2013 GREAT DESIGNS IN STEEL CONFERENCE

Wednesday, May 1st 2013

Go Further

2013 Ford Escape

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Technical Leader & Global Core Manager
Body Structures, Closures & Body CAE

Agenda

- Background
- Material Usage
- Design Approach
- Functional Performance
  - Static Stiffness
  - Dynamic Stiffness
  - Safety

Evolution

- 2013 Escape was designed to replace the original Mazda based design
- New vehicle derived from the new Focus and utilizes styling cues that have helped to make the Focus the best selling vehicle in the world
- The Ford Escape, America's best-selling SUV, will raise the bar even higher with the debut of an all-new model that features 11 new exclusive features and fuel economy projected to top any vehicle of its kind on the market today.
- 'Smarter Utility Vehicle' because it offers the strengths that customers today really value – fuel economy, versatility and new technology that makes driving and living with the vehicle easier and more fun – all wrapped in a sleek, more modern design

Customer Features

Available Power Trains

2.5L iVCT I-4:	22 City / 31 Hwy
1.6L Ti-VCT I-4:	23 City / 33 Hwy
2.0L Ti-VCT I-4:	22 City / 30 Hwy

Bio-Based Foam Seat Cushions

Hands Free Lift Gate Activation

Rain Sensing Wipers

Blind Spot Indicator System

Recycled Materials in Carpet & Sound Treatments

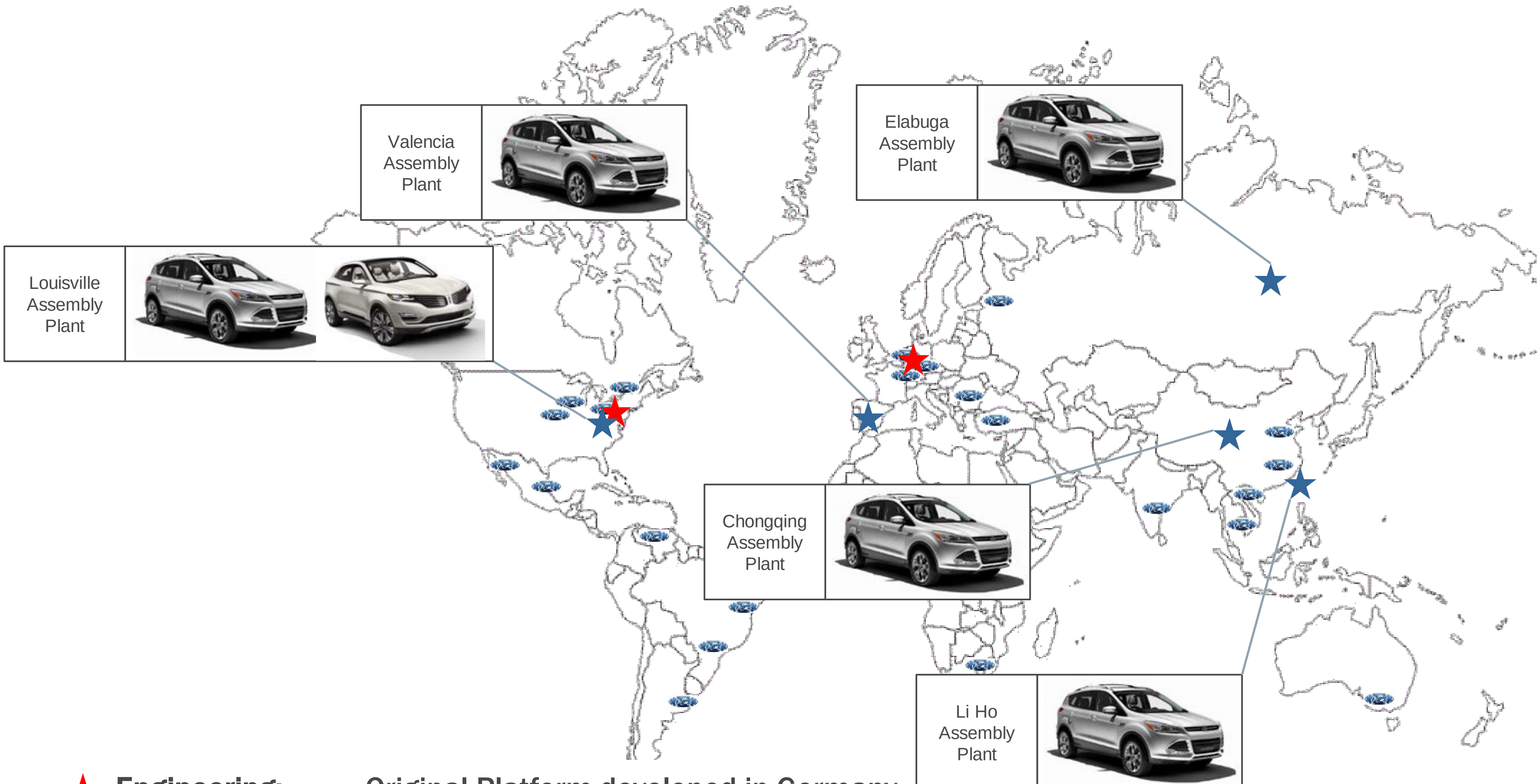
Roll Stability Control, Curve Control, & Torque Vectoring

Intelligent 4WD

Active Park Assist

Active Grille Shutter

Global Footprint



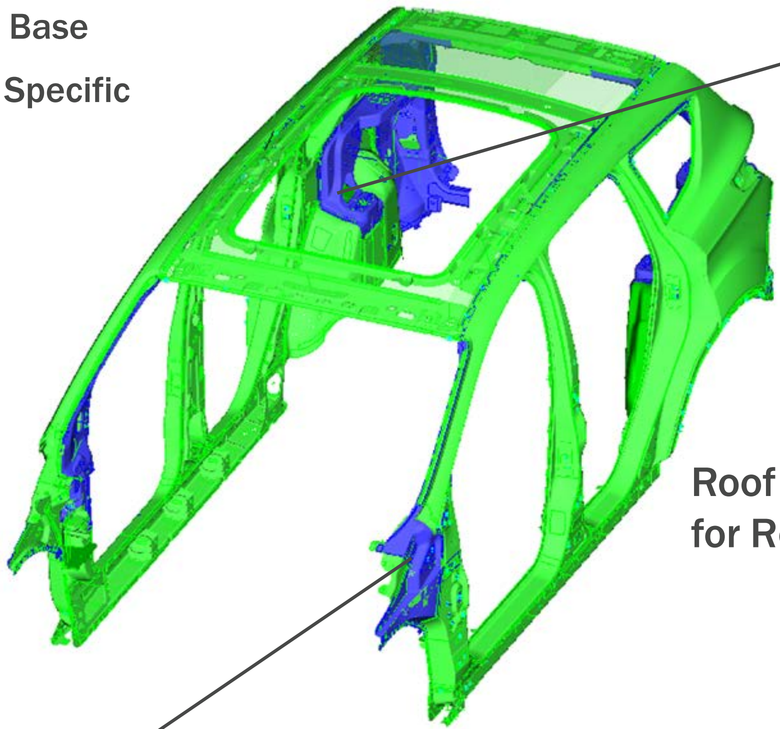
★ **Engineering:** Original Platform developed in Germany
Top Hats developed in Dearborn

★ **Manufacturing:** 2 Model / 5 Manufacturing Sites
Potential for additional derivatives in multiple regions

