Competitive Designs With Tailor Rolled Products

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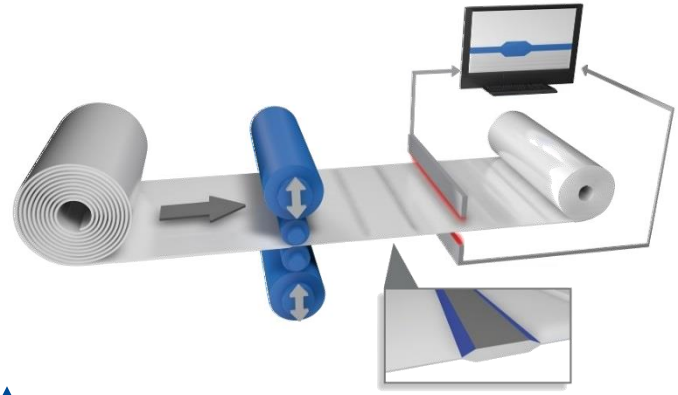
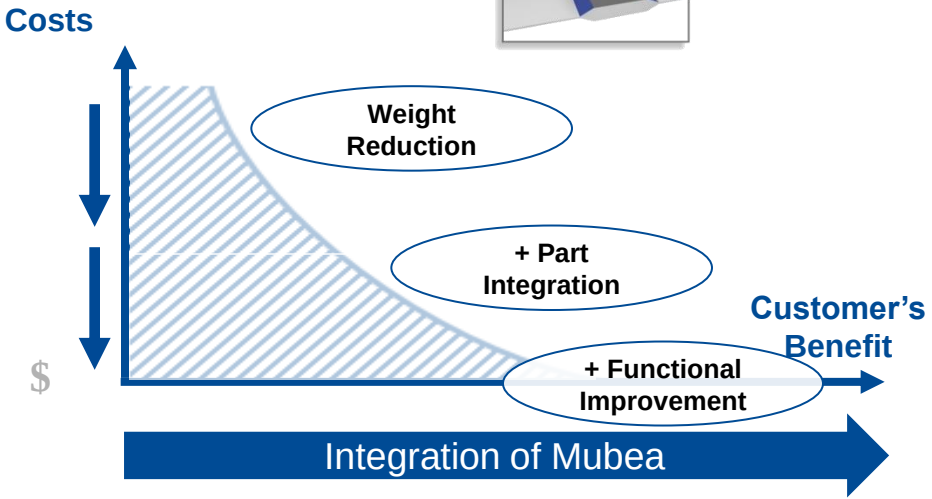
Mubea, Inc.

TRB Principle





Idea

- Lightweight parts with load and function-optimized material usage

Implementation

- Flexible Cold-Rolling Process
- Flat material with repeated, varying thickness runs and harmonious transition zones
- An increased number of thickness zones for an optimized TRB solution results in minimal lightweight cost

Targets / Benefits

- Weight reduction
- Part integration
- Functional Improvement

GDIS 2017 => GDIS 2018

Mubea B-Pillar Slim Foot Design

- Weight reduction of up to 17%
- For parallel nesting and increased material utilization
- Independent thickness run without symmetry conditions
- No spot welds at the high deformation area
- In serial production soon

Mubea Potential Analysis TRB® Rear Rail

- Harmonic load distribution due to transition zones
- Reduced production and assembly costs by part integration
- 10 % weight reduction + 1 part integration with TRB® I
- 21 % weight reduction + 3 part integration with TRB® II

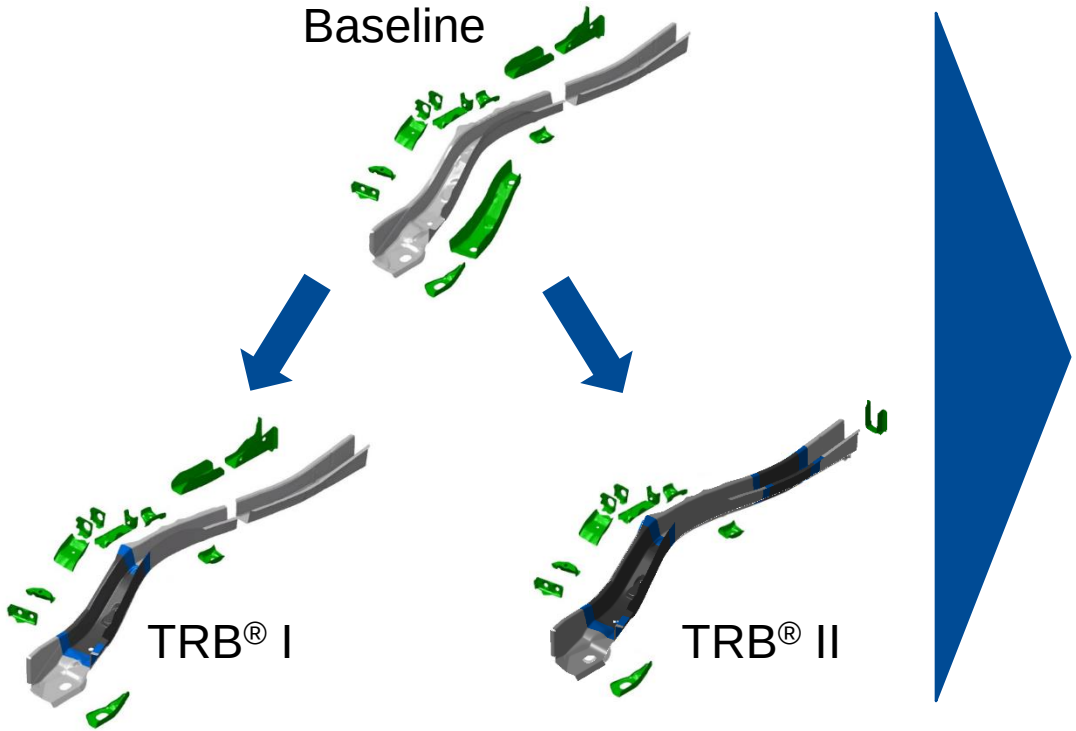
Update TRB® Rear Rail

- Detailed Investigation
  - Feasibility / Forming
  - Light Weight Cost

Potential Analysis TRB® Front Rail

- NCAP Full Frontal
- ODB 40% Offset

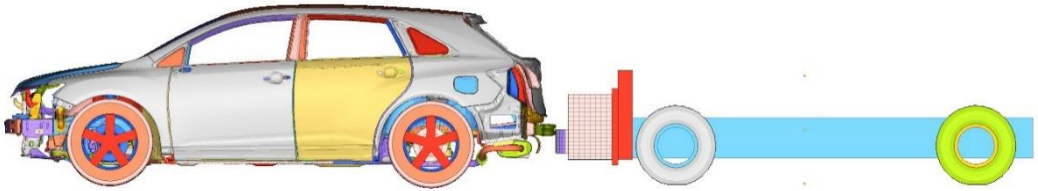
Potential Analysis TRB® Rear Rail



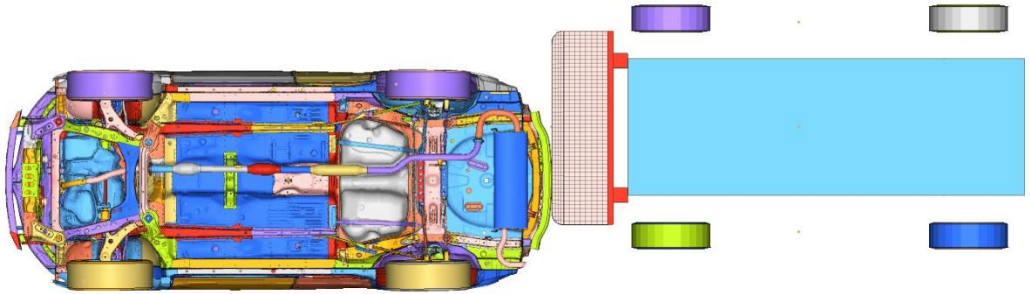
Potential TRB® Rear Rail Design

- Simulation with generic vehicle
  - FMVSS 301 Rear Crash
  - Understructure deformation
  - Plastic strain at Fuel Tank
  - Door opening
  - Stiffness comparison

