Insurance Institute for Highway Safety
Highway Loss Data Institute

IIHS Side Impact 2.0 Barrier Development

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IIHS side impact crashworthiness test

50 km/h perpendicular impact

Began in 2003

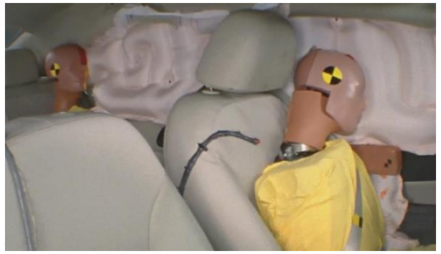
Vehicle Ratings

G ood

A cceptable

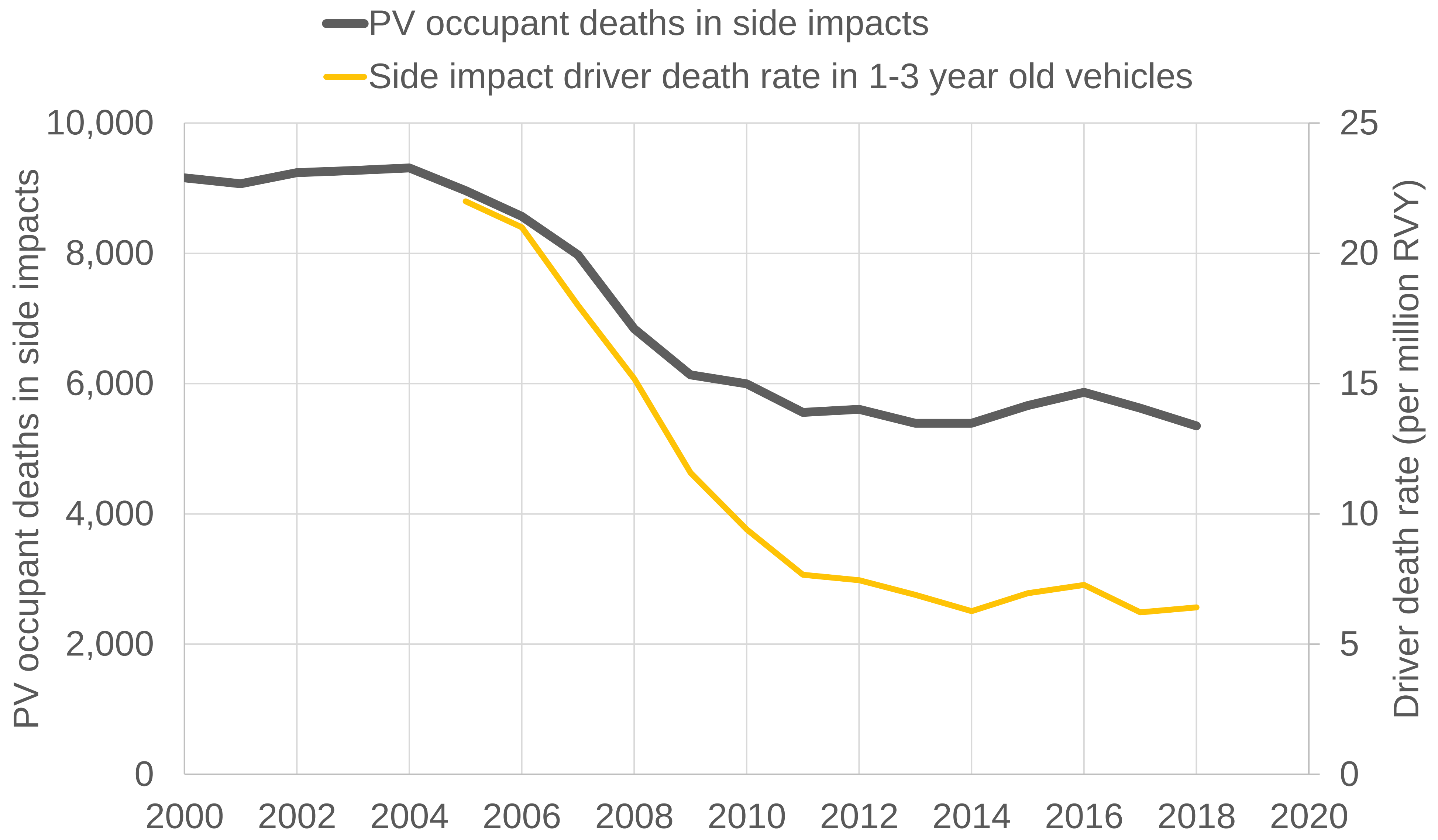
M arginal

P oor



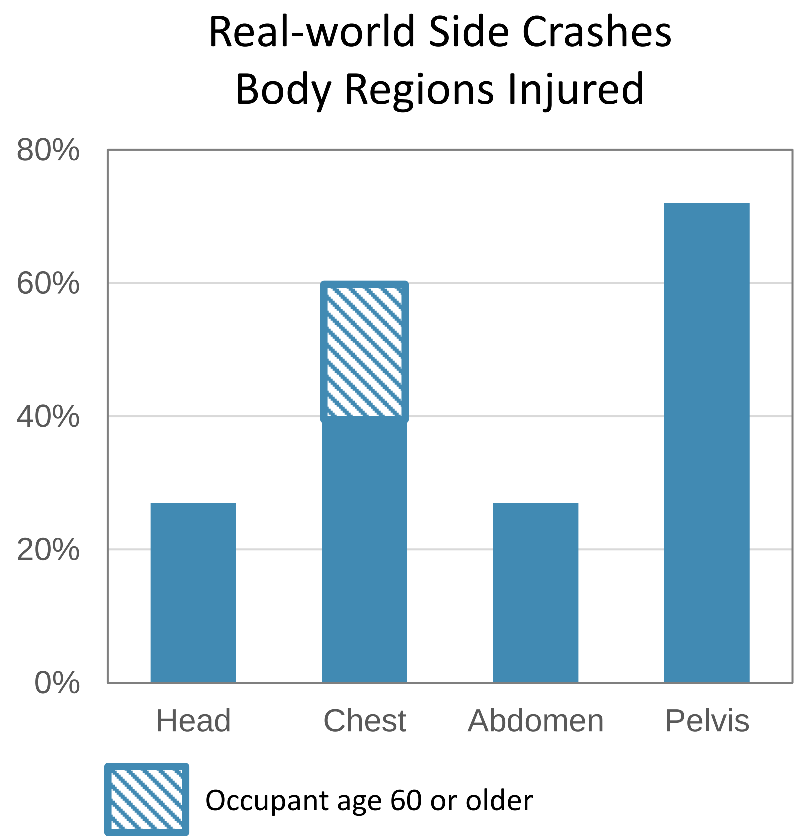
Vehicle ratings based on dummy injury measures, restraints/dummy kinematics and structural performance