Global Commonality

NA Base

EU Specific

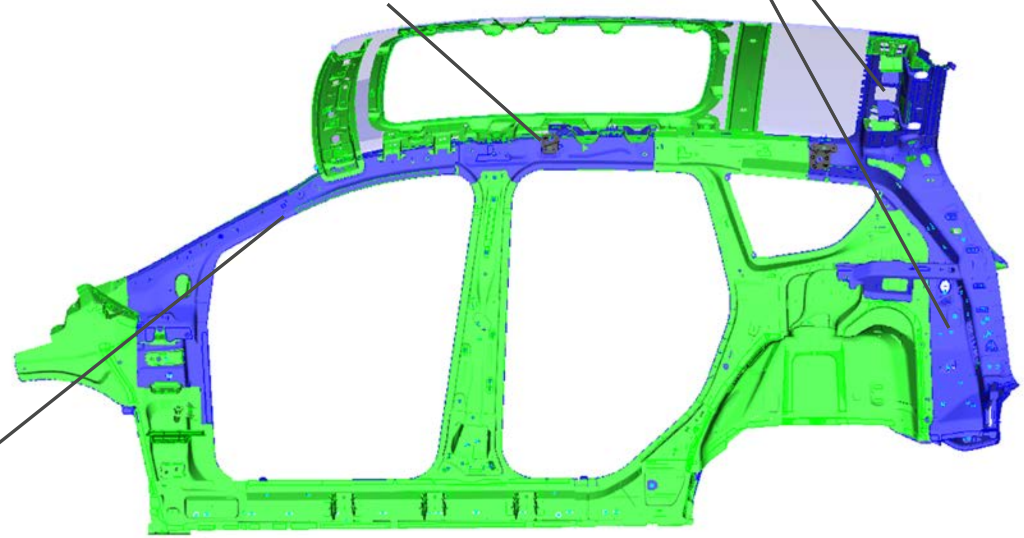


Lion’s Foot changes required for market specific content

D-Pillar and Rear Header geometry differences for region specific content

Roof Rail Inner material change for Roof Strength performance

Stub Shot Gun material strength increased for IIHS Offset

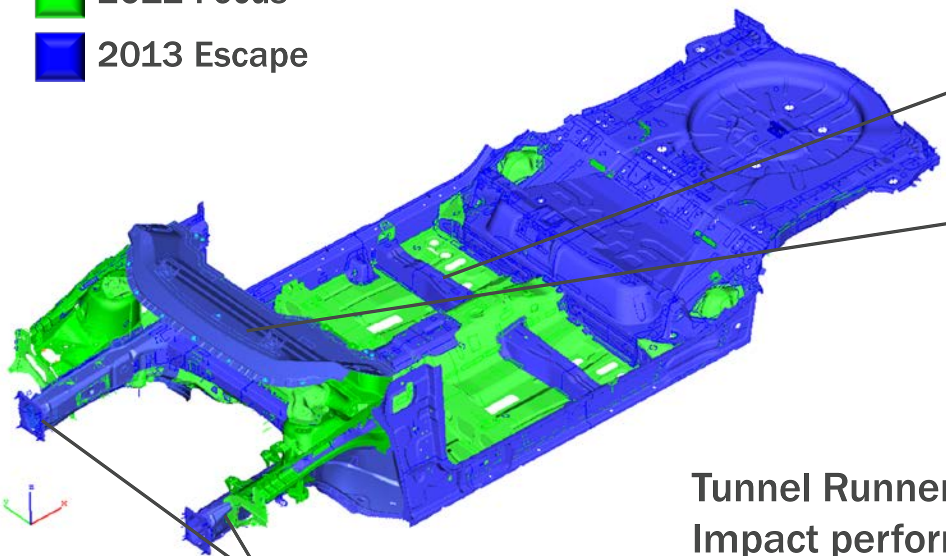


A-Pillar Inner modified for unique Air Curtain and plant specific requirements

Platform Development

2012 Focus

2013 Escape



Seat Cross Members redesigned for unique seating package

Cowl Structure modified for styling differentiation

Front Rails back-up structure up gaged for higher vehicle mass

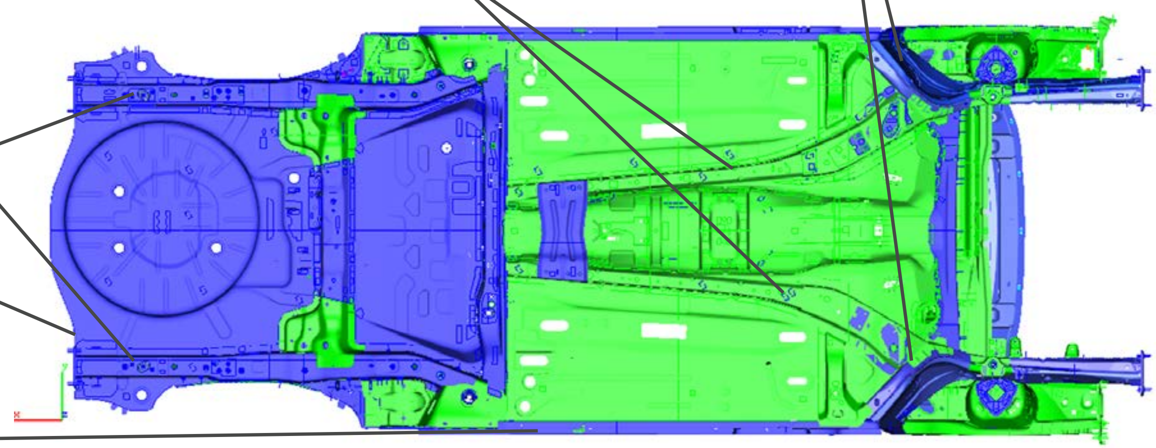
Tunnel Runners reinforced for Front Impact performance