FMVSS 301 Rear Crash



Side View

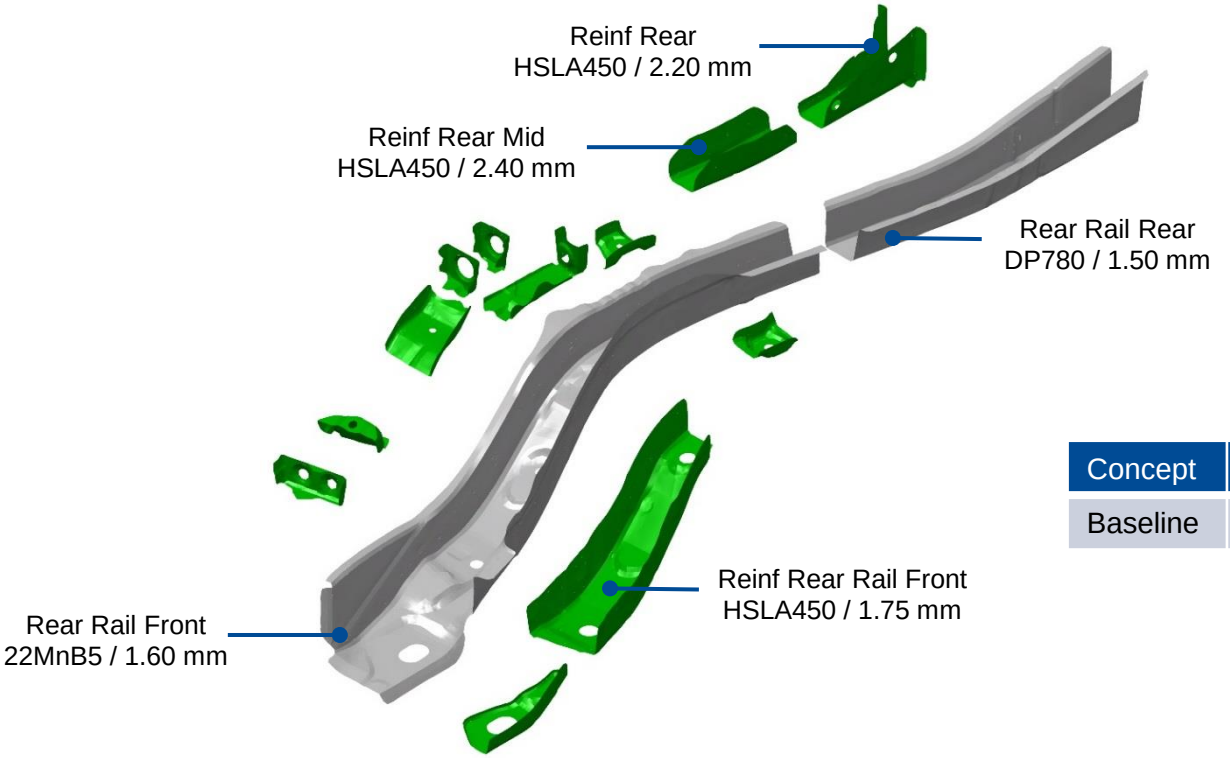


Bottom View

CAE model setup

- Rear moving barrier
- Barrier weight: 3,016 lbs
- Barrier velocity: 50 mph
- Overlap: 70 %

Rear Rail Baseline

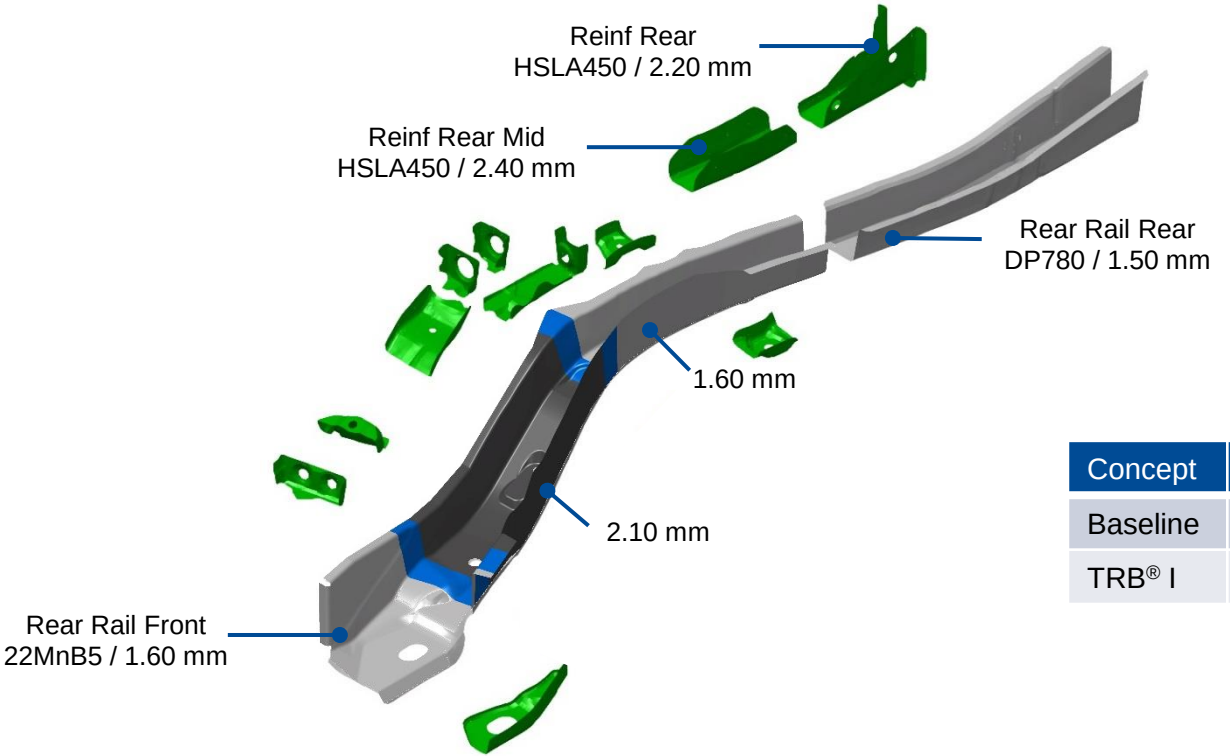


Rear Rail Assembly

- 2 parts for the rail
- 3 major reinforcements
- 9 small reinforcements + bulkheads