Side crash fatalities in the United States



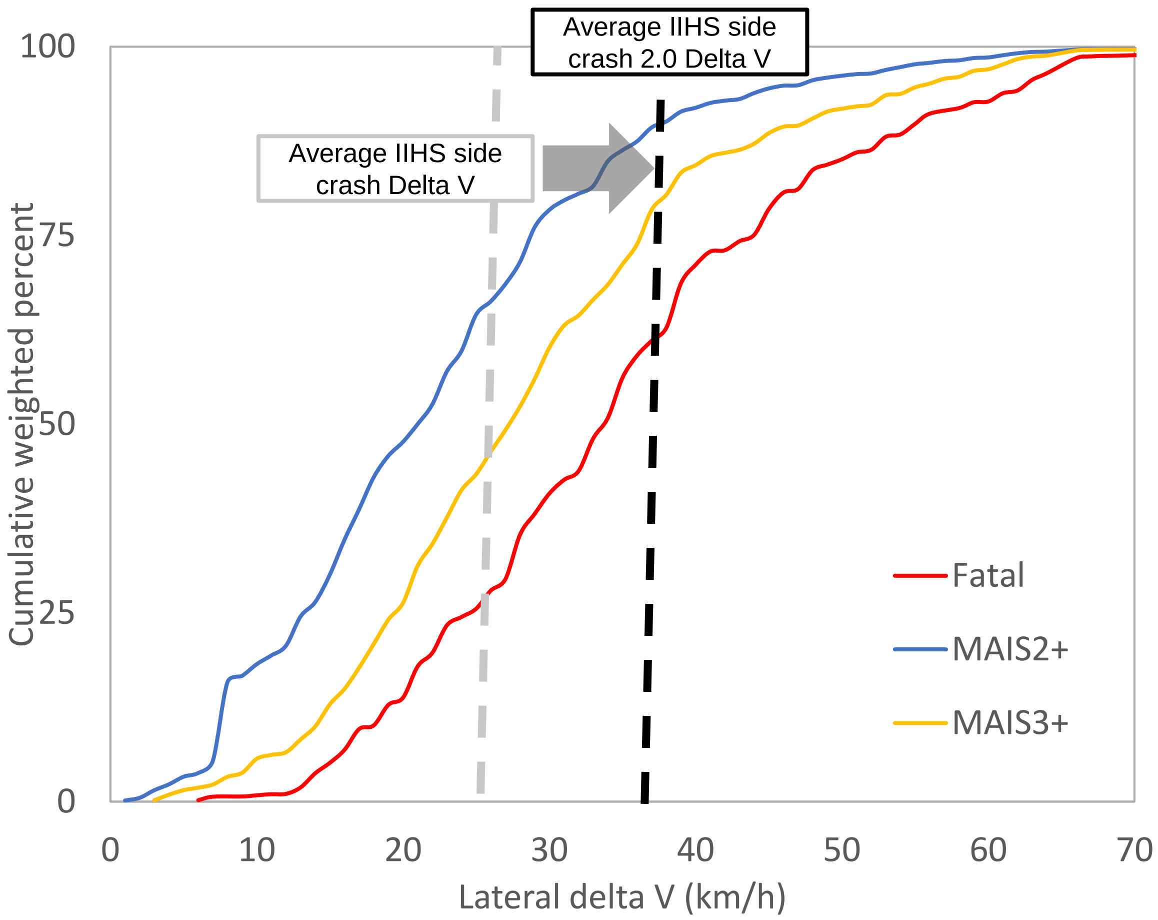
Side impact ratings: crash tests and field data

- 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)

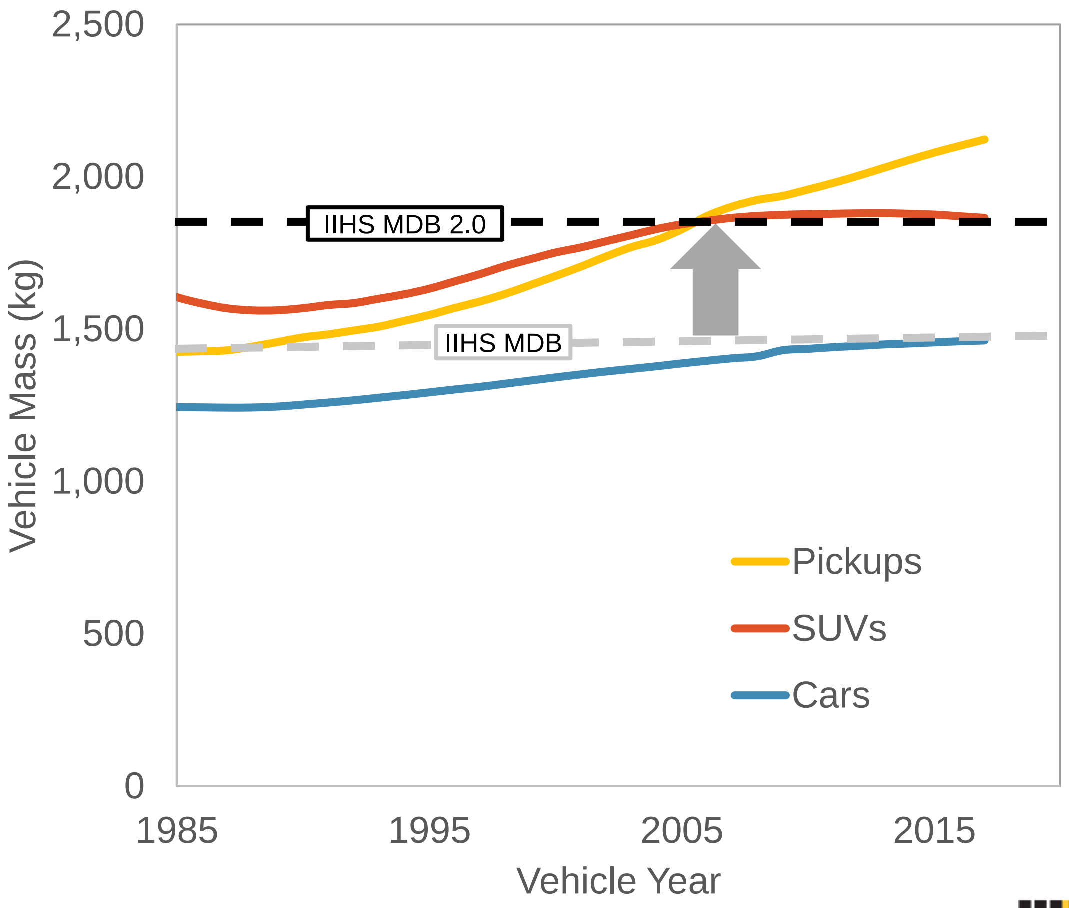


Side impact 2.0 test conditions

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



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



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

Laboratory test of vehicle struck by an SUV

Laboratory test of vehicle struck by 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

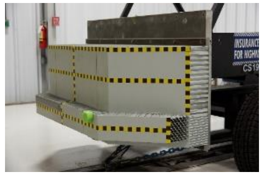
Evaluate a vehicle model with LTV and IIHS MDB striking vehicle test results