Front Rails up gaged for higher vehicle mass

Rear Rails redesigned for higher vehicle mass

Rear Under Body modified for CUV content

Side Sills modified for increased strength due to higher vehicle mass



MATERIAL USAGE

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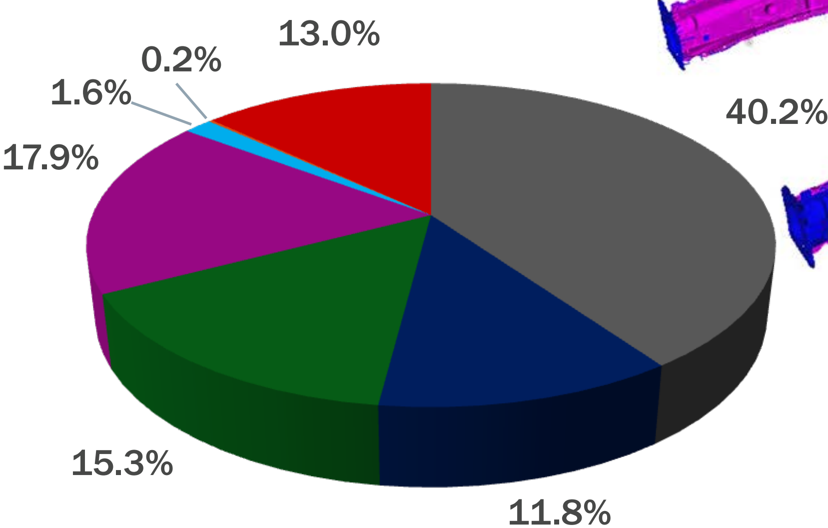
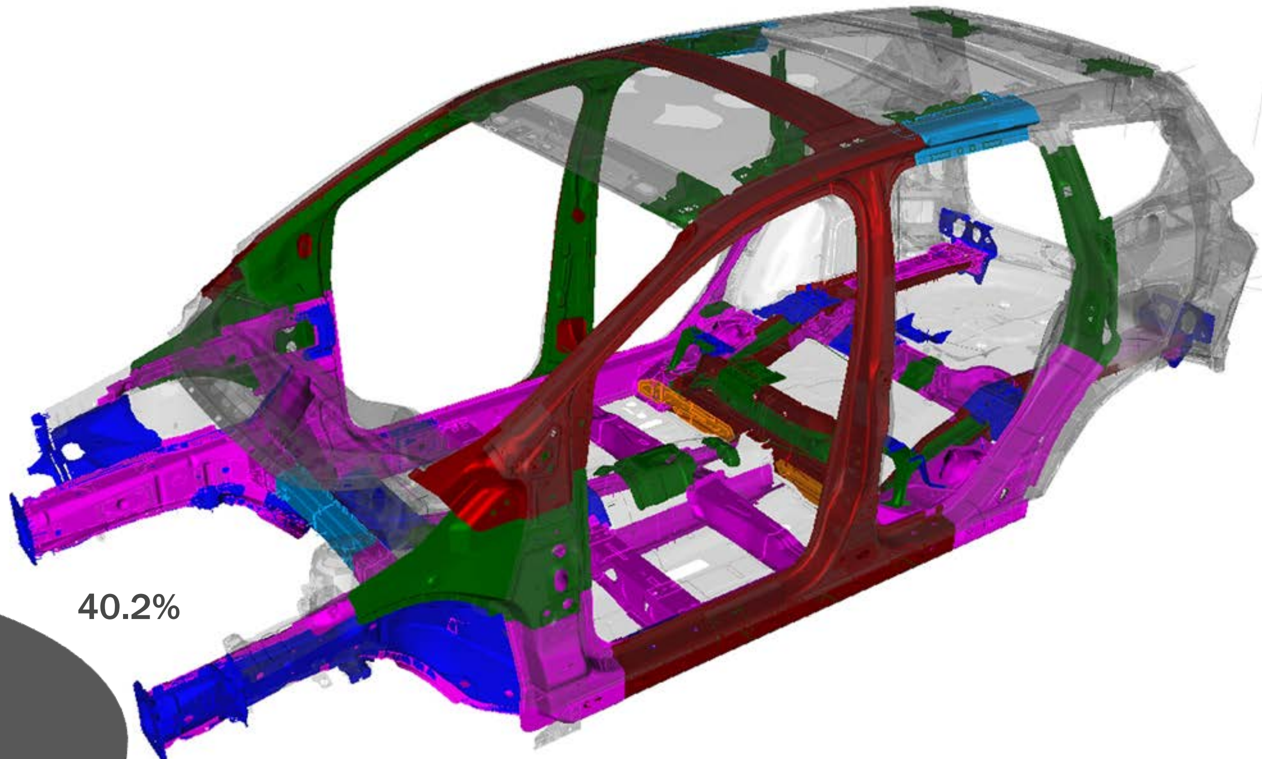
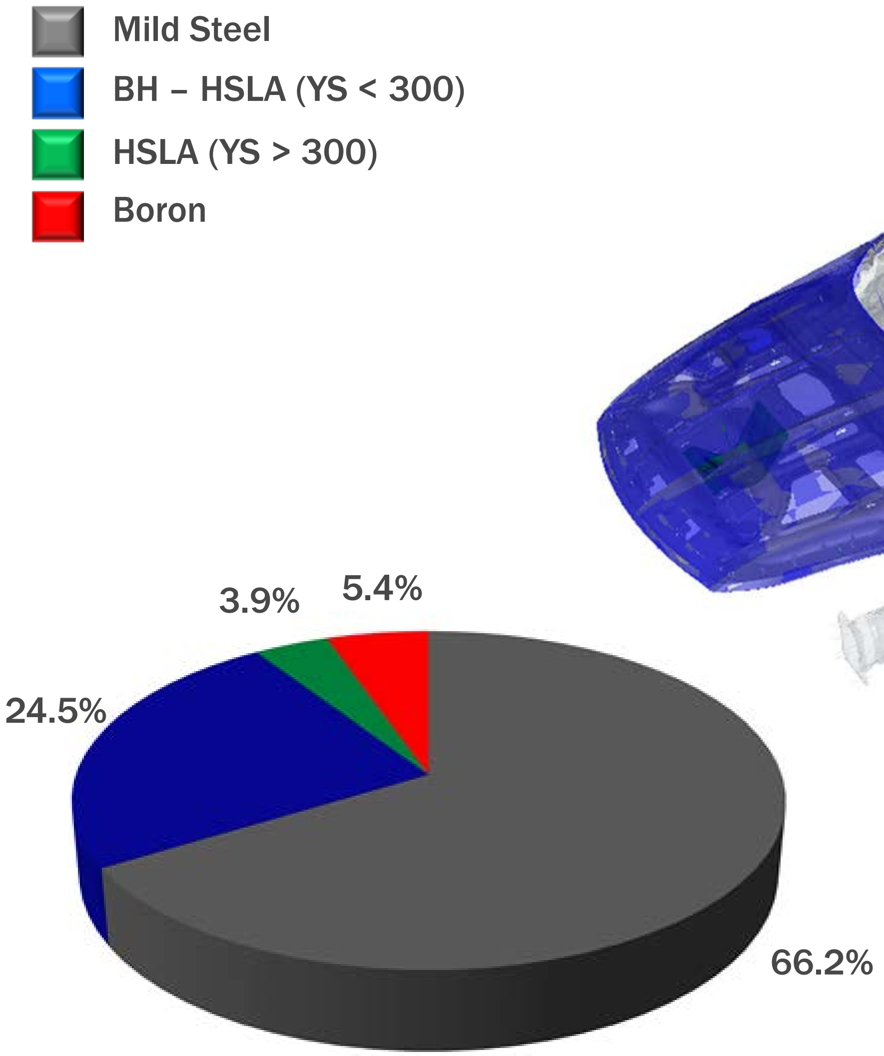
Material - BIW

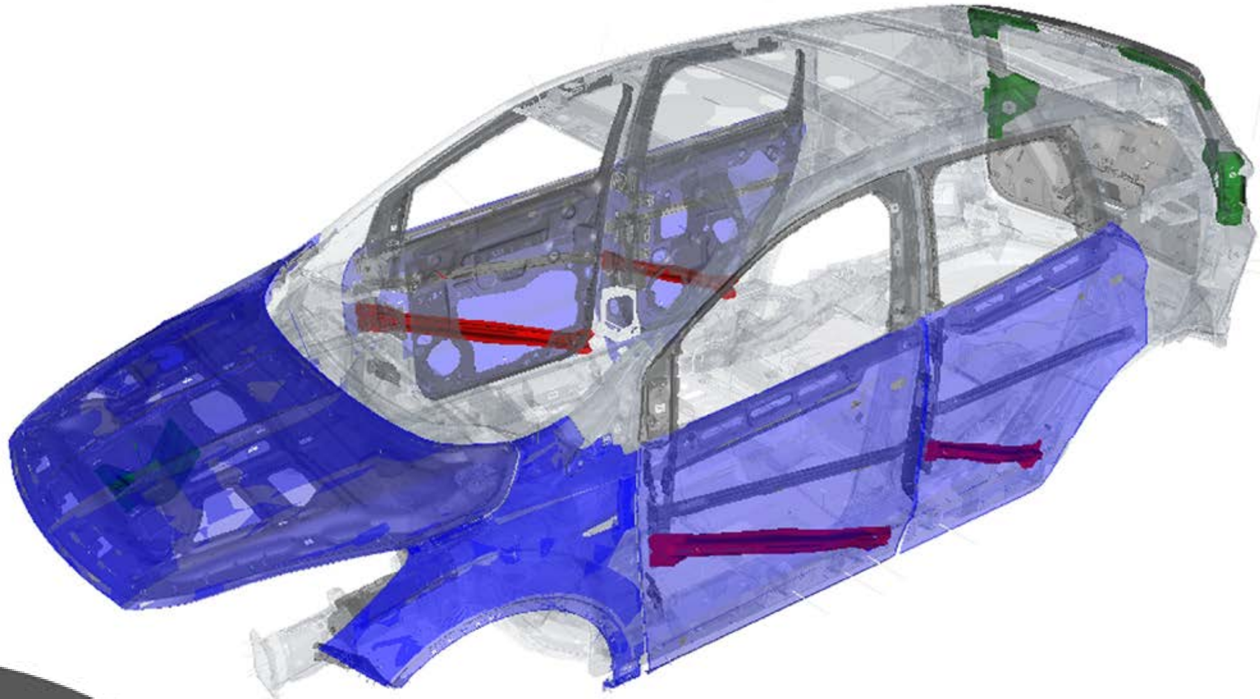
- Mild Steel
- BH – HSLA (YS < 300)
- HSLA (YS > 300)
- DP 600
- DP 800
- DP 1000
- Boron - Martensitic





Material - Closures





DESIGN APPROACH

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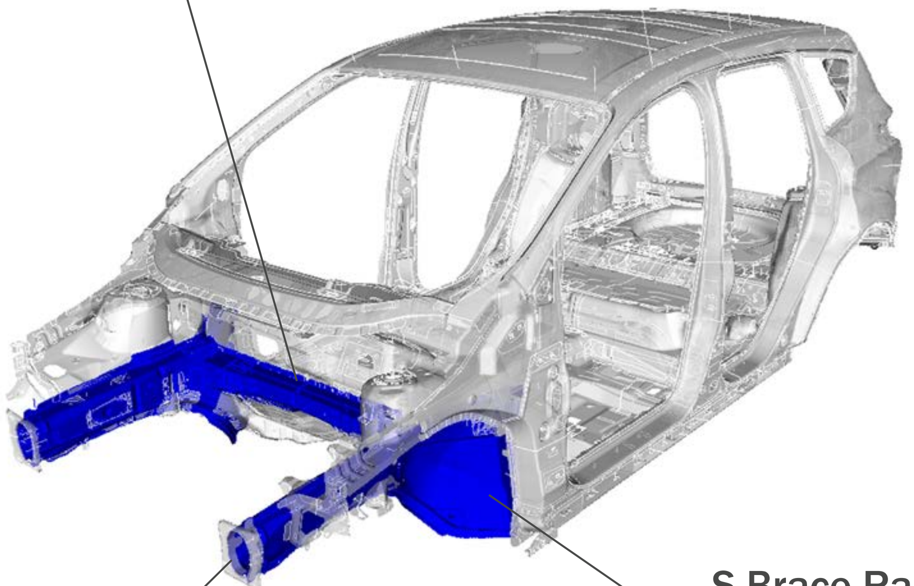
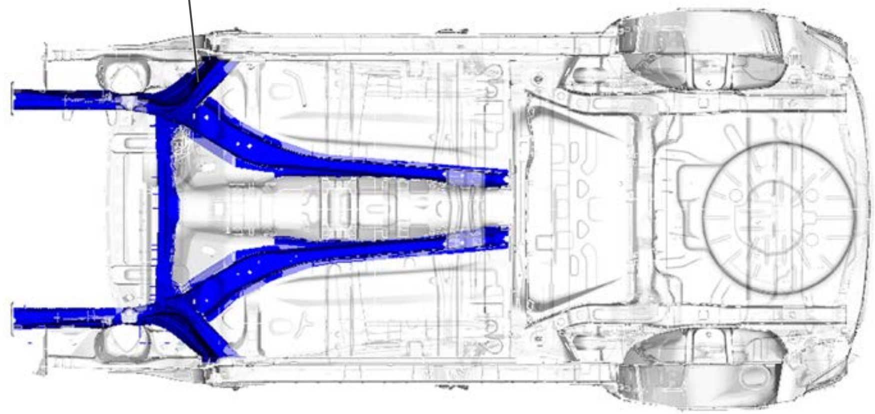
Front Structure Design