Concept	Total Weight	Weight reduction	Change
Baseline	7.27 kg	-	-

Rear Rail TRB® I



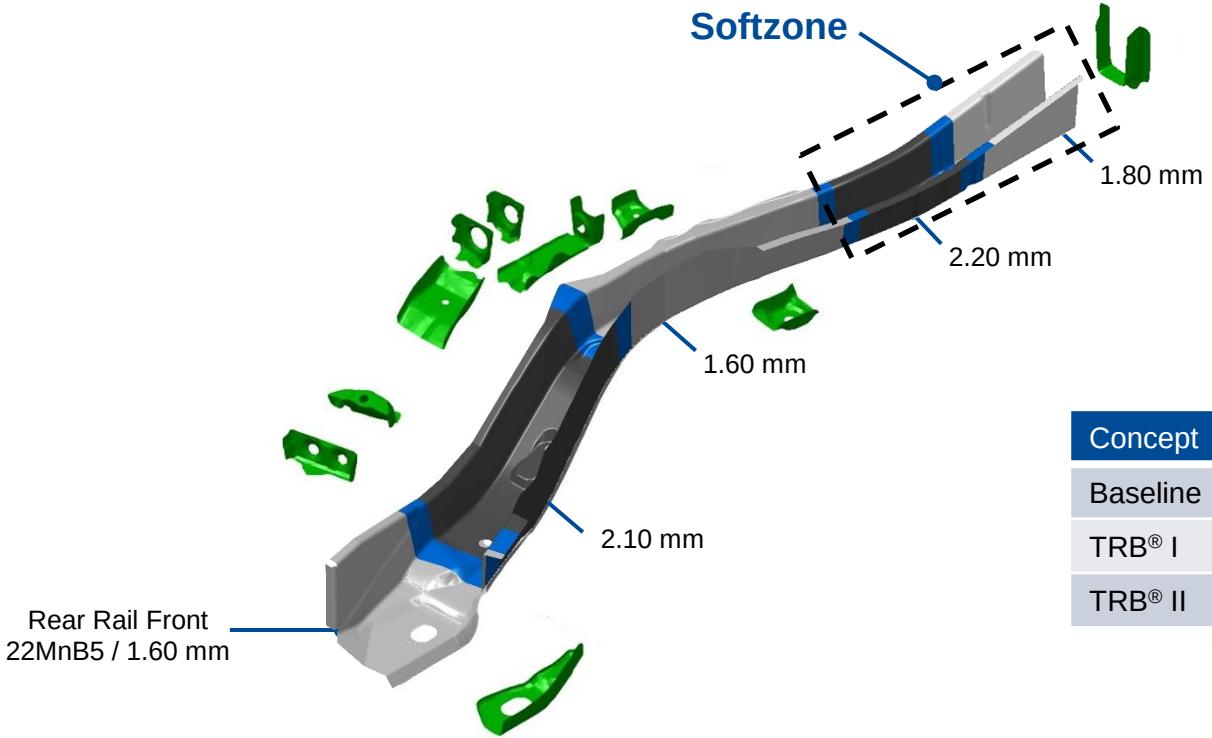
Rear Rail Assembly

- 2 parts for the rail
- 2 major reinforcements
- 9 small reinforcements + bulkheads

Concept	Total Weight	Weight reduction	Change
Baseline	7.27 kg	-	-
TRB® I	6.55 kg	0.72 kg	10 %

Weight reduction: 1.44 kg / veh

Rear Rail TRB® II



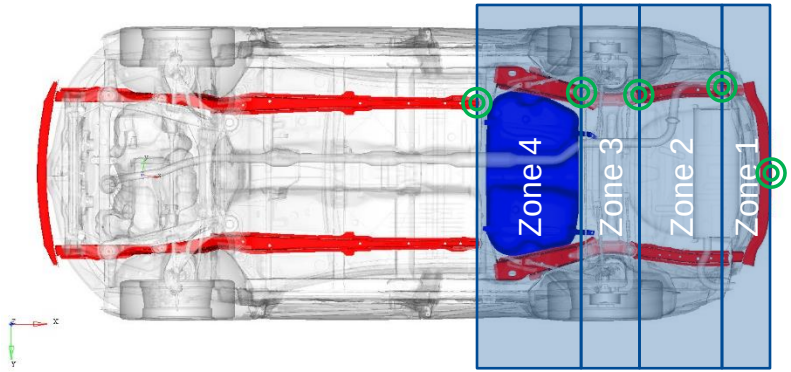
Rear Rail Assembly

- 1 part for the rail + Softzone
- 2 reinforcements integrated
- 10 small reinforcements + bulkheads

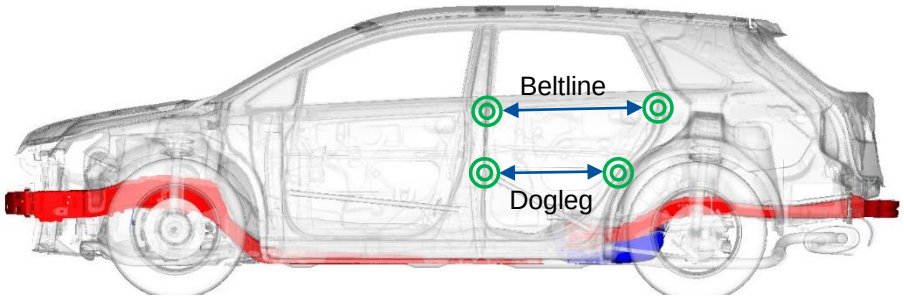
Concept	Total Weight	Weight reduction	Change
Baseline	7.27 kg	-	-
TRB® I	6.55 kg	0.72 kg	10 %
TRB® II	5.72 kg	1.55 kg	21.3 %

Weight reduction: 3.10 kg / veh

Rear Rail TRB® FMVSS 301 Rear Crash Result



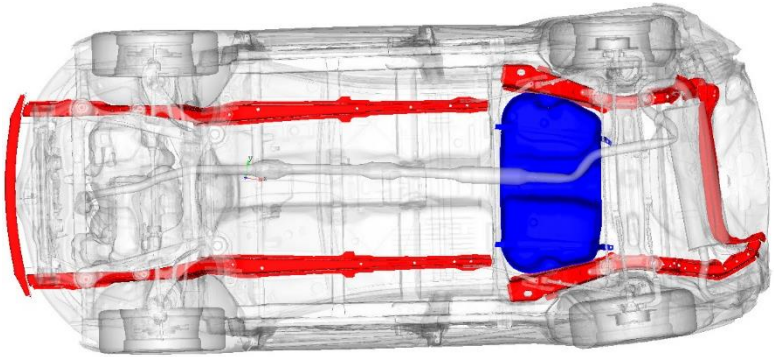
Bottom View



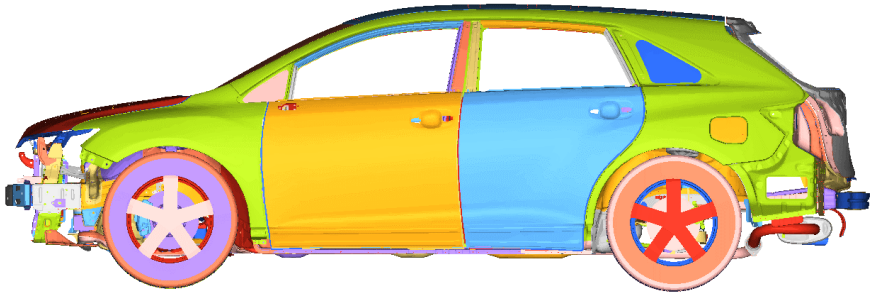
Side View

	Under Structure Zone Deformation [mm]				Door Opening [mm]	
Concept	Zone 1	Zone 2	Zone 3	Zone 4	Beltline	Dogleg
Baseline	50.0	325.8	3.2	6.4	23.9	20.0
TRB® I	42.7	325.8	3.1	6.1	23.3	19.2
TRB® II	51.0	336.9	1.7	6.8	23.4	17.8