26 modern LTV dimensions

Modern LTV dimensions

Material properties and dynamic performance from industry-used barrier tests

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



Initial Prototype Design

Prototype design
Cellbond B

Taper angle, Upper Stiffness, Bumper Stiffness

Fine tuning of prototype design

Best prototype chosen
Cellbond B4

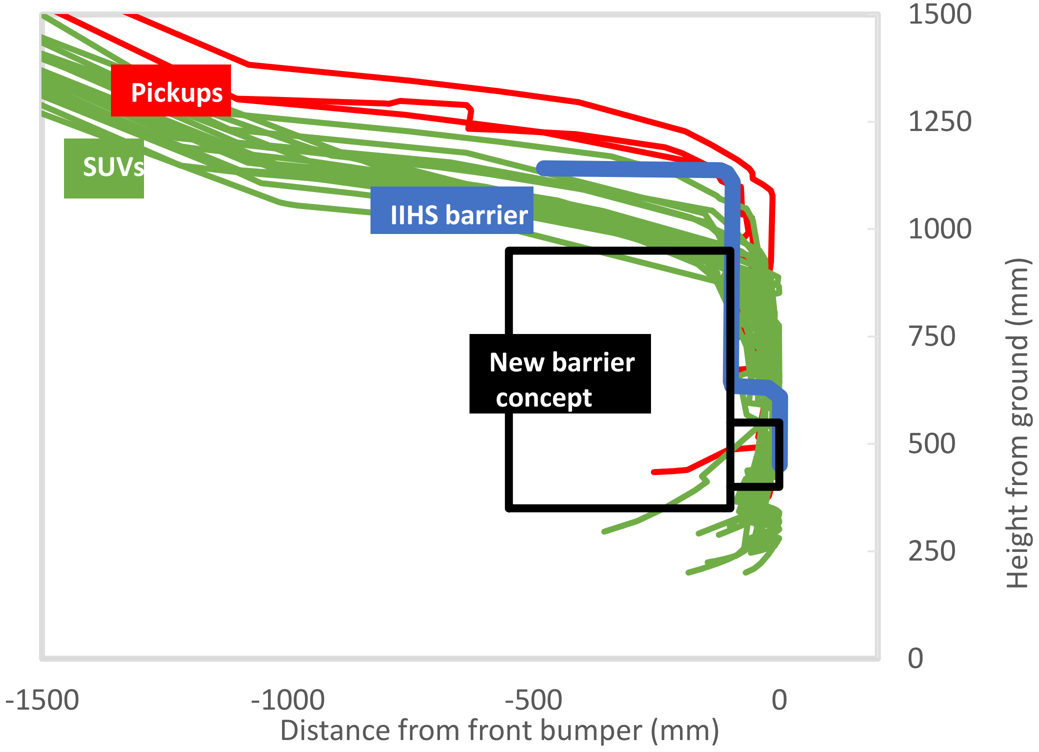
Test multiple vehicle models with prototype design

Final Design

IIHS barrier 2.0

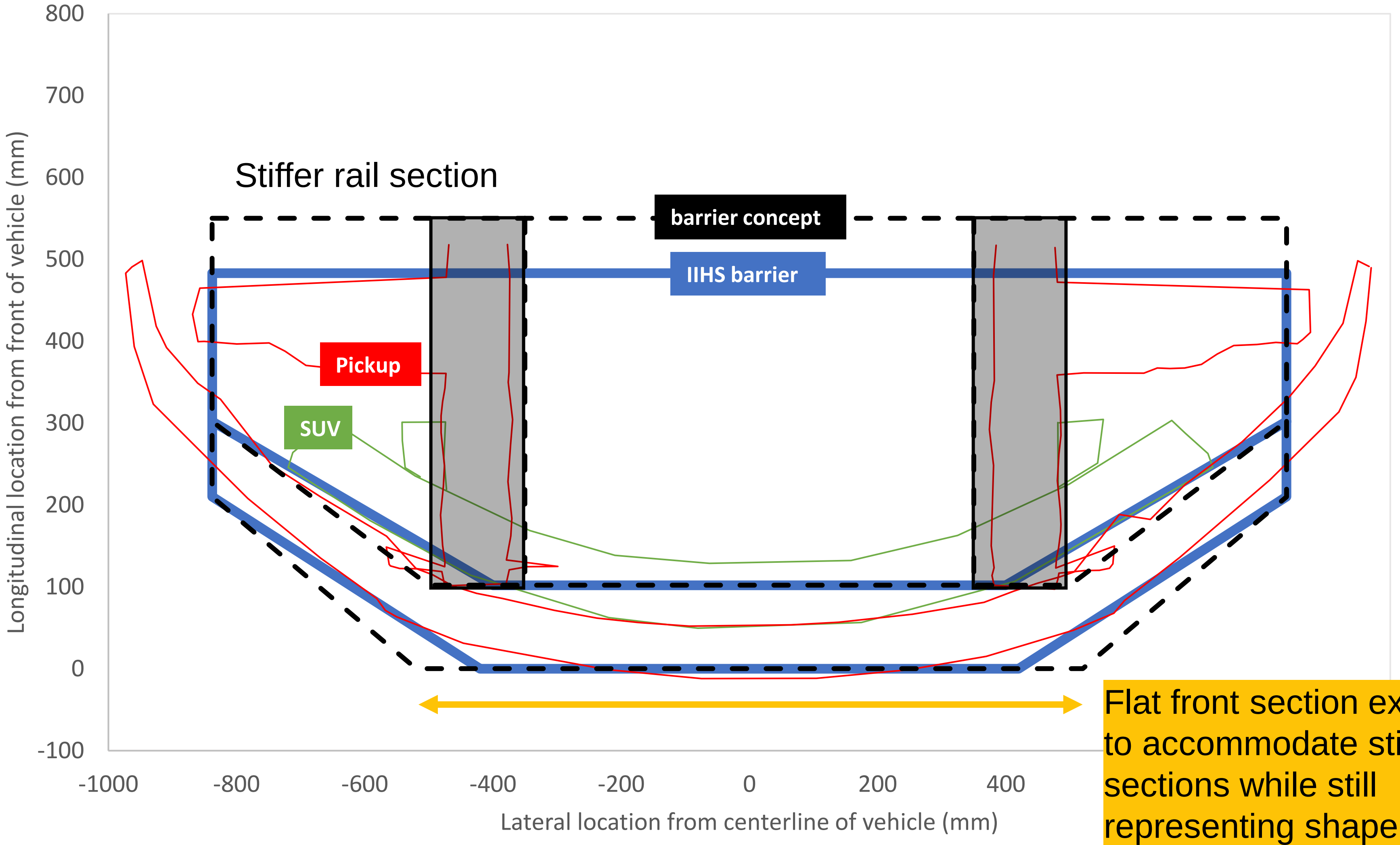
Redefining the barrier shape based on current SUVs and Pickups

Vehicle profiles from 23 SUVs and 3 pickups



Redefining the barrier shape based on current SUV and Pickups

Lateral properties



Flat front section expanded to accommodate stiffer rail sections while still representing shape of vehicles

Characteristics of industry-used barriers and other prototypes

2018 Toyota Camry struck vehicle

MDB modified

AE-MDB raised to SUV height

AE-MDB raised to SUV height modified

Showa barrier

Characteristics compared to standard IIHS MDB	MDB mod	AE-MDB	AE-MDB mod	Showa
Height	↓	↓	↓	-
Width	↓	-	↓	↓
Stiffness (upper)	-	↓	↓	↓
Stiffness (lower center)	↓	↓	↓	↓
Stiffness (lower outside)	↑	↑	↑	↑
Taper	-	↑	↓	↓

Performance of industry-used barriers and other prototypes

2018 Toyota Camry struck vehicle

MDB modified

AE-MDB raised to SUV height

AE-MDB raised to SUV height modified

Showa barrier

Performance compared to goals for new barrier	MDB modified	AE-MDB	AE-MDB raised modified	Showa barrier
Vehicle kinematics	✓	✗	✗	✗
Deformation shape	✗	✗	✗	✓
Upper door deformation	✗	✓	✓	✗
Amount of structural deformation (b-pillar)	✓	✗	✗	✗
Injury patterns	✓	✗	n/a	n/a
No barrier bottoming	✗	✗	✗	✗

Information about good barrier performance was used to develop the cellbond prototype