Dash Cross Member acts as a compression member during loading to stabilize the Front Rail

Y-Brace replaces the typical Torque Box to distribute load to the rocker and the tunnel runners

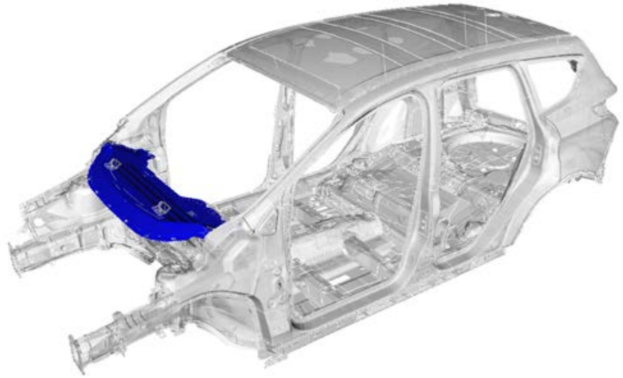




Cross section of the front rails has been designed for optimal load capacity within the provided package

S-Brace Rail section angles toward the rocker as it transitions under the dash for improved load path

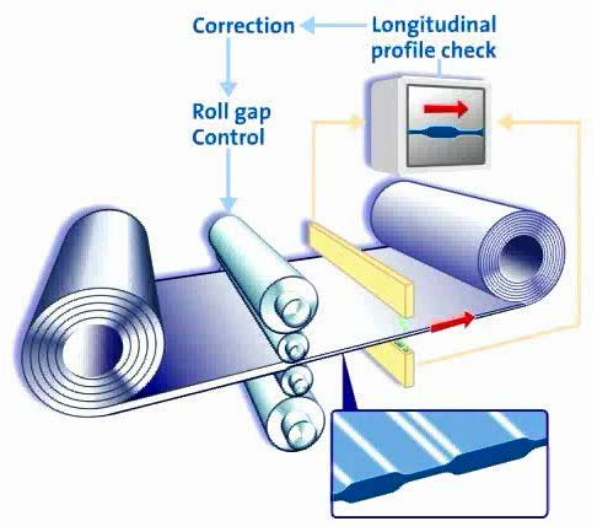
Energy Absorbing Cowl Design

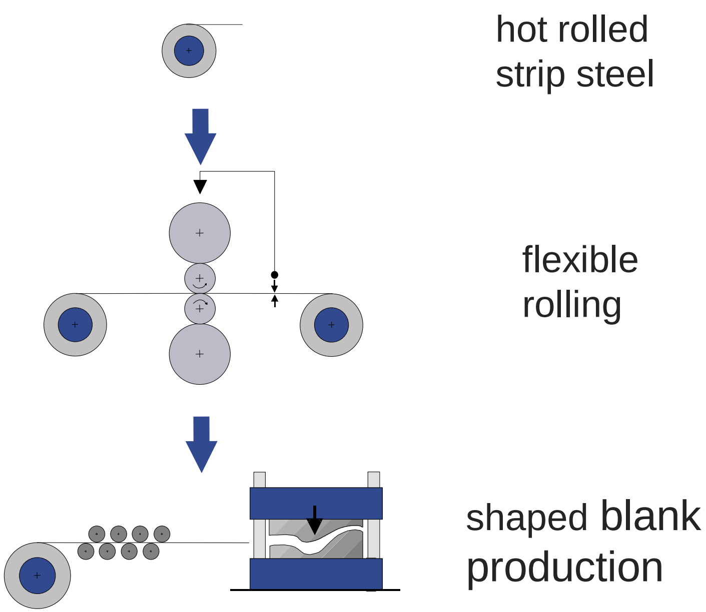


Vehicle needed to be designed to meet both EuroNCAP - Gen II and proposed Global (GTR) requirements for Head Impact

Cantilevered Cowl Section allows the structure to flex under impact loads, reducing loads applied to a head form

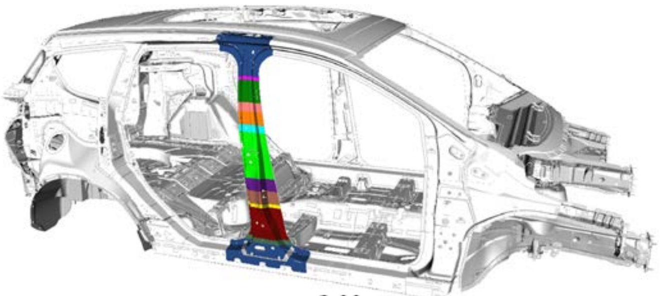
Tailor Rolled Blanks



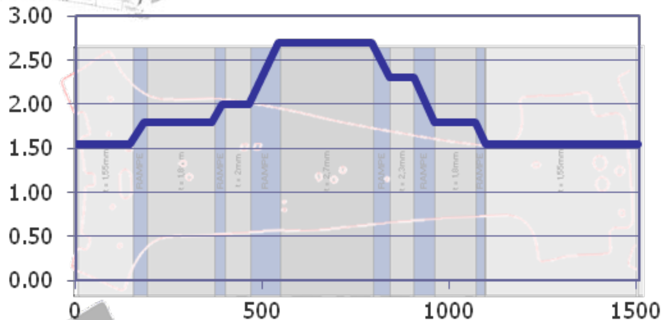


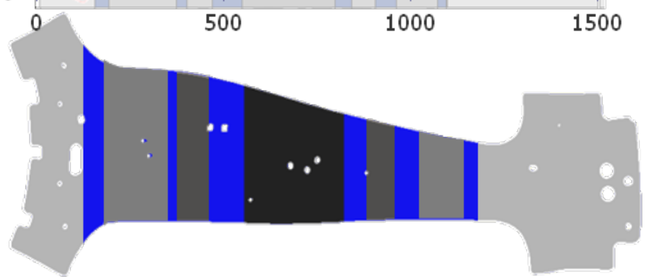
- TRB® allows the tailoring of the steel material thickness according to the requirement in the finished part.
- Thickness can be increased in areas with high load and decreased in other areas to optimize the part mass.
- Number of thicknesses has no influence on the process cost. Less weight leads to less cost
- Possible Advantages:
  - Weight reduction
  - Improvement of crash performance
  - Part integration
  - Simplification of design
  - NVH improvement
  - System cost reduction
- Criteria
  - Weight reduction > 20%
  - Material utilization > 65%
  - Part adapted to load case