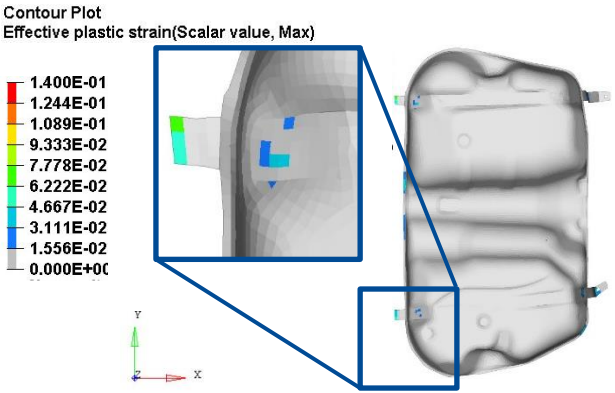
Rear Rail TRB® FMVSS 301 Rear Crash Result



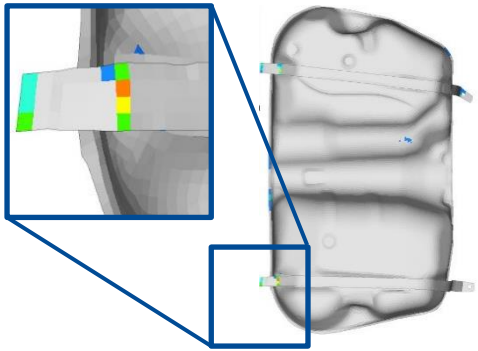
Bottom View



Side View



Top View



Bottom View

Concept	Max. Plastic Strain	
	Fuel Tank	Strap
Baseline	5.8 %	13.3 %
TRB® I	5.9 %	13.3 %
TRB® II	6.6 %	12.3 %

Rear Rail TRB® I & TRB® II Stiffness

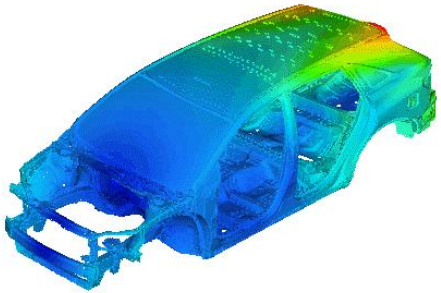
Global Stiffness Analysis

Analysis	Baseline	TRB® I	TRB® II	Change
Global Torsion Stiffness (KN-m/Deg)	22.12	22.13	22.12	0%
Global Bending Stiffness (KN/mm)	9.76	9.77	9.77	0%

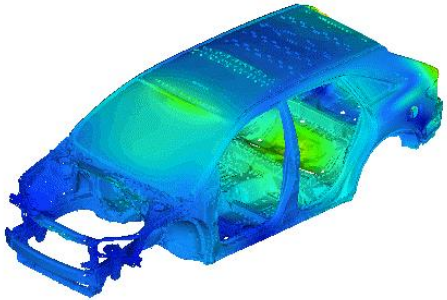
Normal Mode Analysis

Analysis	Baseline	TRB® I	TRB® II	Change
Torsion Mode (Hz)	32.47	32.53	32.63	0%
Frontal Lateral Bending Mode (Hz)	34.28	34.28	34.30	0%
Overall Bending Mode (Hz)	42.33	42.45	42.62	+1%

