prototypes

<table>
<thead>
<tr>
<th>Performance compared to goals for new barrier</th>
<th>MDB modified</th>
<th>AE-MDB</th>
<th>AE-MDB raised modified</th>
<th>Showa barrier</th>
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</thead>
<tbody>
<tr>
<td>Vehicle kinematics</td>
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<td>x</td>
<td>x</td>
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<tr>
<td>Deformation shape</td>
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<td>x</td>
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<tr>
<td>Upper door deformation</td>
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<td>✓</td>
<td>x</td>
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<tr>
<td>Amount of structural deformation (b-pillar)</td>
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<td>x</td>
<td>x</td>
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<tr>
<td>Injury patterns</td>
<td>✓</td>
<td>x</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>No barrier bottoming</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

- **MDB modified**: 2018 Toyota Camry struck vehicle
- **AE-MDB raised to SUV height**
- **AE-MDB raised to SUV height modified**
- **Showa barrier**

- Information about good barrier performance was used to develop the cellbond prototype.
Initial Prototype Designs

Incorporated modern vehicle dimensions and dynamic performance of industry-used barriers

Two slightly different geometries with similar principles

- Lower overall height of deformable element
- Lower mounting of barrier (decrease ground clearance)
- Larger barrier thickness to reduce bottoming of deformable element
- Wider flat front face to match vehicle structures
- Reduced height of bumper beam element to match current vehicles
- Softer bumper beam
- Lower outboard stiffer “frame rail” sections of honeycomb (different geometries of these sections)

Manufacturing limit for design A: cannot build a variation of this design with a different upper stiffness. Design B proposed as an option that can accommodate different variations in core materials for future revisions.
Prototype barriers
Barrier performance compared to study goals

<table>
<thead>
<tr>
<th>Performance compared to goals for new barrier</th>
<th>Cellbond A</th>
<th>Cellbond B</th>
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</thead>
<tbody>
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<td>✓</td>
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<tr>
<td>Upper door deformation</td>
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<td>✗</td>
</tr>
<tr>
<td>Amount of structural deformation (b-pillar)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Injury patterns</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>No barrier bottoming</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

Remaining problems can be solved with less loading to the upper section (softer upper core)

Must pursue “B” variants since “A” cannot be manufactured with a separate top section
细调缓冲器原型

2018 丰田 Camry 撞击车辆

Cellbond B1
- 更柔软的顶部
- 45° 楔形
- 顶盖刚度 130 kPa

Cellbond B4
- 更柔软的顶部
- 原始 24° 楔形
- 顶盖刚度 310 kPa

<table>
<thead>
<tr>
<th>性能与新屏障目标的比较</th>
<th>Cellbond B1</th>
<th>Cellbond B4</th>
</tr>
</thead>
<tbody>
<tr>
<td>车辆惯性力学</td>
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<td>✔</td>
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<tr>
<td>变形形状</td>
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<td>✔</td>
</tr>
<tr>
<td>上部门变形</td>
<td>✔</td>
<td>✔</td>
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<tr>
<td>结构变形 (b-柱)</td>
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<td>损伤模式</td>
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<tr>
<td>无底部碰撞</td>
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</table>

最终原型是 B4 概念
- 保持原始楔形角度 24°
- 改善 M 形状超过 B1
- 改善 B-柱变形超过 B1

Final prototype is B4 concept
- Maintains original taper angle 24°
- Improved M shape over B1
- Improved B-pillar deformation over B1
Vehicles tested with final prototype barrier

<table>
<thead>
<tr>
<th>Striking vehicle</th>
<th>Toyota Camry</th>
<th>Volkswagen Atlas</th>
<th>Honda Accord</th>
<th>Kia Forte</th>
<th>Honda Civic 2 DR</th>
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<tbody>
<tr>
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<tr>
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<td>IIHS MDB</td>
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<td>X</td>
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<td>Ford F150</td>
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</table>
Correlation of performance between LTV-to-vehicle tests and final prototype

<table>
<thead>
<tr>
<th>Goals to Achieve</th>
<th>Toyota Camry</th>
<th>VW Atlas</th>
<th>Honda Accord</th>
<th>Kia Forte</th>
<th>Honda Civic 2 DR</th>
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</thead>
<tbody>
<tr>
<td>Vehicle kinematics/roll</td>
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<td>Amount of structural deformation (bpillar)</td>
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<tr>
<td>Injury patterns</td>
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<td>✓</td>
<td>✓</td>
<td>na/✓</td>
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<tr>
<td>No barrier bottoming</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
Vehicle motion with final prototype barrier

Camry

Atlas

Accord

Forte

Civic 2 DR
Deformation shape and depth at mid door with final prototype barrier

Camry

Atlas

Accord

Forte

Civic 2 DR

Civic performance at b-pillar not a perfect match, but as good as honeycomb can be expected to represent a solid frame-rail support.
# Rating Components Comparison