IIHS HLDI

Initial Prototype Designs

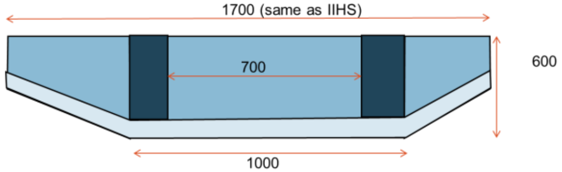
Incorporated modern vehicle dimensions and dynamic performance of industry-used barriers

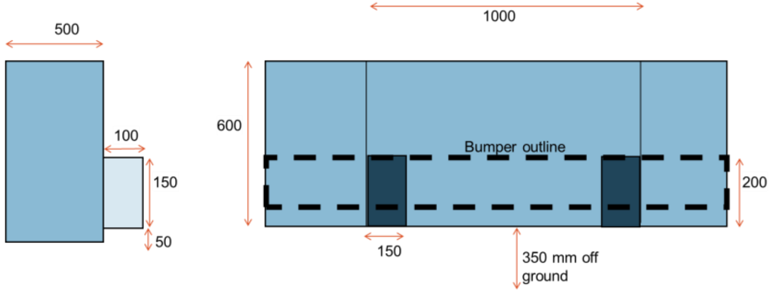
Two slightly different geometries with similar principles

- 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)

Cellbond A

	kPa
Main	310
Bumper	170
Rails	1080

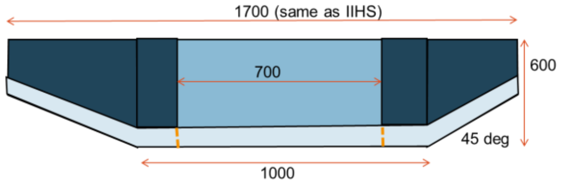


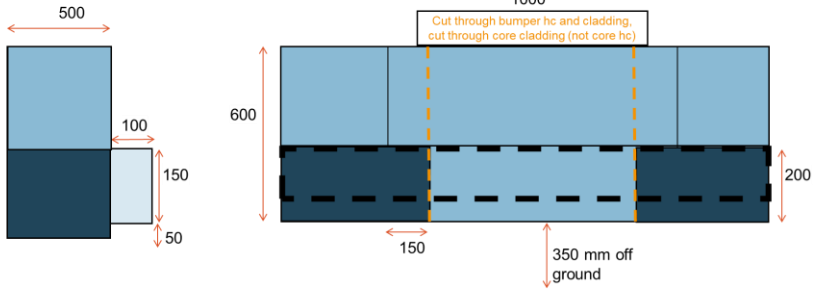


Manufacturing limit for design A: cannot build a variation of this design with a different upper stiffness. Design B proposed as an option that can accommodate different variations in core materials for future revisions

Cellbond B

	kPa
Upper	310
Mid Bottom	310
Bumper	170
Rails	1080





Prototype barriers

Barrier performance compared to study goals

2018 Toyota Camry
struck vehicle

Cellbond A

Cellbond B

Performance compared to goals for new barrier	**Cellbond A**	**Cellbond B**
Vehicle kinematics	✗	✗
Deformation shape	✓	✓
Upper door deformation	✗	✗
Amount of structural deformation (b-pillar)	✓	✓
Injury patterns	✗	✗
No barrier bottoming	✓	✓

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

Fine tuning of barrier prototype

2018 Toyota Camry
struck vehicle

Cellbond B1

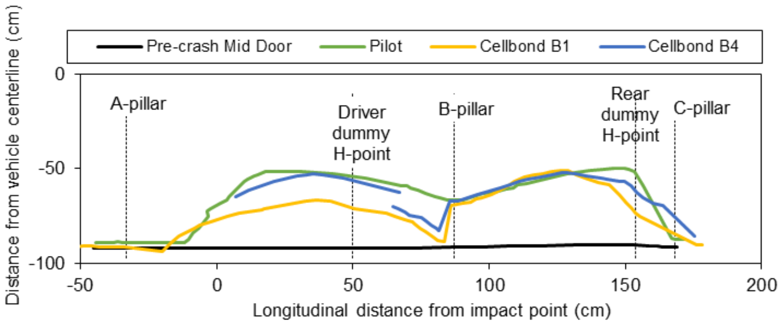
Softer top
45° taper
Bumper stiffness 130 kPa

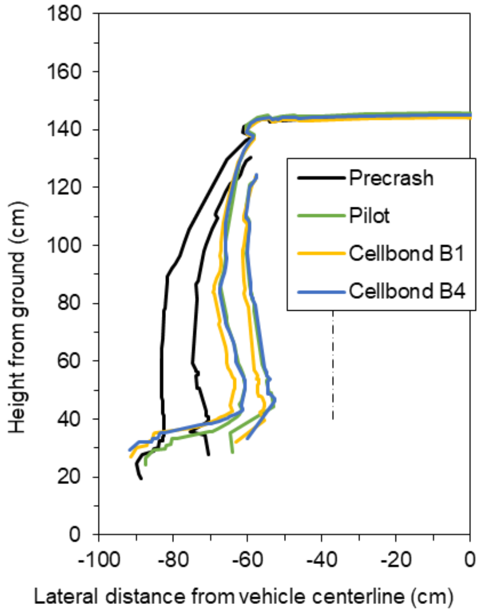
Cellbond B4

Softer top
Original 24° taper
Bumper stiffness 310 kPa

Performance compared to goals for new barrier	Cellbond B1	Cellbond B4
Vehicle kinematics	✓	✓
Deformation shape	✓	✓
Upper door deformation	✓	✓
Amount of structural deformation (b-pillar)	✓	✓
Injury patterns	✓	✓
No barrier bottoming	✓	✓

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

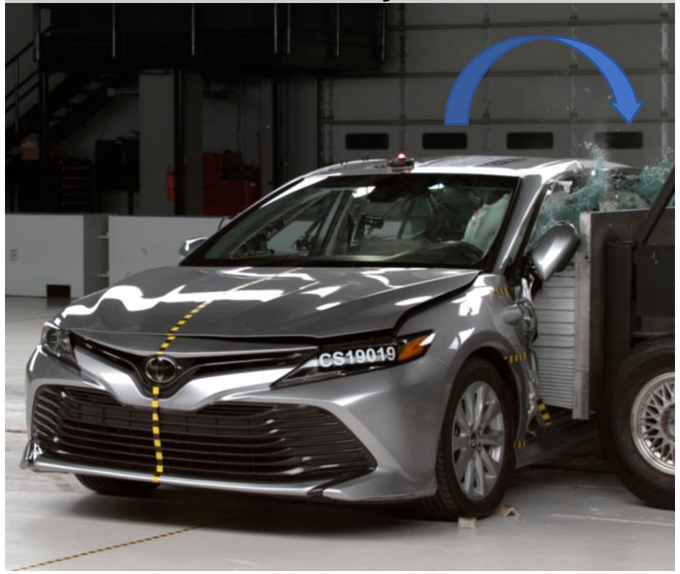
	Full comparison of LTV, IIHS MDB and prototype			Limited comparison of LTV and prototype	
					
Striking vehicle	**Toyota Camry**	**Volkswagen Atlas**	**Honda Accord**	**Kia Forte**	**Honda Civic 2 DR**
Honda Pilot	X	X	X	X	X
Final Prototype	X	X	X	X	X
IIHS MDB	X	X	X		
Ford F150	X	X			