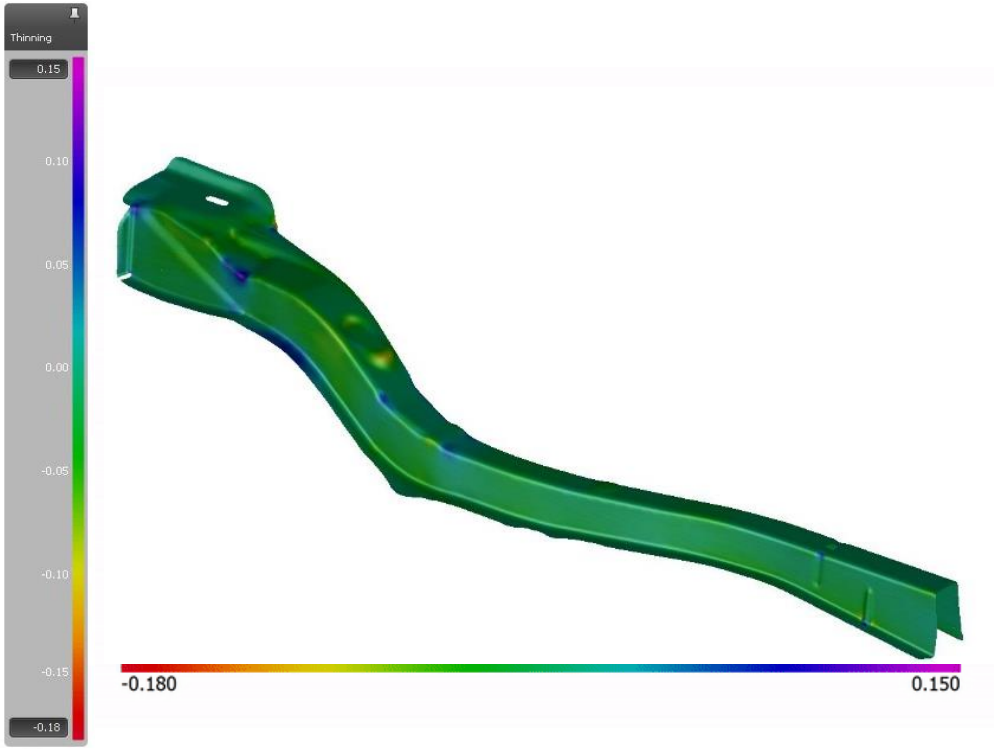
Torsion Mode

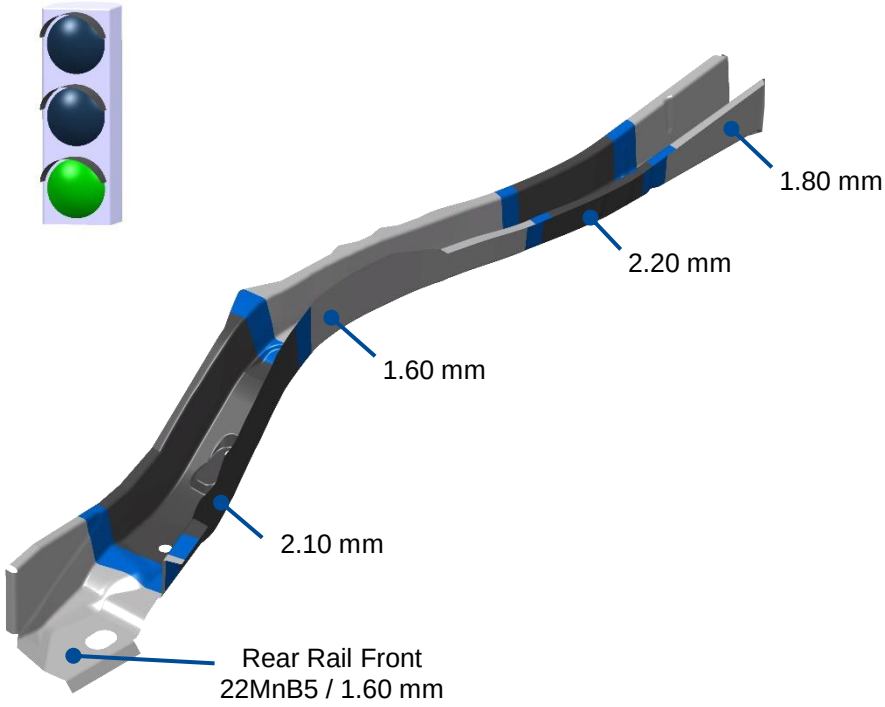


Bending Mode



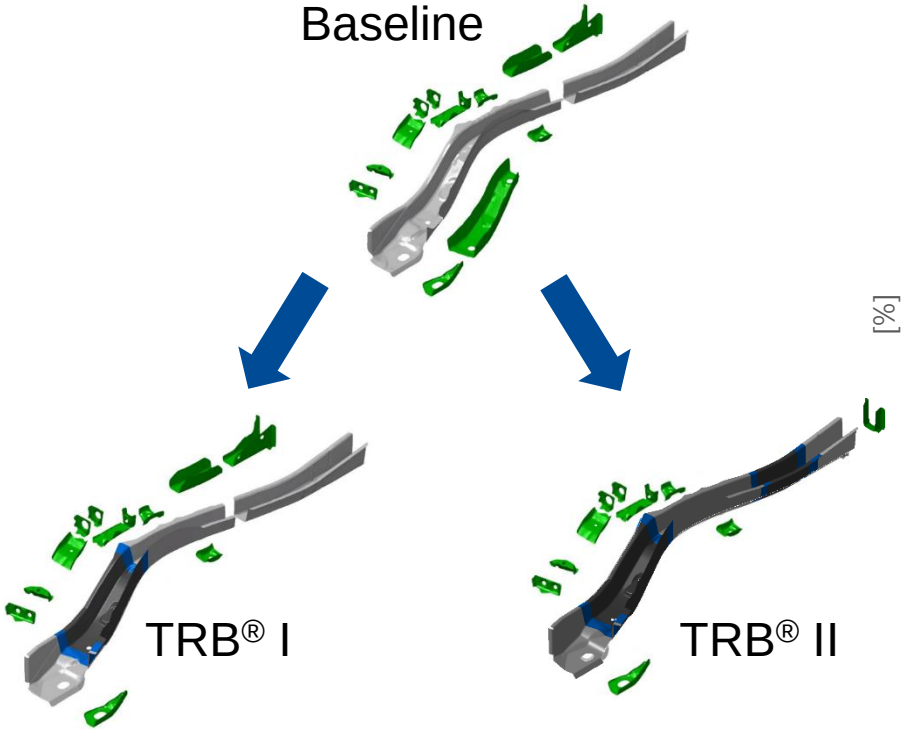
Rear Rail TRB® II Forming Simulation





Part feasibility with max. thinning of 16 %

Rear Rail TRB® Lightweight Cost



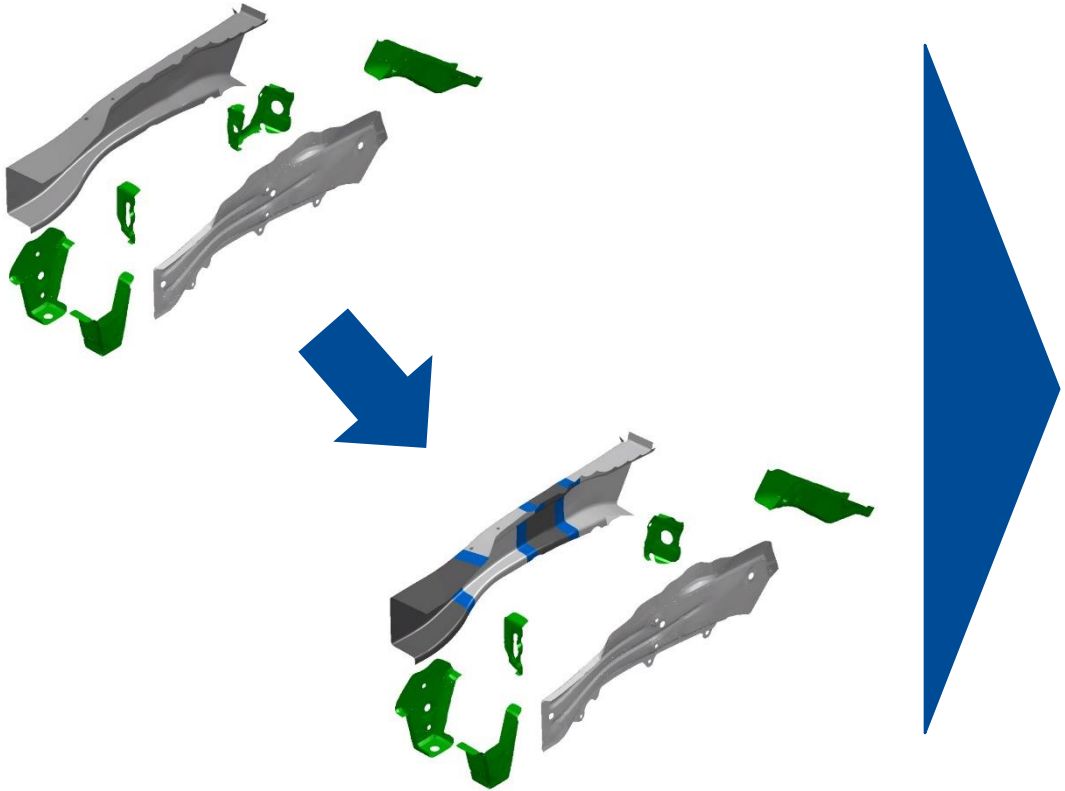
Lightweight cost => TRB® I: $ 1.97/kg ; TRB® II: $ 1.72/kg

Summary Potential Analysis TRB® Rear Rail

- ***Harmonic load distribution due to transition zones***
- ***Optimal thickness distribution along the part to improve Crash and Stiffness***
- ***Attractive Lightweight Cost due to weight reduction and part integration***

	Weight reduction	Part integration	Lightweight Cost
TRB® I	10 % (1.4 kg/veh)	1 Part	$ 1.97 /kg
TRB® II	21 % (3.1 kg/veh)	2 Parts	$ 1.72 /kg

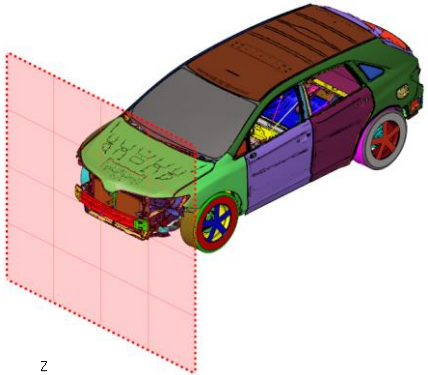
Potential Analysis TRB® Front Rail

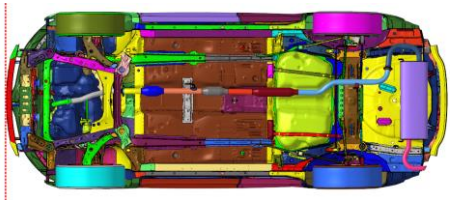


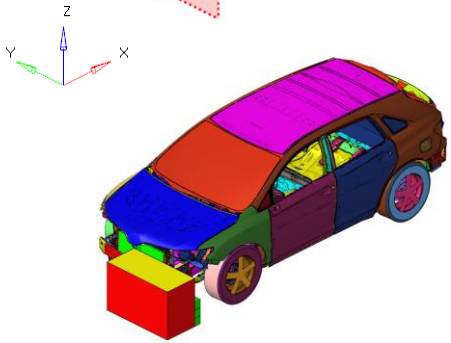
Potential TRB® Front Rail Design

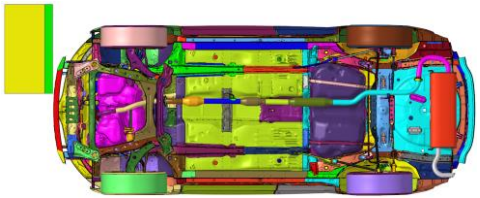
- Simulation with generic vehicle
  - NCAP Full Frontal
  - ODB 40 % Offset