## Current vs. Prototype honeycomb performance compared to V-2-V

- New barrier corrects overprediction of driver head injury seen in IIHS barrier
- New barrier corrects underprediction of driver and rear passenger pelvic injury seen in IIHS barrier
- New barrier better represents structural value (within 1-2 cm of v-2-v)

## Prototype compared to V-2-V

- Acceptable representation of structure
- Similar prediction of injury

<table>
<thead>
<tr>
<th></th>
<th>Toyota Camry</th>
<th>VW Atlas</th>
<th>Honda Accord</th>
<th>Kia Forte</th>
<th>Honda Civic 2DR</th>
</tr>
</thead>
<tbody>
<tr>
<td>V-2-V</td>
<td>V-2-V</td>
<td>V-2-V</td>
<td>V-2-V</td>
<td>V-2-V</td>
<td>V-2-V</td>
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<td>Structure</td>
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<td>IIHS barrier</td>
<td>IIHS barrier</td>
<td>Final Prototype</td>
<td>Final Prototype</td>
<td>Final Prototype</td>
</tr>
<tr>
<td>Driver</td>
<td></td>
<td>V-2-V</td>
<td>V-2-V</td>
<td>V-2-V</td>
<td>V-2-V</td>
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<tr>
<td>Rear Passenger</td>
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<td>IIHS barrier</td>
<td>Final Prototype</td>
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<td></td>
</tr>
<tr>
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<td>9</td>
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</tbody>
</table>

**IIIHS barrier**

- Final Prototype

**Prototype**

- V-2-V
- Final Prototype

**Structure**

- Acceptable representation of structure
- Similar prediction of injury

**Driver**

- New barrier corrects overprediction of driver head injury seen in IIHS barrier
- New barrier corrects underprediction of driver and rear passenger pelvic injury seen in IIHS barrier
- New barrier better represents structural value (within 1-2 cm of v-2-v)

**Rear Passenger**

- Data lost
Conclusions

IIHS side impact barrier 2.0 design is final

- IIHS side impact barrier 2.0 does a better job of replicating characteristics of higher severity vehicle-to-vehicle crash tests than current IIHS side impact barrier
  - Camry, Atlas, and Accord, with most datapoints for comparison, show very good correlation between side impact barrier 2.0 and vehicle-to-vehicle in terms of vehicle motion, deformation and injury.
  - Forte test had some data loss, but of the available data was a good match between side impact barrier 2.0 and vehicle-to-vehicle
  - Civic 2DR with side impact barrier 2.0 had some structural differences with the vehicle-to-vehicle test but overall showed the need for similar kinds of improvements
Timeline/Next Steps

- April 2020 - Official announcement, test protocol and barrier specifications document
- Summer 2020 – final MDB cart design, technical drawings and specs available
- Summer 2020 – Pilot program testing (expected small SUV)
- Fall 2020 – Ratings protocol
- First official ratings tests in 2021
- TSP 2022 inclusion

*All deadlines may be impacted by COVID-19*
Summary of Side Impact Barrier 2.0 Technical Specifications
Current IIHS Side Impact Barrier

<table>
<thead>
<tr>
<th></th>
<th>kPa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mid Bottom</td>
<td>310</td>
</tr>
<tr>
<td>Bumper</td>
<td>1690</td>
</tr>
</tbody>
</table>
IIHS side impact barrier 2.0

Drawing not to scale

<table>
<thead>
<tr>
<th></th>
<th>kPa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper</td>
<td>140</td>
</tr>
<tr>
<td>Mid Bottom</td>
<td>325</td>
</tr>
<tr>
<td>Bumper</td>
<td>325</td>
</tr>
<tr>
<td>Rails</td>
<td>1100</td>
</tr>
</tbody>
</table>
IIHS side impact barrier 2.0

Front 1700
Barrier “converted” to metric values

Drawing not to scale

<table>
<thead>
<tr>
<th>Component</th>
<th>kPa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper</td>
<td>140</td>
</tr>
<tr>
<td>Mid Bottom</td>
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</tr>
<tr>
<td>Rails</td>
<td>1100</td>
</tr>
</tbody>
</table>

Changes in stiffness to components

Increase barrier depth

Wider front face

Changes in overall height

Smaller bumper height

Lower overall height

Lower ground height

350 mm off ground

Wider front face

1700

1000

600
Summary of barrier changes

- Lower overall height of deformable element
- Lower mounting of barrier (decrease ground clearance)
- Larger barrier thickness to reduce bottoming of deformable element
- Wider flat front face to match vehicle structures
- Reduced height of bumper beam element to match current vehicles
- Changes to honeycomb stiffness to reflect vehicle characteristics
- Converting all dimensions to “metric-friendly” values (ie 103 mm to 100 mm)
IIHS side impact crashworthiness test 2.0

60 km/h perpendicular impact

1,900 kg cart w/suspension MDB 2.0 barrier face

Vehicle Ratings

- **Good**
- **Acceptable**
- **Marginal**
- **Poor**

Vehicle ratings based on dummy injury measures, restraints/dummy kinematics and structural performance
More information at iihs.org and on our social channels:

[iihs.org](http://iihs.org)

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