Correlation of performance between LTV-to-vehicle tests and final prototype

Goals to Achieve	Toyota Camry	VW Atlas	Honda Accord	Kia Forte	Honda Civic 2 DR
Vehicle kinematics/roll	✓	✓	✓	✓	✓
Deformation shape and depth at mid door	✓	✓	✓	✓	–
Amount of structural deformation (bpillar)	✓	✓	✓	–	–
Injury patterns	✓	✓	✓	na/✓	✓
No barrier bottoming	✓	✓	✓	✓	✓

Vehicle motion with final prototype barrier

Camry



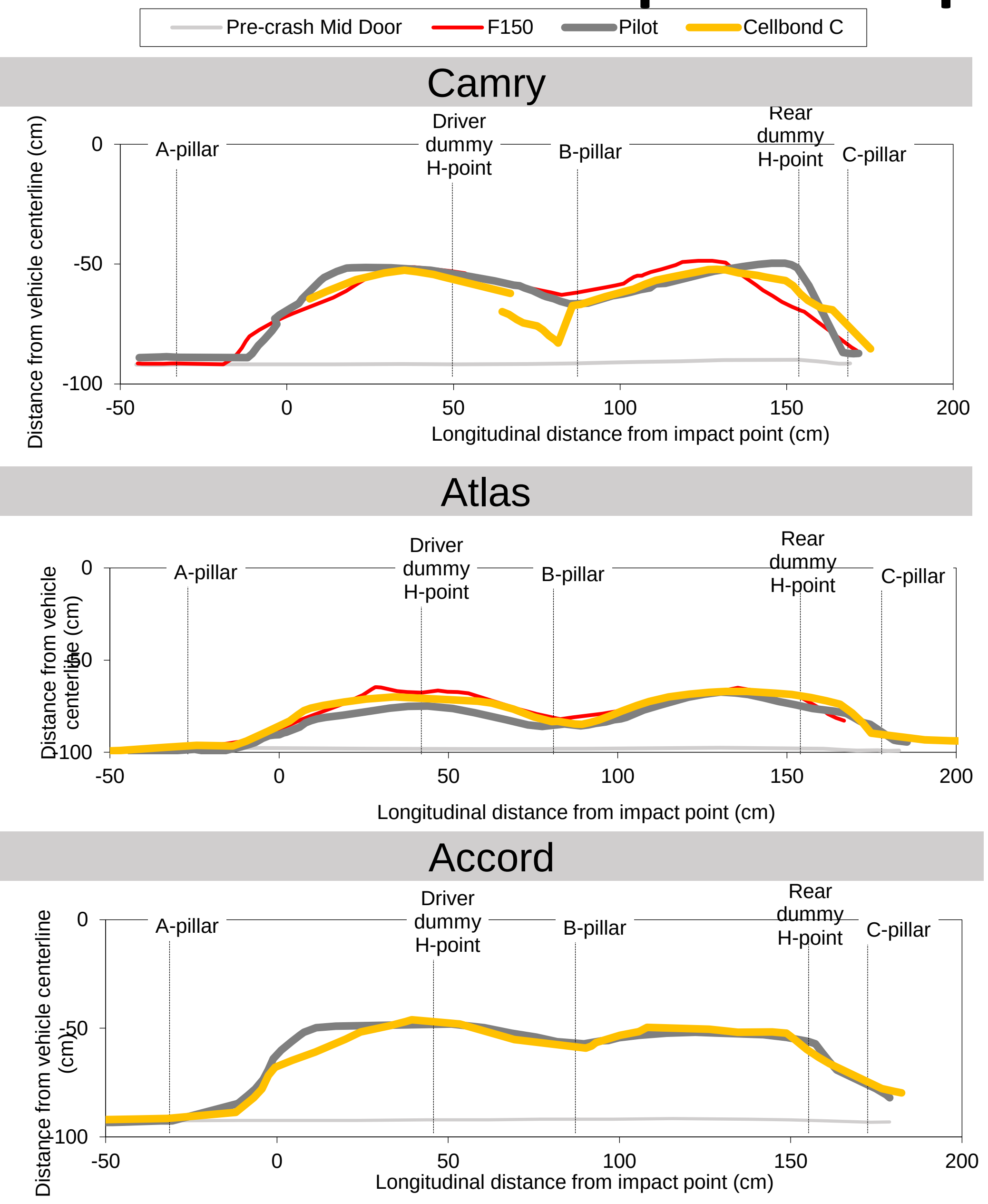
Atlas

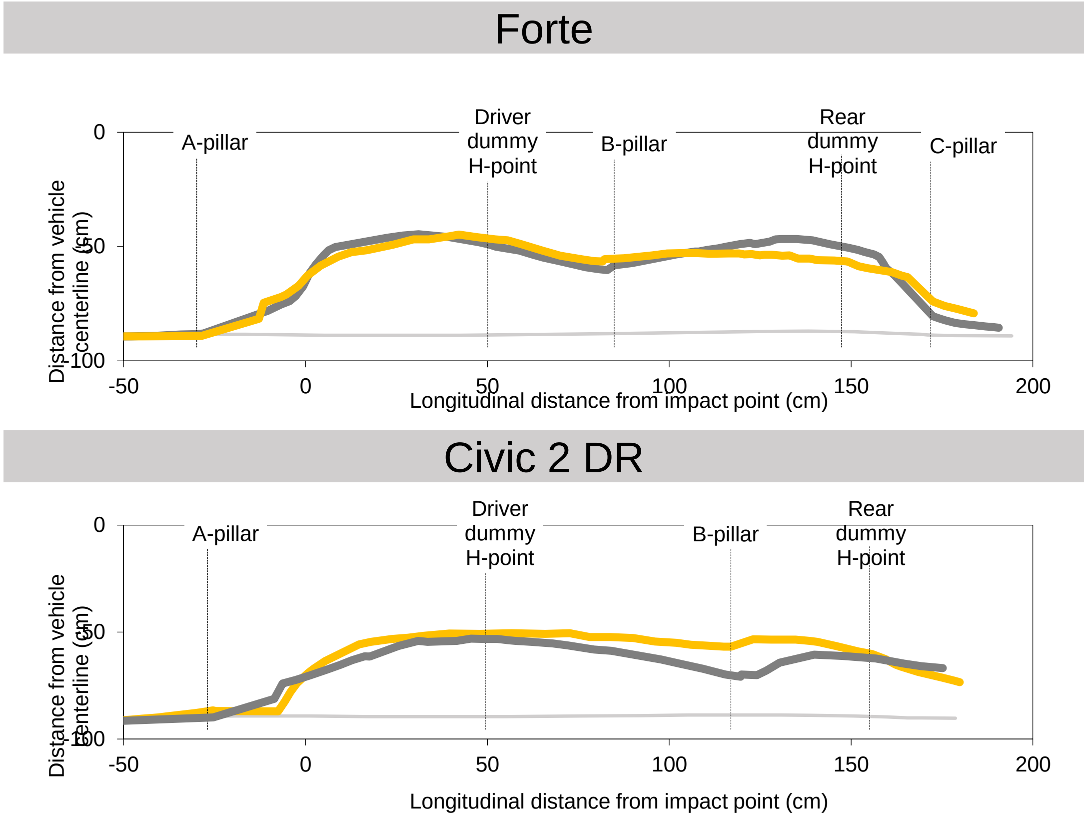
Accord

Forte

Civic 2 DR

Deformation shape and depth at mid door with final prototype barrier





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

	Toyota Camry			VW Atlas			Honda Accord			Kia Forte		Honda Civic 2DR	
	V-2-V	IIHS barrier	Final Prototype	V-2-V	IIHS barrier	Final Prototype	V-2-V	IIHS barrier	Final Prototype	V-2-V	Final Prototype	V-2-V	Final Prototype
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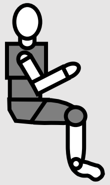
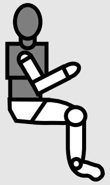
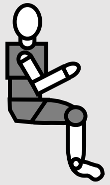
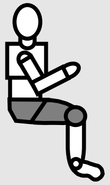