Load Cases TRB® Front Rail Study









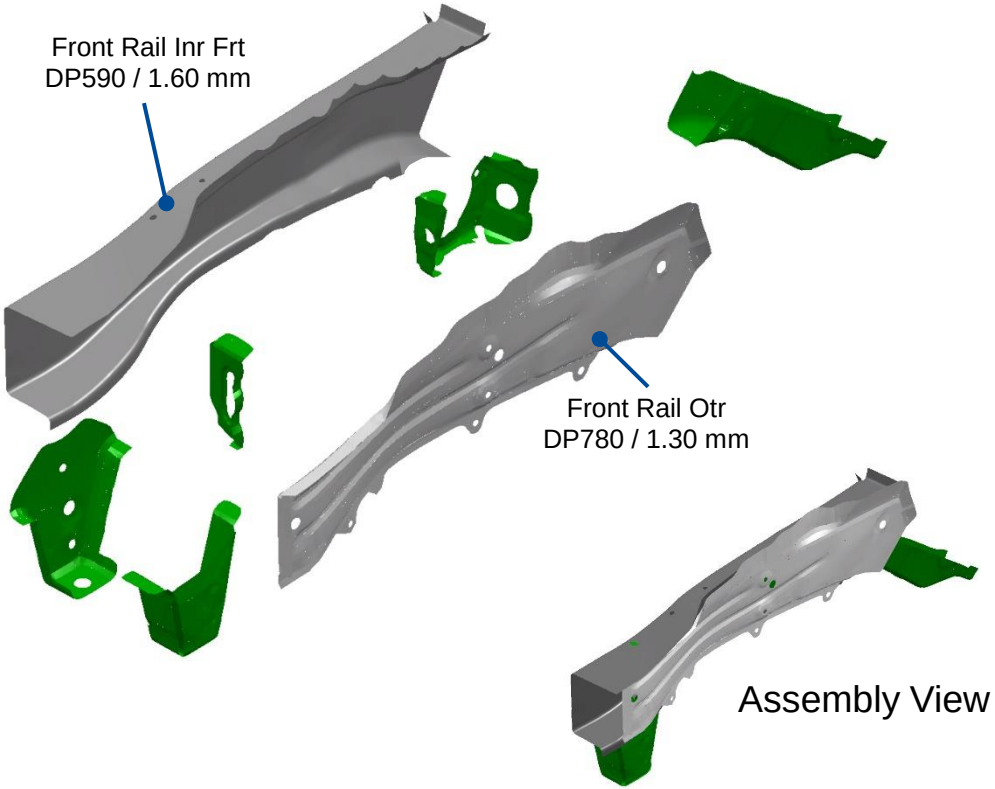
Isometric View

Bottom View

CAE model setup

- Curb weight: 4,000 lbs
- NCAP Full Frontal
  - Rigid barrier
  - Vehicle velocity: 35 mph
  - Overlap: 100 %
- ODB 40 % Offset
  - Deformable barrier
  - Vehicle velocity: 40 mph
  - Overlap: 40 %

Front Rail Baseline

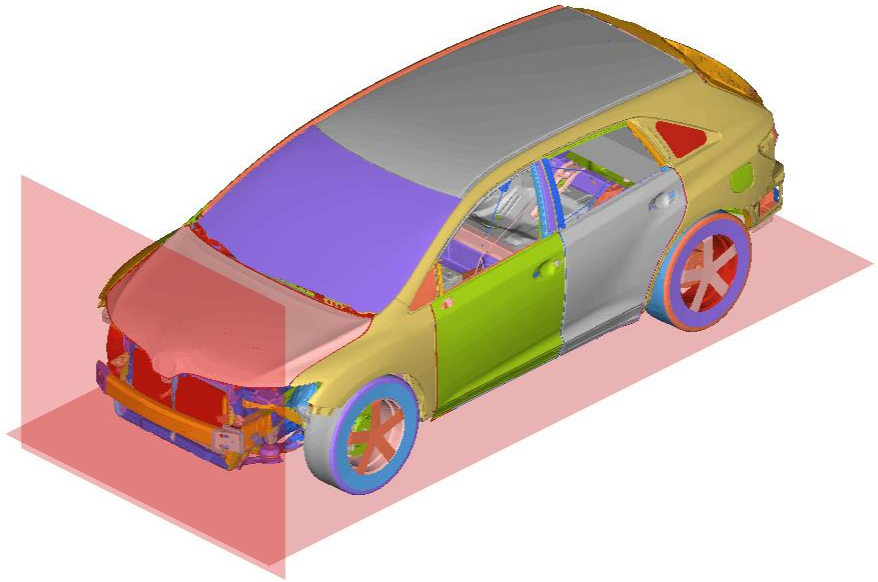


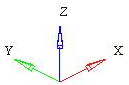
Front Rail Assembly

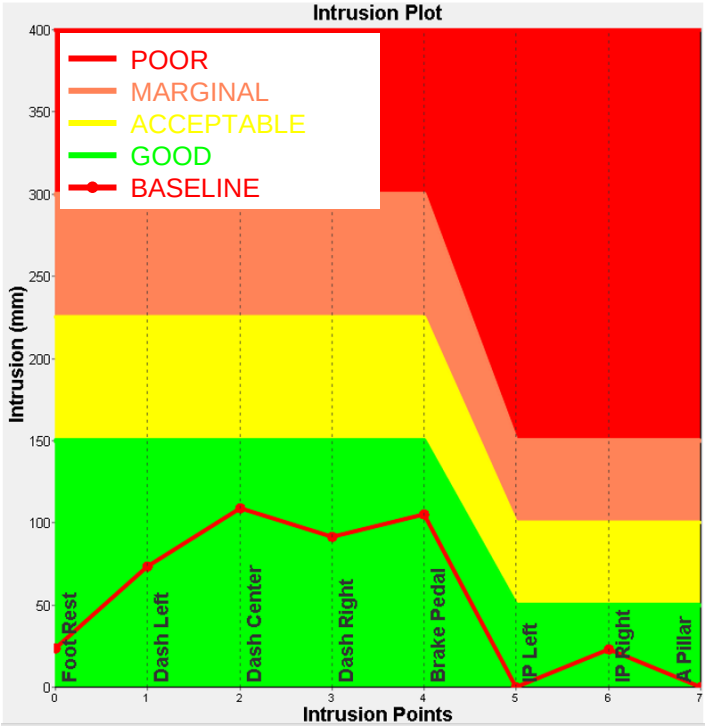
- 2 parts for the rail
- 3 major reinforcements
- 2 small reinforcements + bulkheads