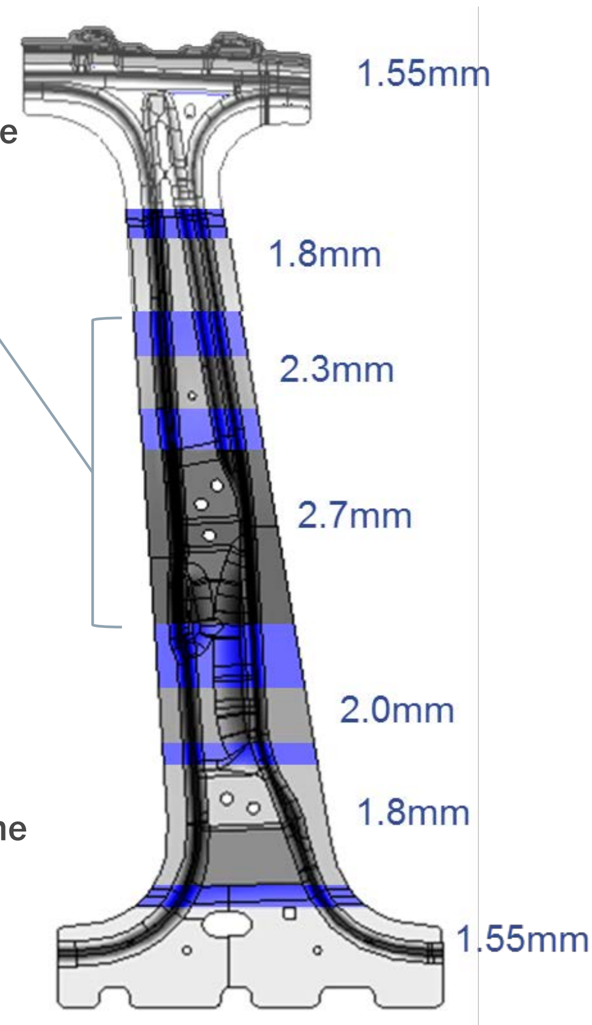
B-Pillar Design



Variation of gage allowed for the elimination of the B-Pillar Reinforcement





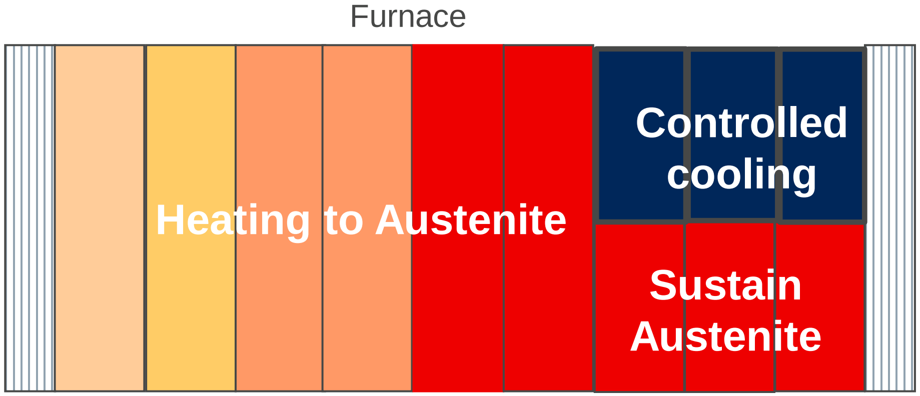


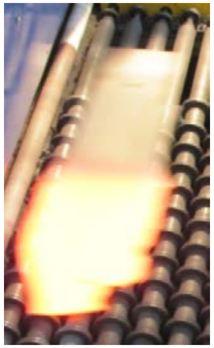
Press Hardened Steel Center Hinge Pillar Reinforcement used to provide the necessary performance for Roof Strength and Side Impact Events

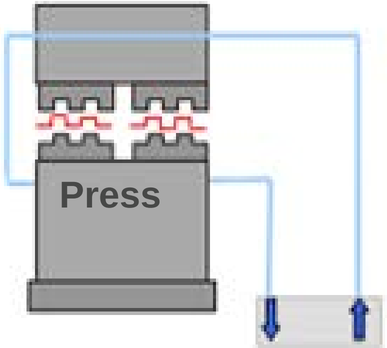
Tailor Rolled Blank introduced to place gage where needed to meet the performance requirements and provide mass savings

Mass savings of 1.2 kg achieved over the conventional approach

Partial Hardening

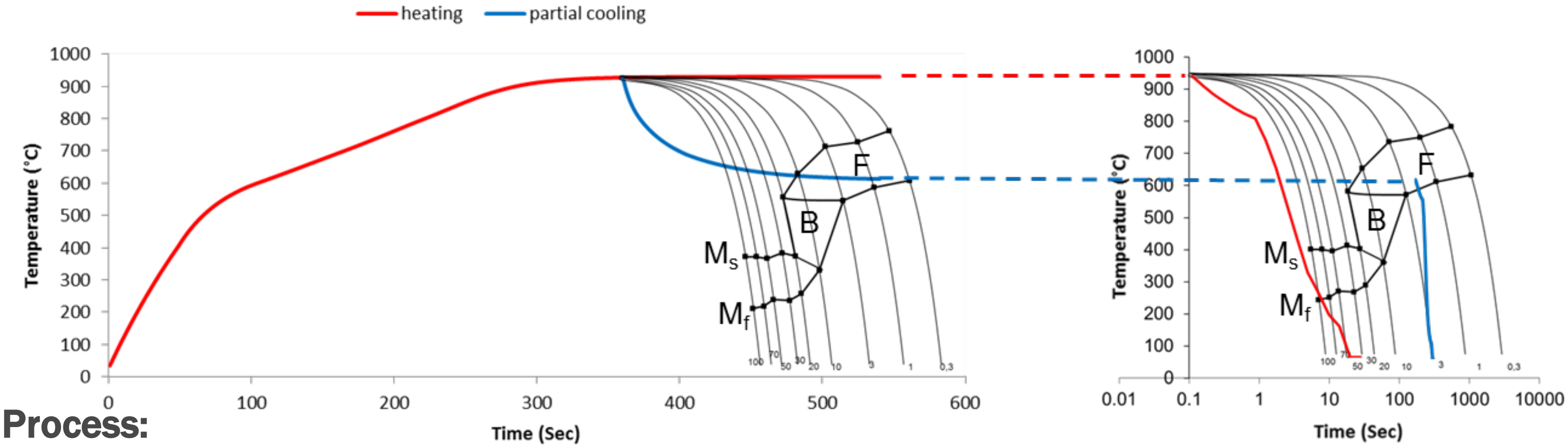






Transfer and Quenching

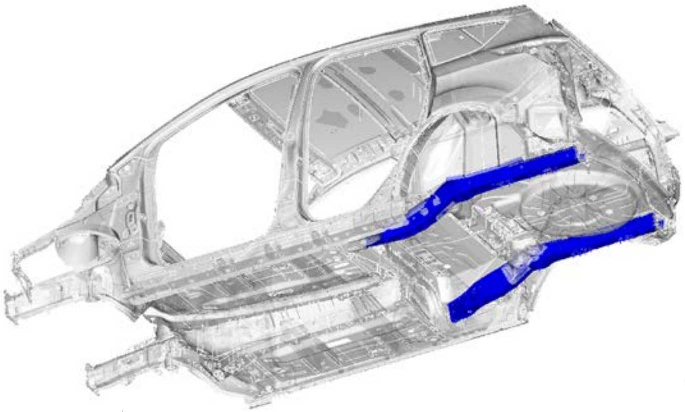
Heating curve



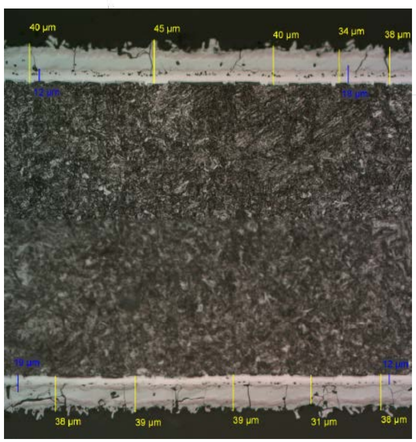
Process:

- Austenitize entire blank
- AlSi coating properly diffused for entire blank
- Controlled cooling of soft zone in the furnace to Bainite or Ferrite structure
- In-die quenching to martensite in hard zone and Bainite and (or) Ferrite in soft zone

Rear Rail Concept



- Rails were shortened for donor vehicle to provide correct vehicle proportions
- Mass of the vehicle increased over the donor vehicle

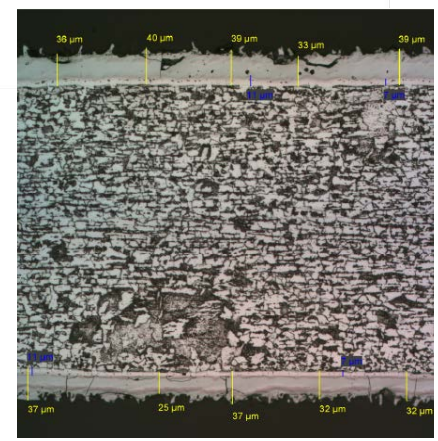


Hard area

Transition zone from soft to hard area

Typical mechanical properties:
R_m = 1450 MPa
R_e = 1100 MPa
$\varepsilon_{(A5)}$ > 6%

