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
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

- Occupant age 60 or older
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

Cumulative weighted percent

Lateral delta V (km/h)

Vehicle Mass (kg)

Vehicle Year


Pickups SUVs Cars

Average IIHS side crash Delta V

Average IIHS side crash 2.0 Delta V

Fatal MAIS2+ MAIS3+

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

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

Modern LTV dimensions

Material properties and dynamic performance from industry-used barrier tests

Initial Prototype Design

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

26 modern LTV dimensions

Taper angle, Upper Stiffness, Bumper Stiffness

IIHS modified, AE-MDB, AE-MDB modified, Showa-prototype
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>
<td>-</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
</tr>
<tr>
<td>Stiffness (lower center)</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
</tr>
<tr>
<td>Stiffness (lower outside)</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>Taper</td>
<td>-</td>
<td>↑</td>
<td>↓</td>
<td>↓</td>
</tr>
</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>
<td>✔</td>
<td>×</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>Deformation shape</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>Upper door deformation</td>
<td>×</td>
<td>×</td>
<td>✔</td>
<td>×</td>
</tr>
<tr>
<td>Amount of structural deformation (b-pillar)</td>
<td>✔</td>
<td>×</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>Injury patterns</td>
<td>✔</td>
<td>×</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>No barrier bottoming</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
</tr>
</tbody>
</table>

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>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle kinematics</td>
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<td>☒</td>
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<tr>
<td>Deformation shape</td>
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<td>✓</td>
</tr>
<tr>
<td>Upper door deformation</td>
<td>☒</td>
<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

2018 Toyota Camry struck vehicle

Cellbond A

Cellbond B
**Fine tuning of barrier prototype**

**2018 Toyota Camry struck vehicle**

<table>
<thead>
<tr>
<th>Performance compared to goals for new barrier</th>
<th>Cellbond B1</th>
<th>Cellbond B4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle kinematics</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Deformation shape</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Upper door deformation</td>
<td>✓</td>
<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>

**Cellbond B1**
- Softer top 45° taper
- Bumper stiffness 130 kPa

**Cellbond B4**
- Softer top Original 24° taper
- Bumper stiffness 310 kPa

**Final prototype is B4 concept**
- Maintains original taper angle 24°
- Improved M shape over B1
- Improved B-pillar deformation over B1

---

**Diagram:**
- Distance from vehicle centerline (cm)
- Height from ground (cm)
- Lateral distance from vehicle centerline (cm)

**Legend:**
- Pre-crash
- Mid Door
- Pilot
- Cellbond B1
- Cellbond B4
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>
</tr>
</thead>
<tbody>
<tr>
<td>Honda Pilot</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Final Prototype</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>IIHS MDB</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Ford F150</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</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>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle kinematics/roll</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Deformation shape and depth at mid door</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>Amount of structural deformation (bpillar)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Injury patterns</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>na/✓</td>
<td>✓</td>
</tr>
<tr>
<td>No barrier bottoming</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
Vehicle motion with final prototype barrier

<table>
<thead>
<tr>
<th>Camry</th>
<th>Atlas</th>
<th>Accord</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Camry" /></td>
<td><img src="image2" alt="Atlas" /></td>
<td><img src="image3" alt="Accord" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Forte</th>
<th>Civic 2 DR</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image4" alt="Forte" /></td>
<td><img src="image5" alt="Civic 2 DR" /></td>
</tr>
</tbody>
</table>
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><strong>Structure</strong></td>
<td>V-2-V 17</td>
<td>IIHS barrier 18</td>
<td>Final Prototype 16</td>
<td>V-2-V 32</td>
<td>IIHS barrier 22</td>
</tr>
</tbody>
</table>
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

- IIHS side impact barrier 2.0 is currently available for purchase through Cellbond and will be available through Argosy and Plascore in the future
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

IIHS Side Impact Barrier (Original) 2003-2021

IIHS Side Impact Barrier 2.0 2022-
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>

Drawing not to scale
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>
<td>325</td>
</tr>
<tr>
<td>Bumper</td>
<td>325</td>
</tr>
<tr>
<td>Rails</td>
<td>1100</td>
</tr>
</tbody>
</table>

Changes in stiffness to components

350 mm off ground

Lower overall height

Upper bumper height

Lower ground height

Wider front face

Increase barrier depth

24 deg
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

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://www.iihs.org)  
[@iihs_autosafety](https://www.instagram.com/iihs_autosafety)  
[@IIHS_autosafety](https://www.twitter.com/IIHS_autosafety)  
[iihs.org](http://www.iihs.org)