Concept	Total Weight	Weight reduction	Change
Baseline	5.70 kg	-	-

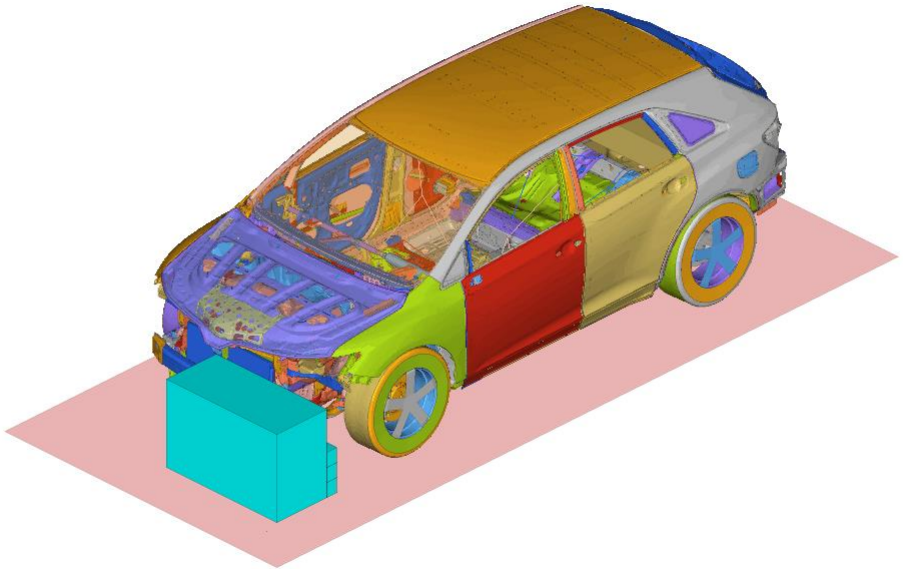
NCAP Full Frontal Baseline Result

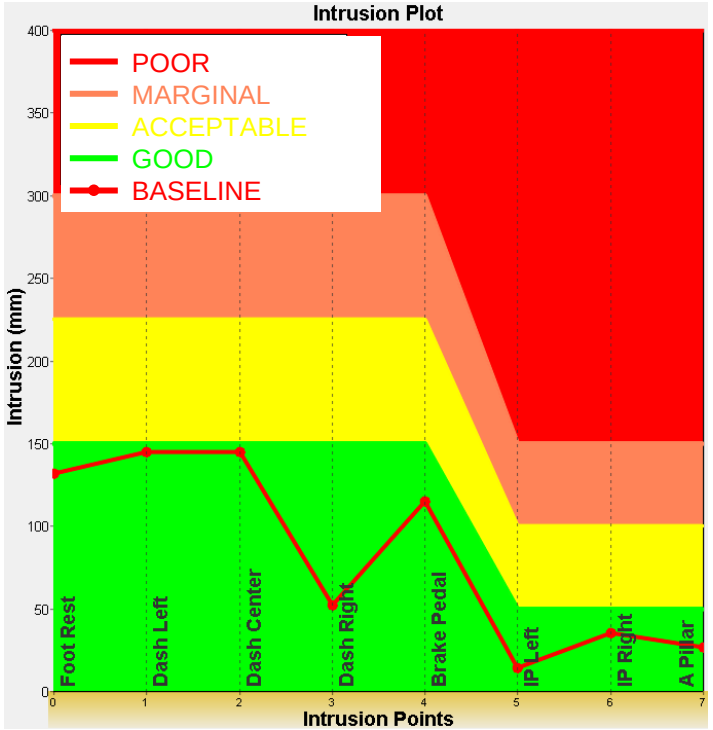




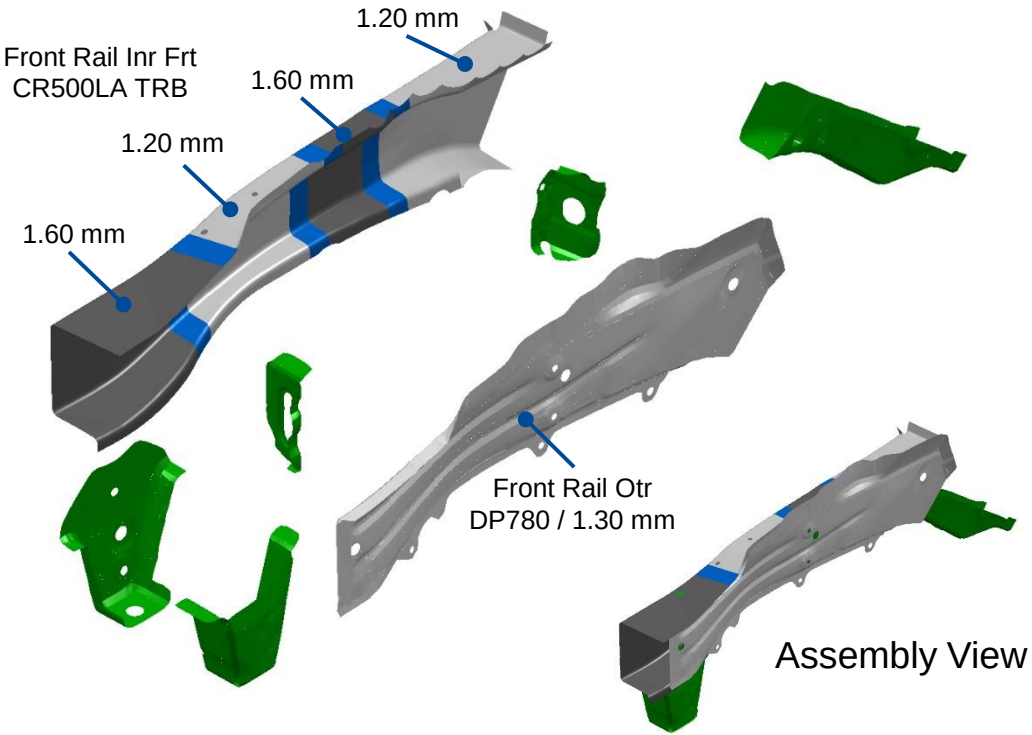


ODB 40 % Offset Baseline Result





Front Rail TRB®



Assembly View

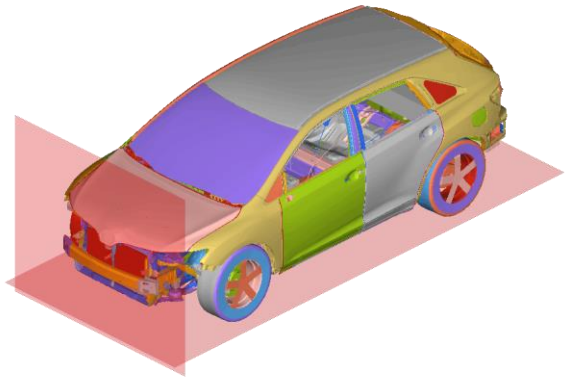
Front Rail Assembly

- 2 parts for the rail
- 3 major reinforcements
- 2 small reinforcements + bulkheads

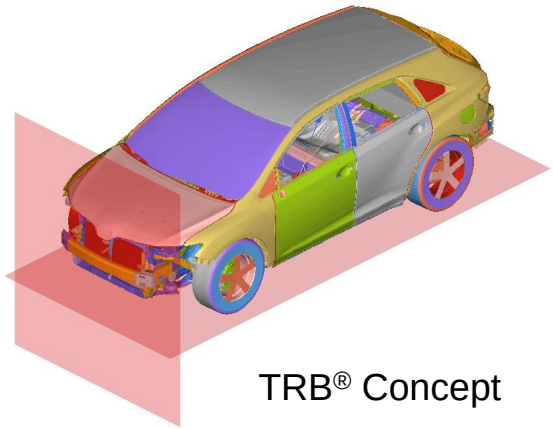
Concept	Total Weight	Weight reduction	Change
Baseline	5.70 kg	-	-
TRB®	5.20 kg	0.5 kg	9 %