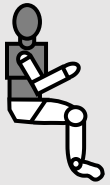
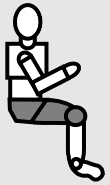
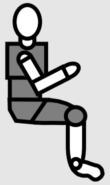
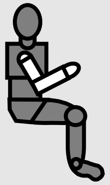
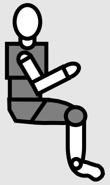
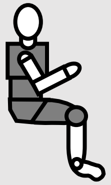
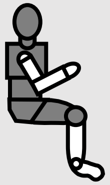
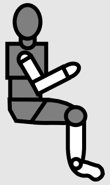
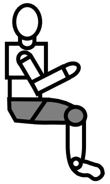
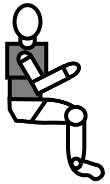
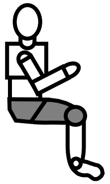
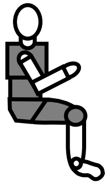
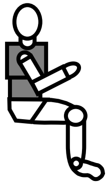
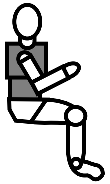
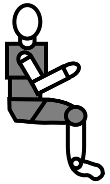
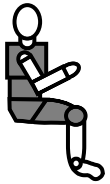
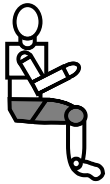
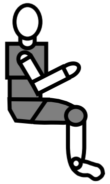
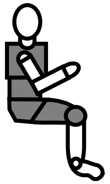
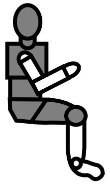
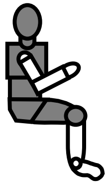
Driver											data lost		
Rear Passenger													

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

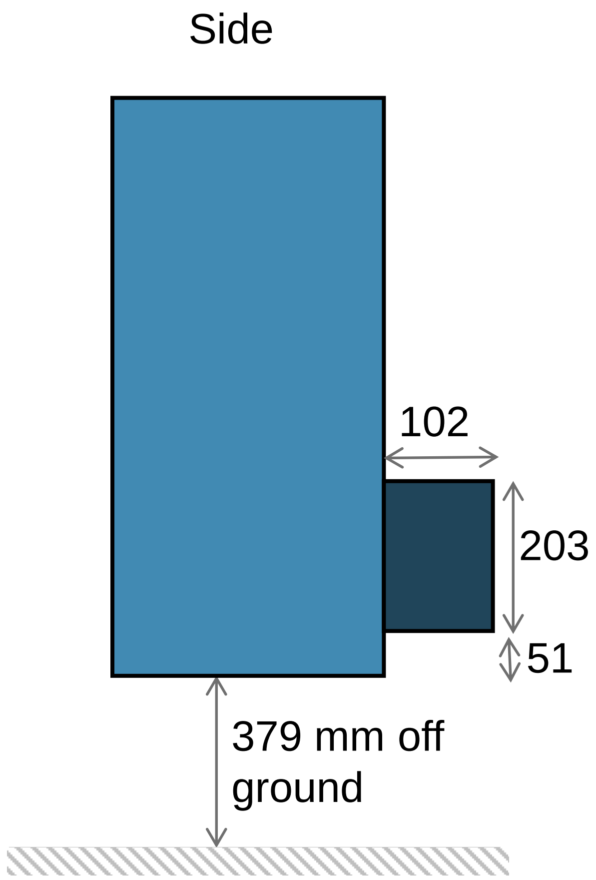
IIHS HLDI

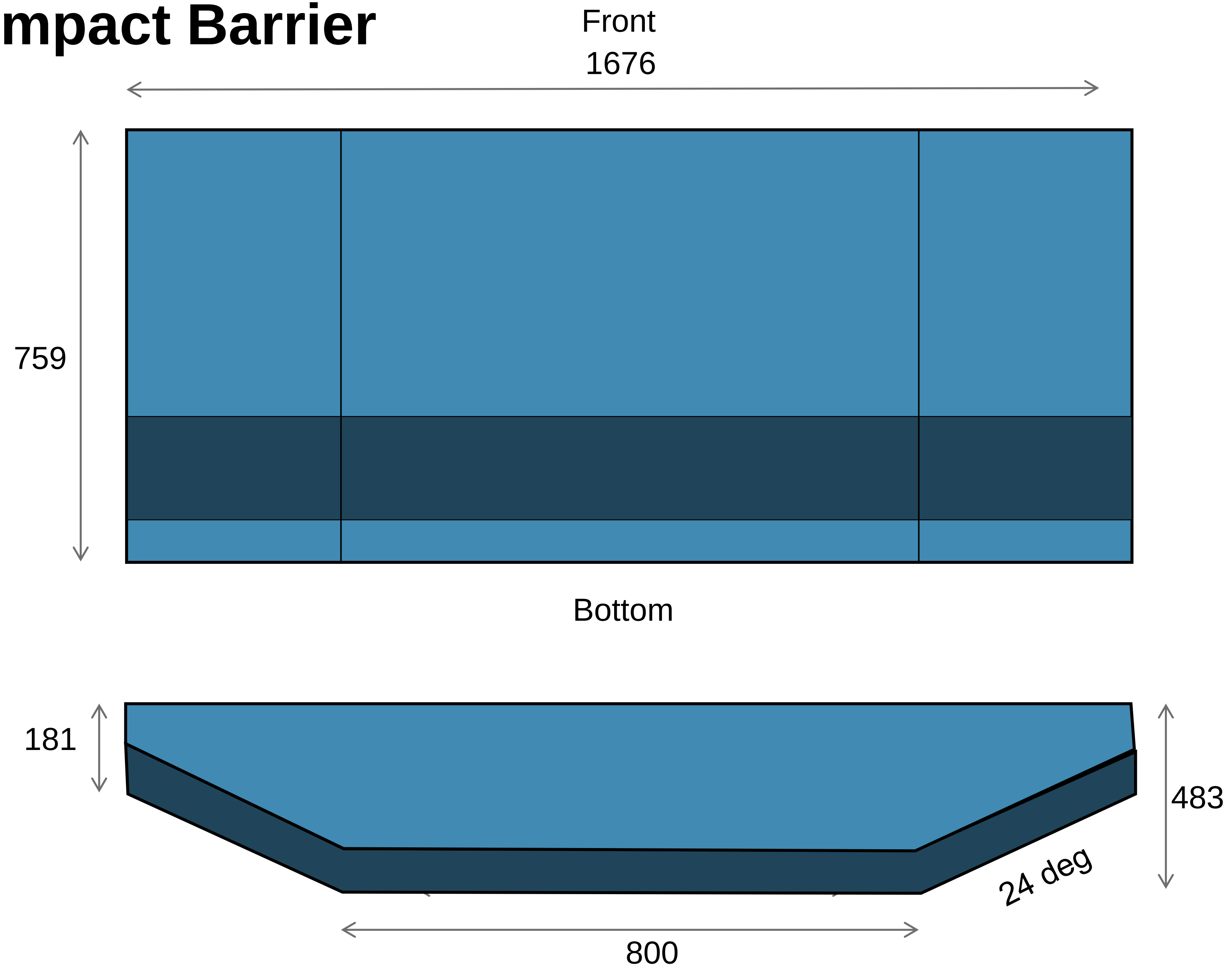
Summary of Side Impact Barrier 2.0 Technical Specifications