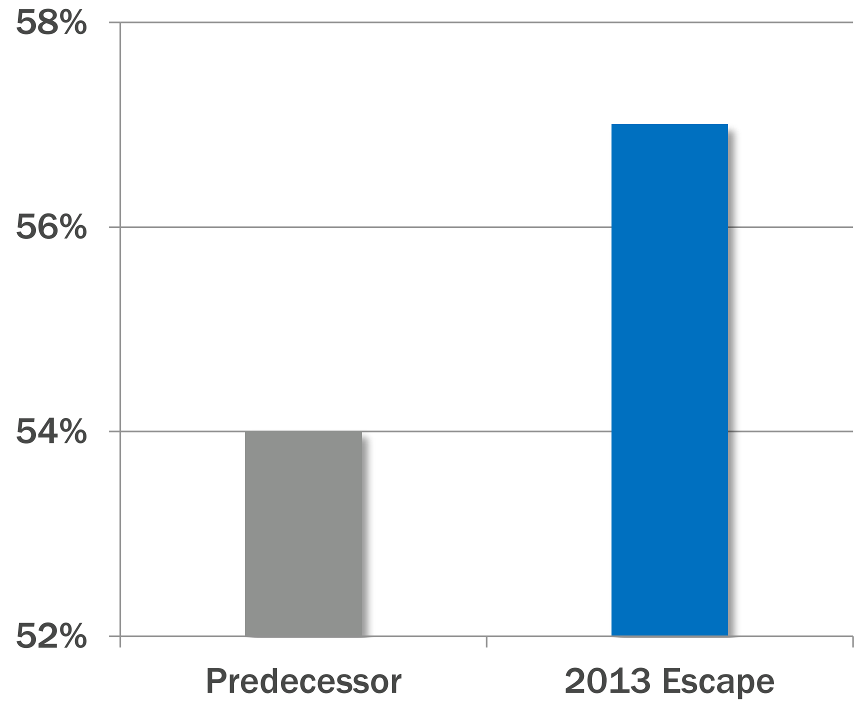
Typical mechanical properties:
R_m = 550 MPa
R_e = 400 MPa
$\varepsilon_{(A5)}$ > 20%



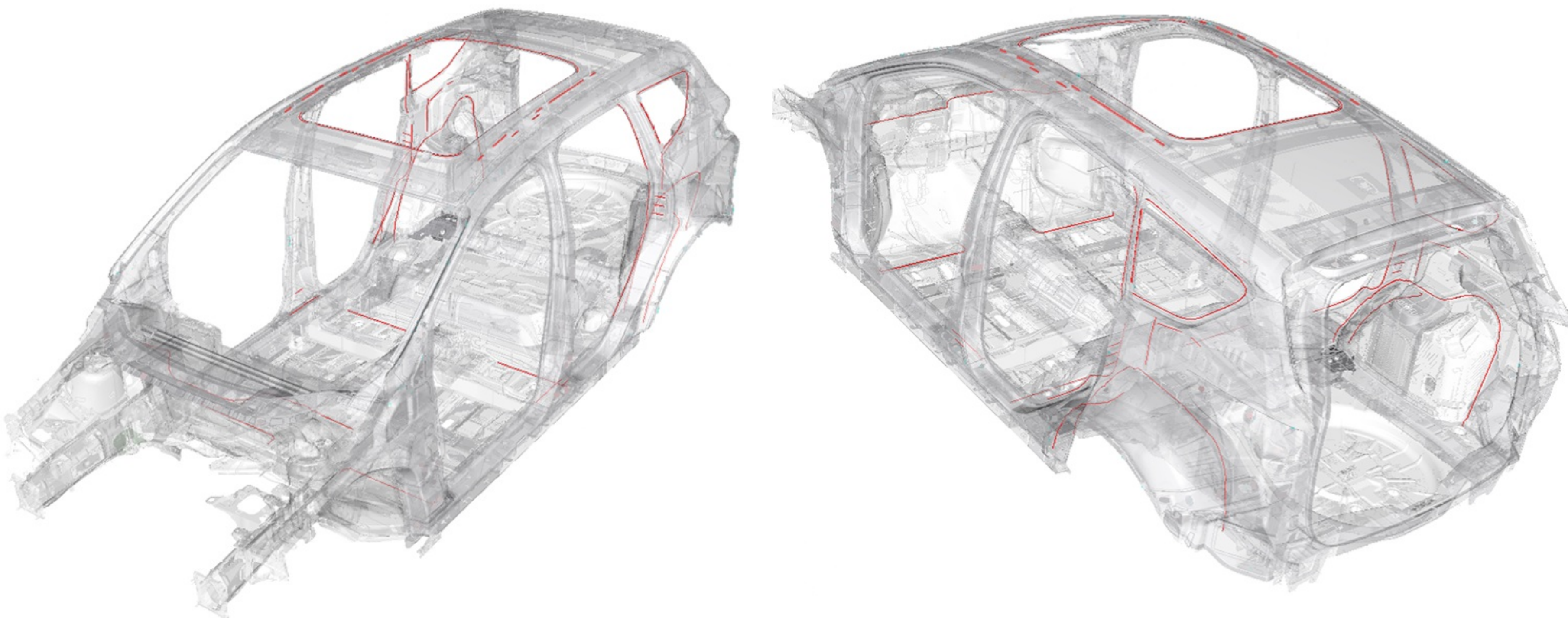
“Soft”

Material Utilization

- Optimization for material utilization starts during the design phase
  - Simulation software used to develop ideal blank layout and nesting
  - Part geometry is revised to maximize efficiency of blank nesting
- Reuse of offal is examined and cost studies are conducted to develop the required business case
- Blanking technologies are reviewed for feasibility and implemented based on business case results
  - Laser welded blanks for nesting optimization
  - Scalloped blanks