Weight reduction: 1 kg / veh

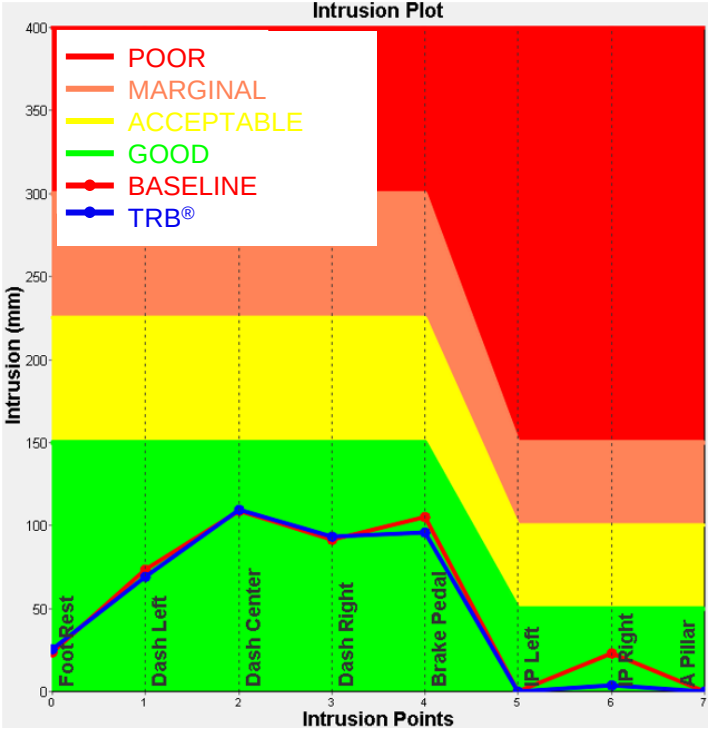
NCAP Full Frontal TRB® Result



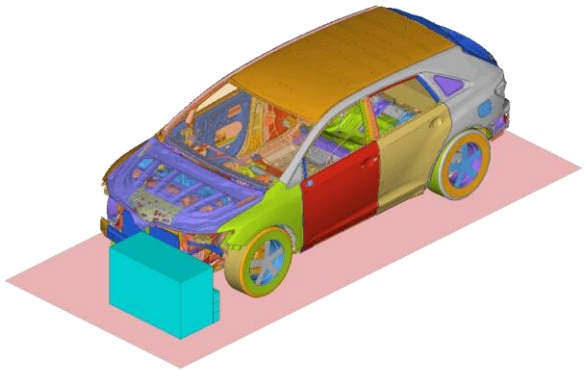
Baseline



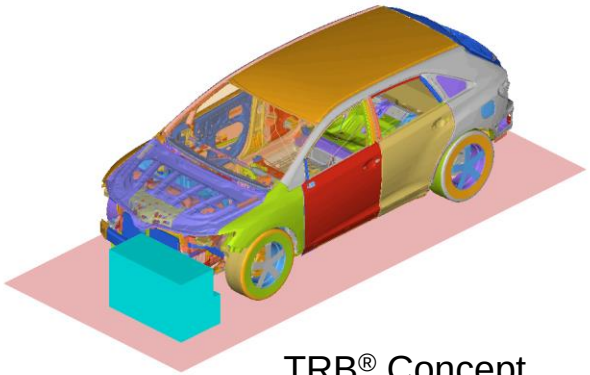
TRB® Concept



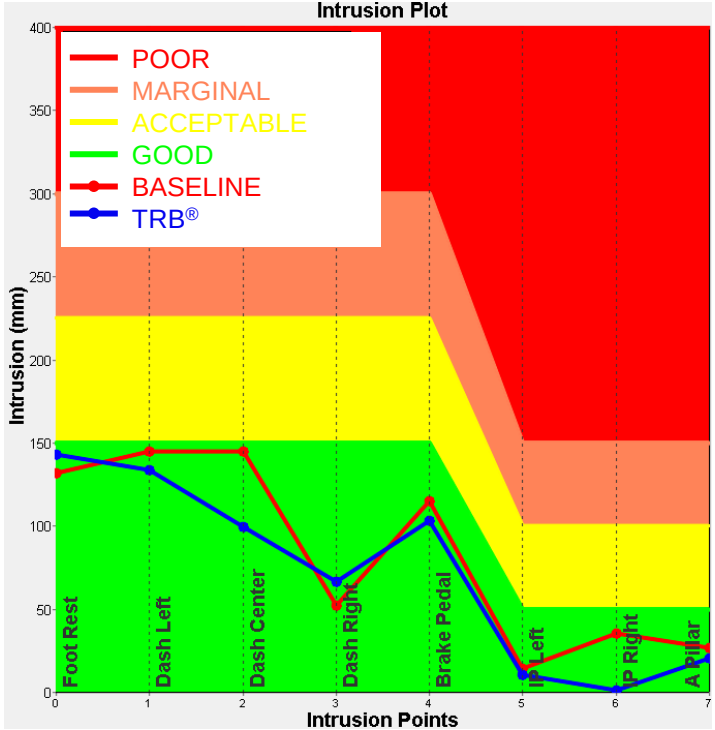
ODB 40 % Offset TRB® Result



Baseline

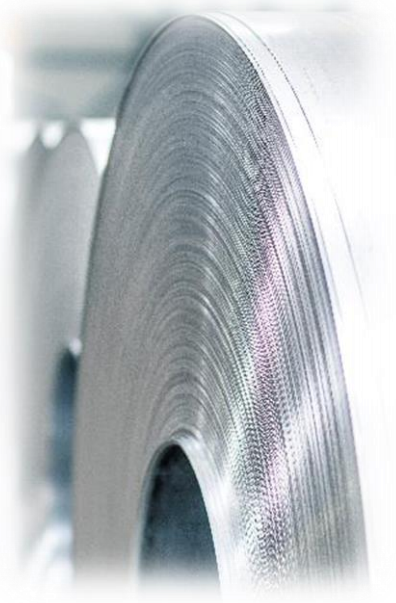


TRB® Concept

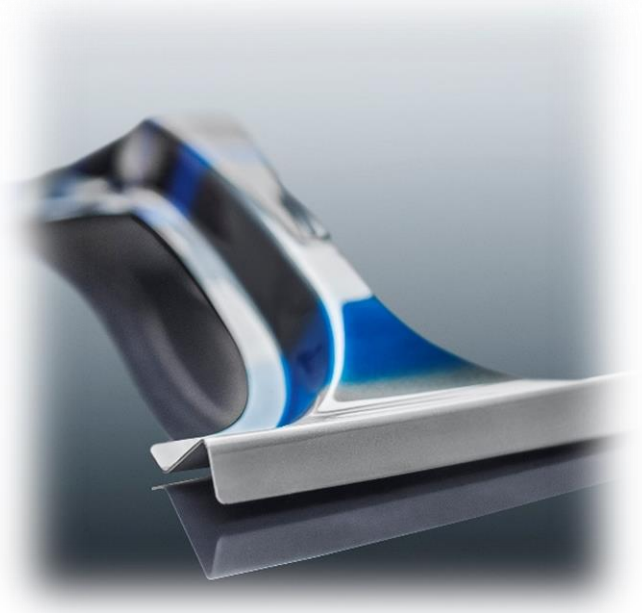


Summary Potential Analysis TRB® Front Rail

- ***Harmonic load distribution due to transition zones***
- ***Crash optimized thickness run for minimal intrusions***
- ***TRB® concept competitive to Dual Phase steel designs***
- ***Weight reduction up to 10 %***



Thank you very much for your attention!



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