IIHS Side Impact Barrier (Original) 2003-2021

IIHS Side Impact Barrier 2.0   2022-

Current IIHS Side Impact Barrier

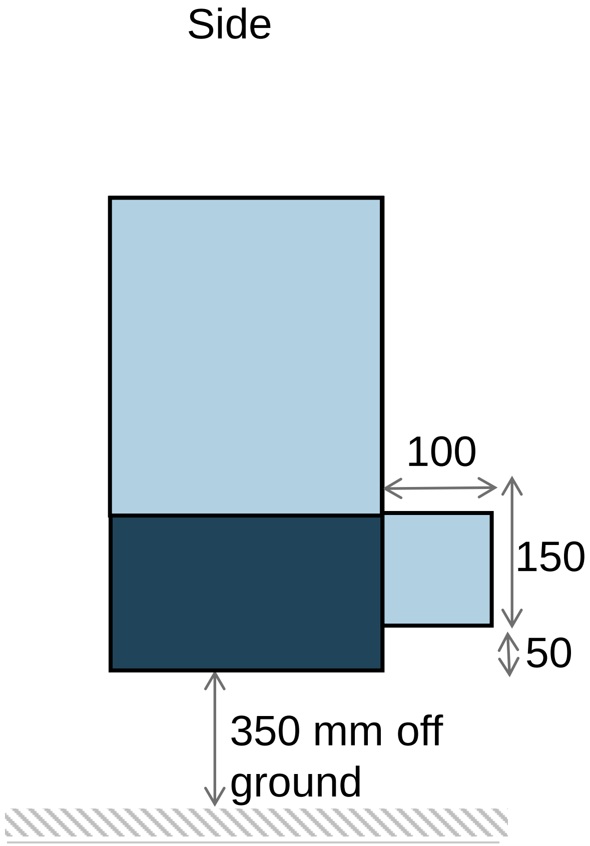


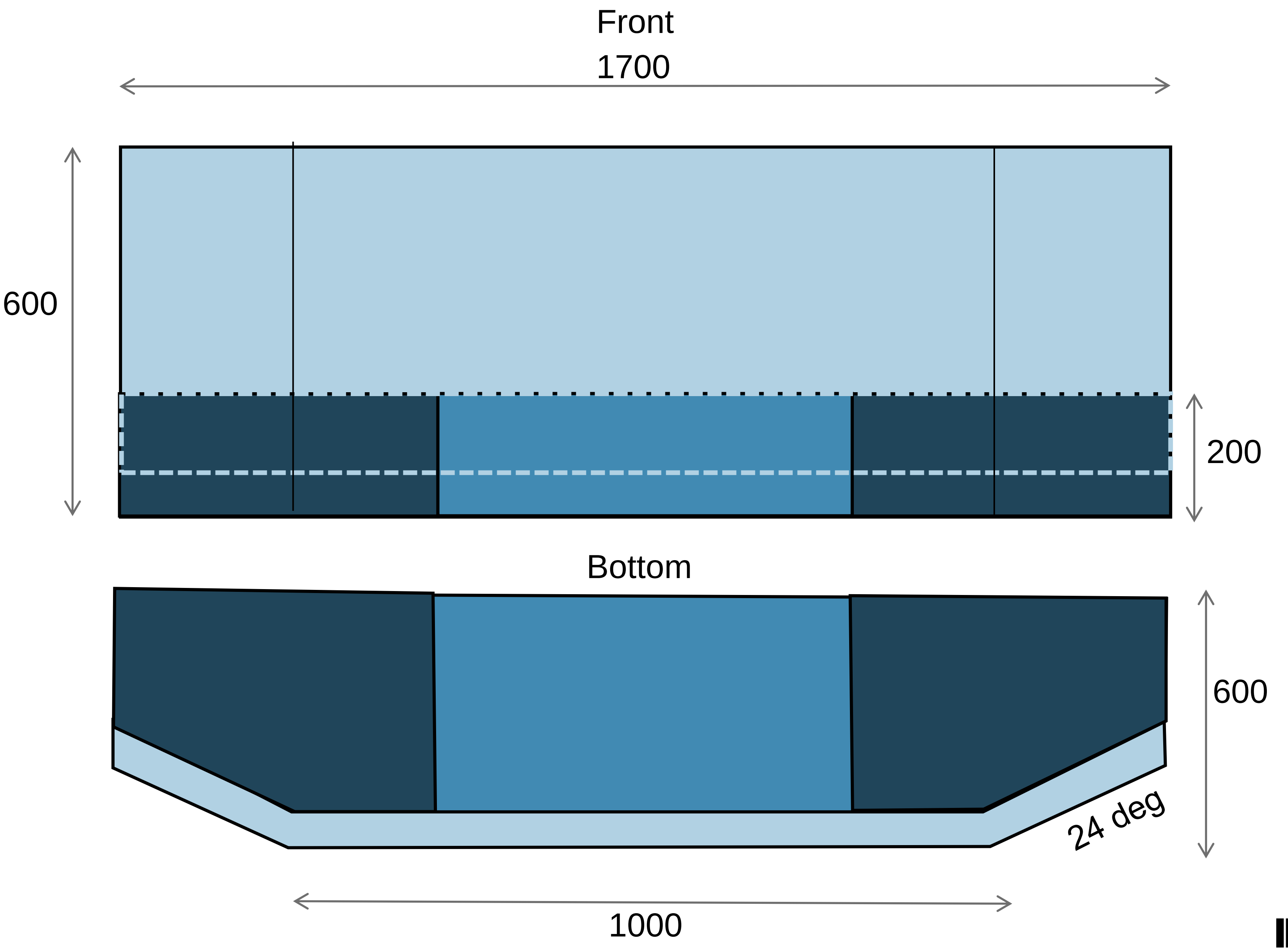


Drawing not to scale

	kPa
Mid Bottom	310
Bumper	1690

IIHS side impact barrier 2.0

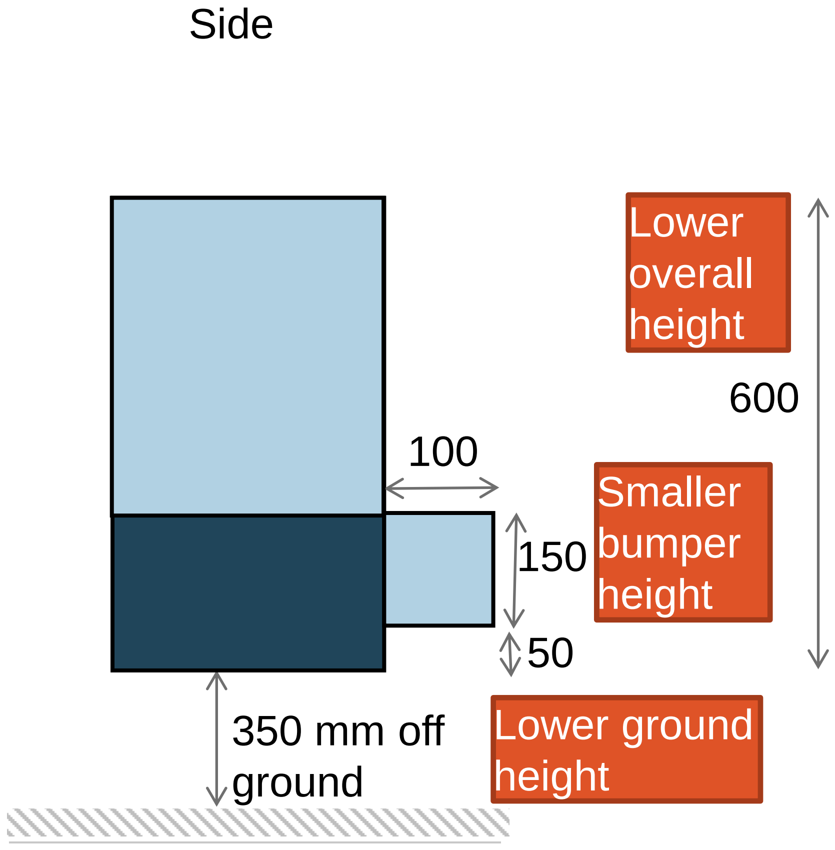


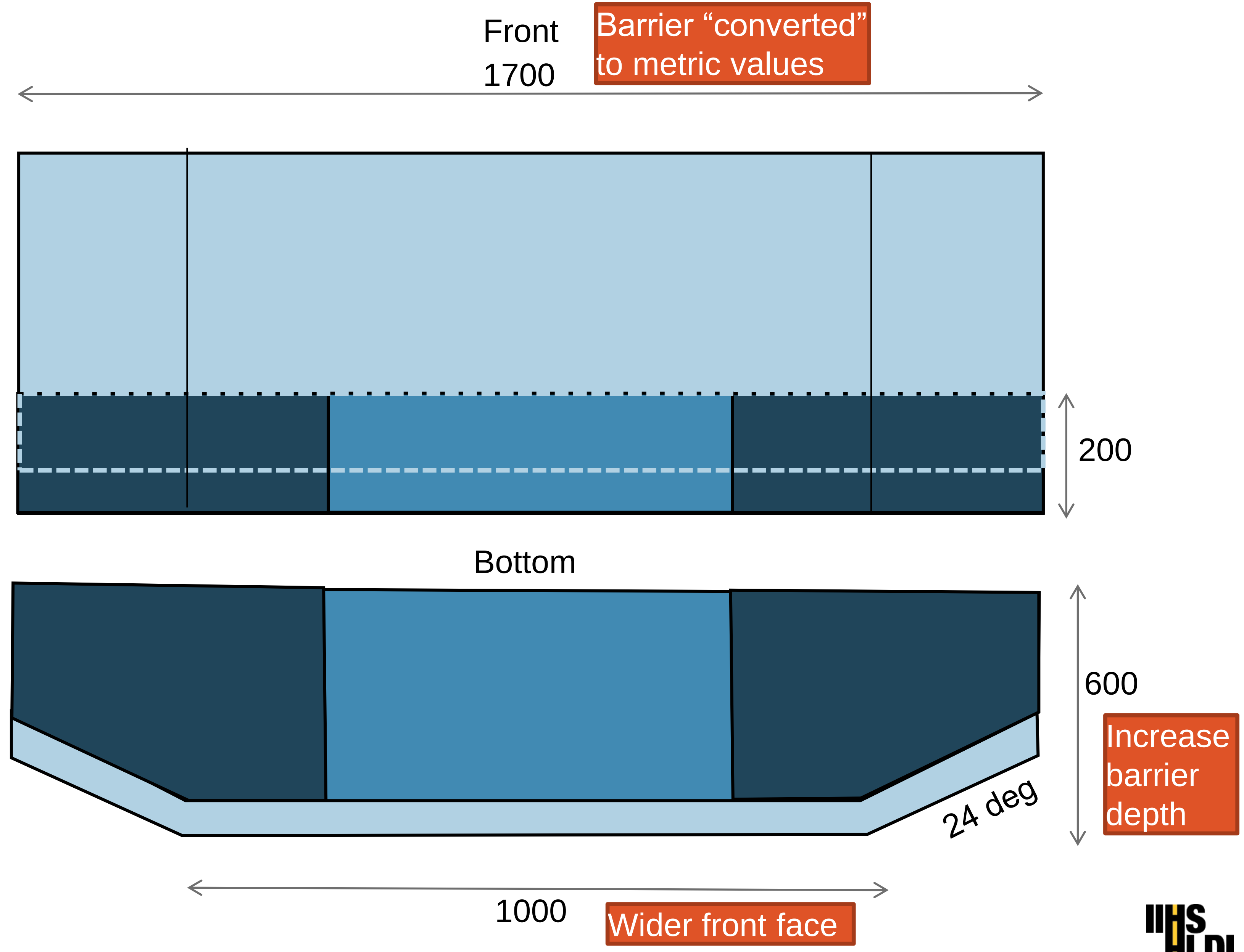


Drawing not to scale

	kPa
Upper	140
Mid Bottom	325
Bumper	325
Rails	1100

IIHS side impact barrier 2.0





Drawing not to scale

	kPa
Upper	140
Mid Bottom	325
Bumper	325