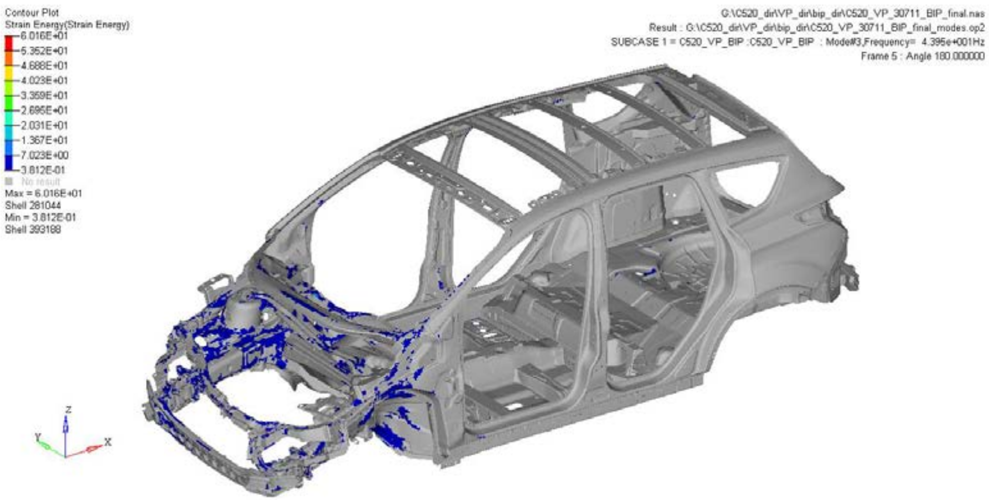
Structural Adhesive

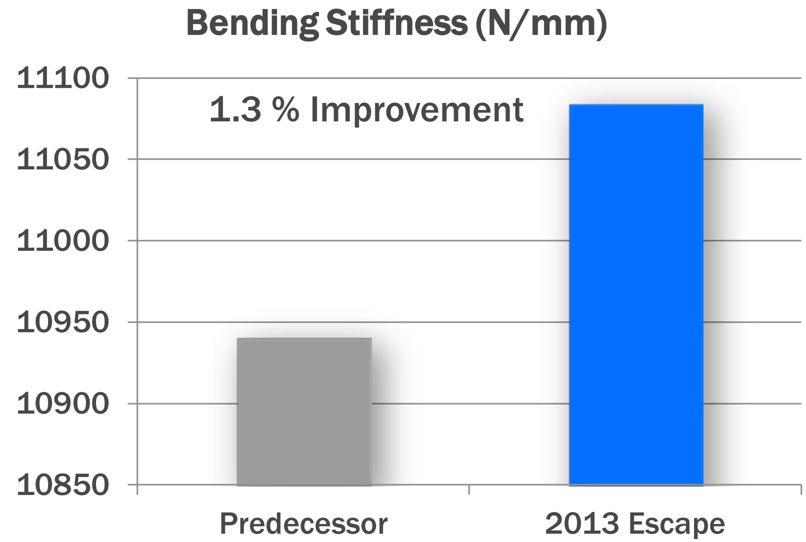


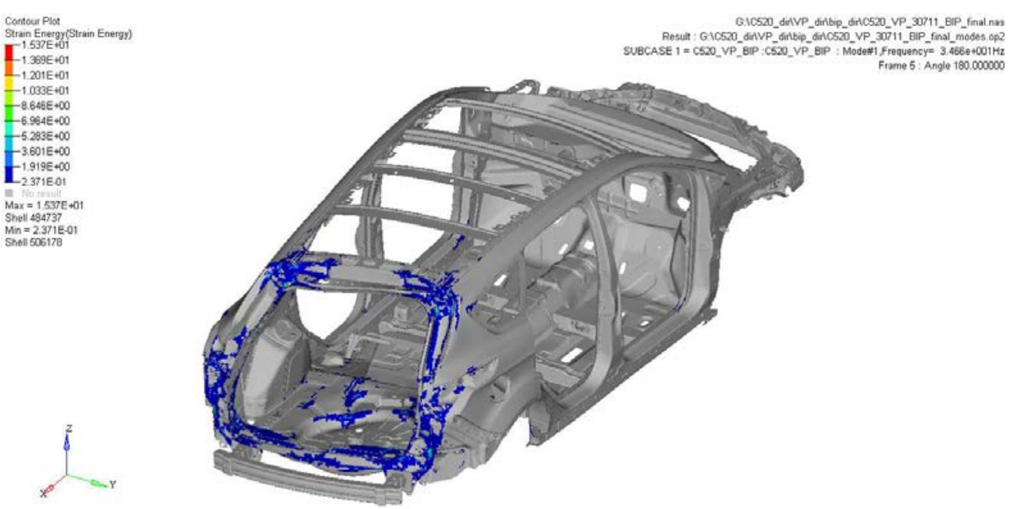
- 18 m of adhesive added to the BIW
- Adhesive added Dash, Wheel House, and Rear Door Opening to improve torsional stiffness
- Material added to the Dash to Floor Pan joint for improved durability