Rails	1100

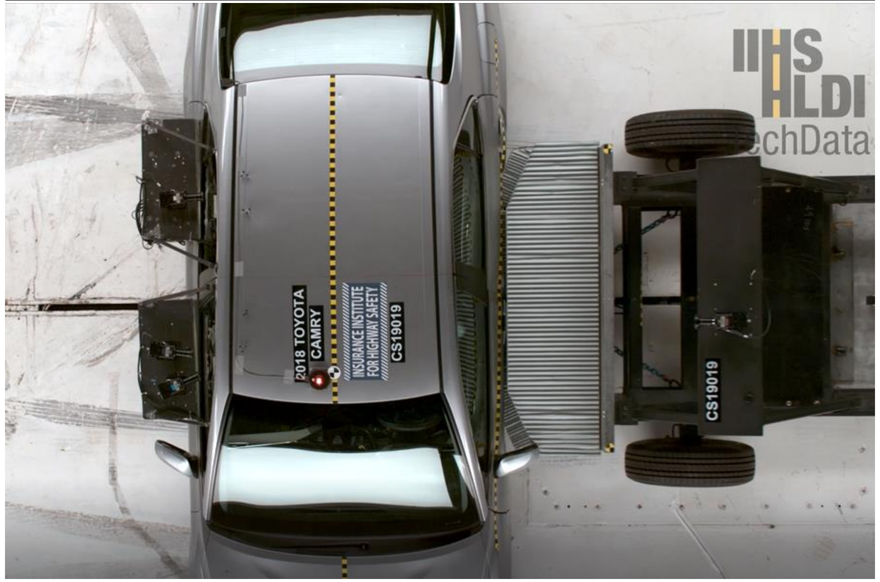
Changes in stiffness to components

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

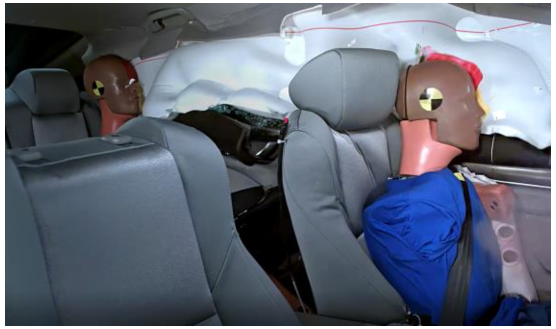
60 km/h perpendicular impact



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

Vehicle Ratings

- **G** ood
- **A** cceptable
- **M** arginal
- **P** oor



Vehicle ratings based on dummy injury measures, restraints/dummy kinematics and structural performance

Insurance Institute for Highway Safety
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