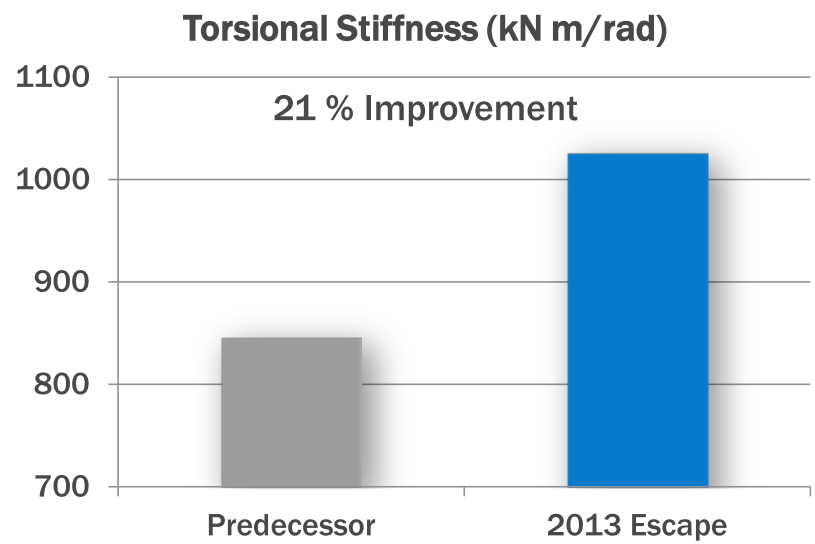
PERFORMANCE

Static Stiffness

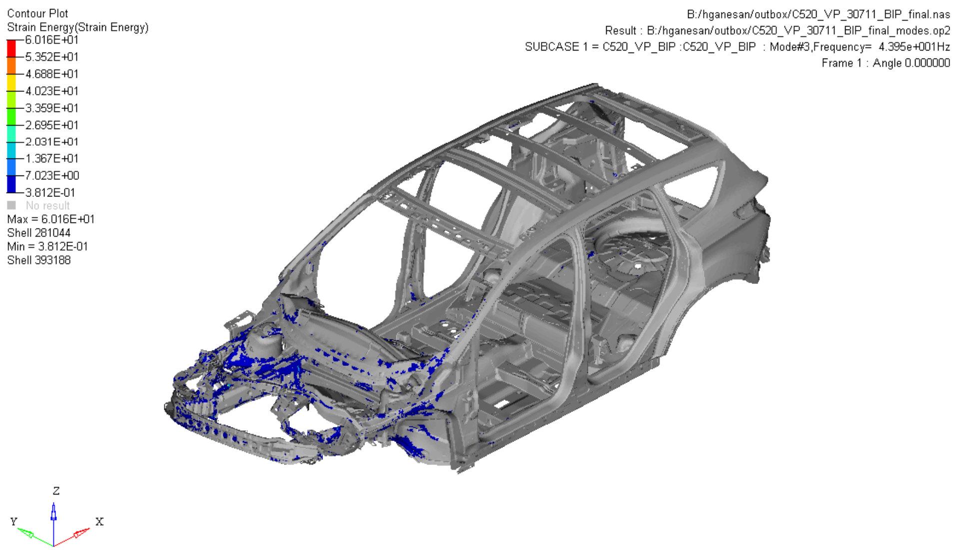


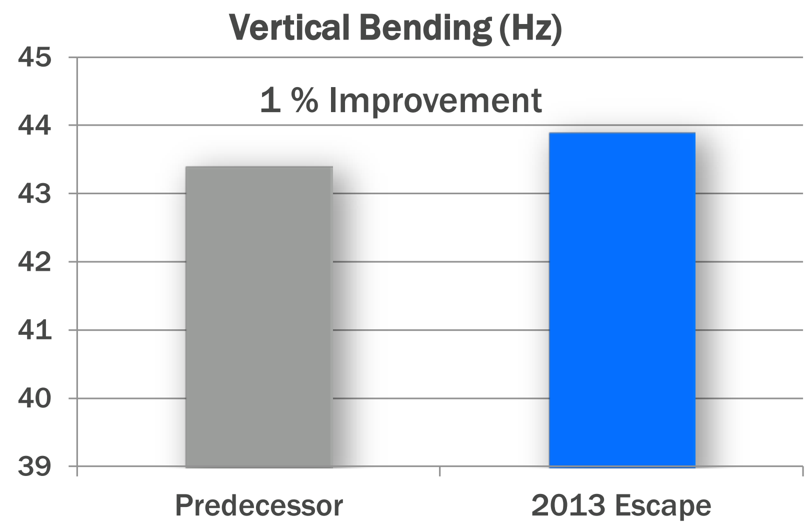


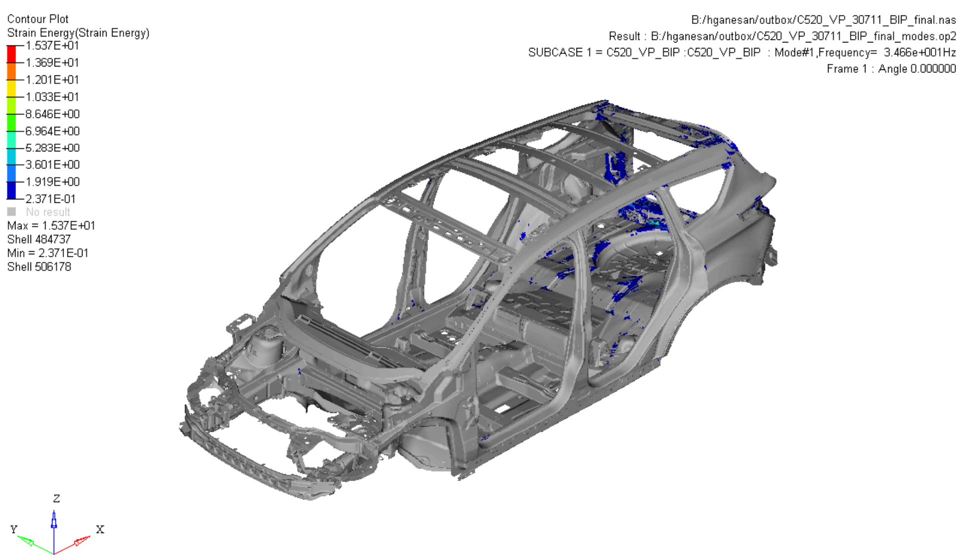


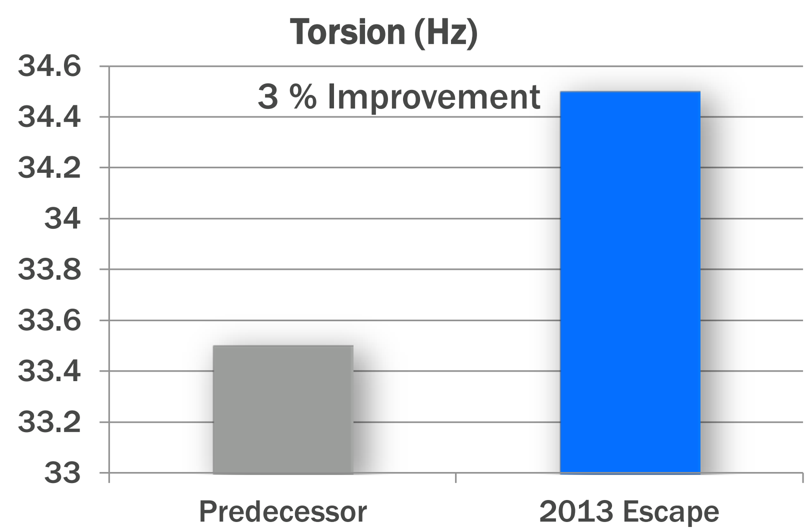


BIP Dynamic Modes



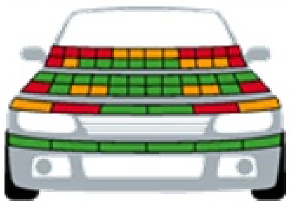




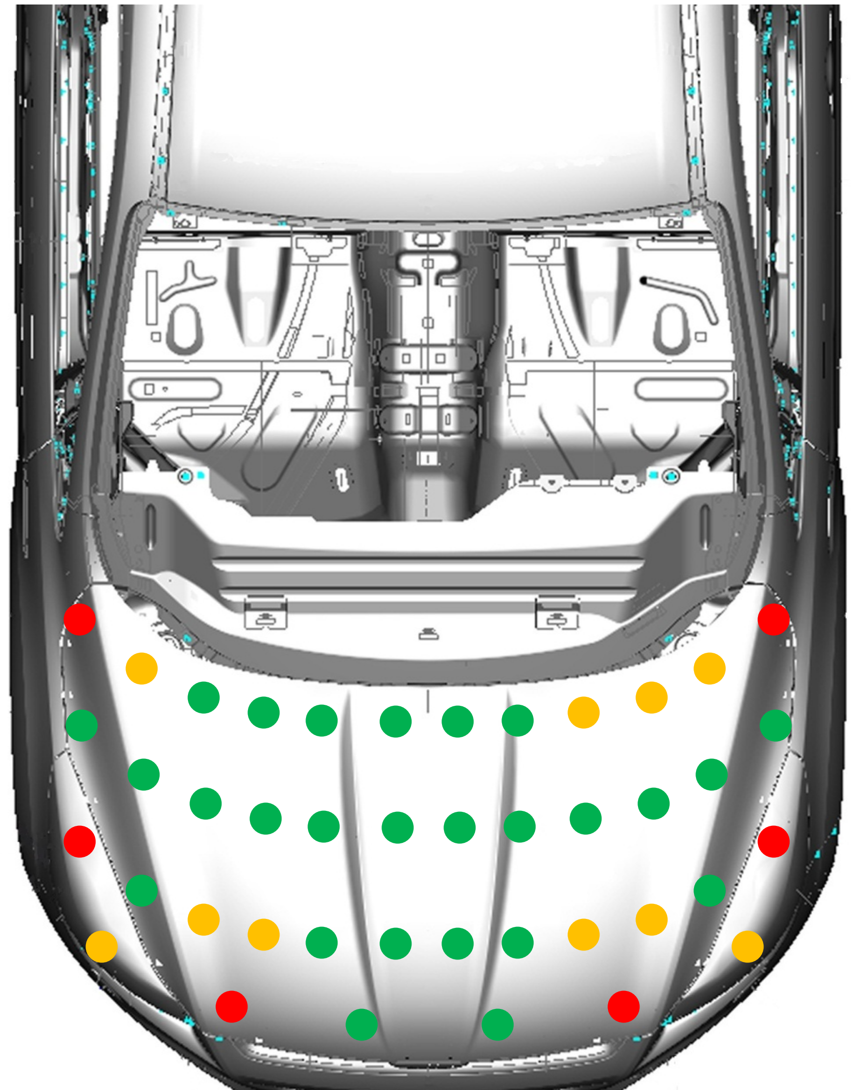


Pedestrian Protection

Pedestrian	Total 25 pts | 70%
HEAD	15.4 pts
PELVIS	3.7 pts
LEG	6.0 pts



- GOOD
- ADEQUATE
- MARGINAL



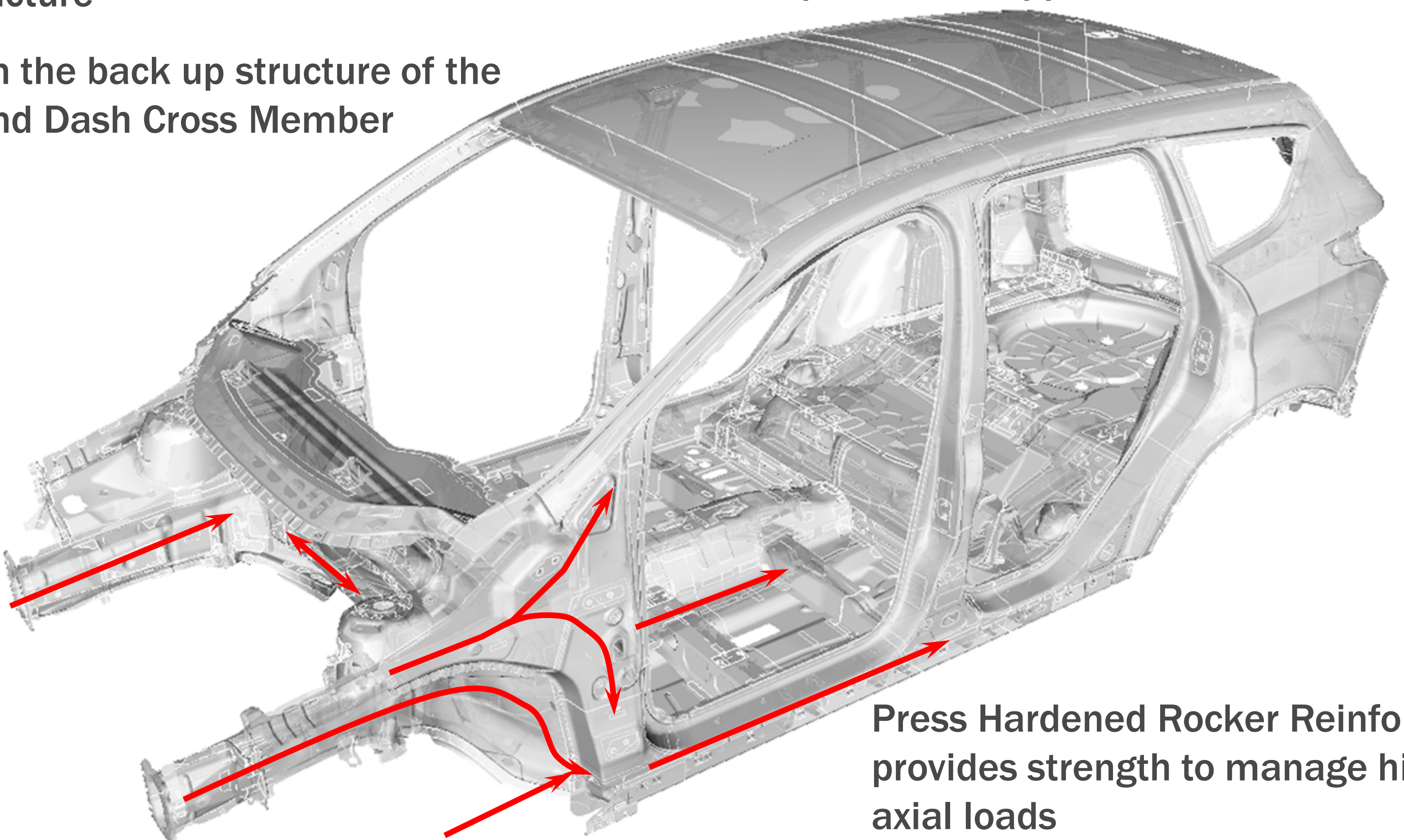
Common Hood design developed to meet GTR proposed Head Impact requirements as well as the more stringent Euro NCAP

Load Path – Front Structure

Sub-Frame provides a lower load path into the structure

AHSS in the back up structure of the Rails and Dash Cross Member

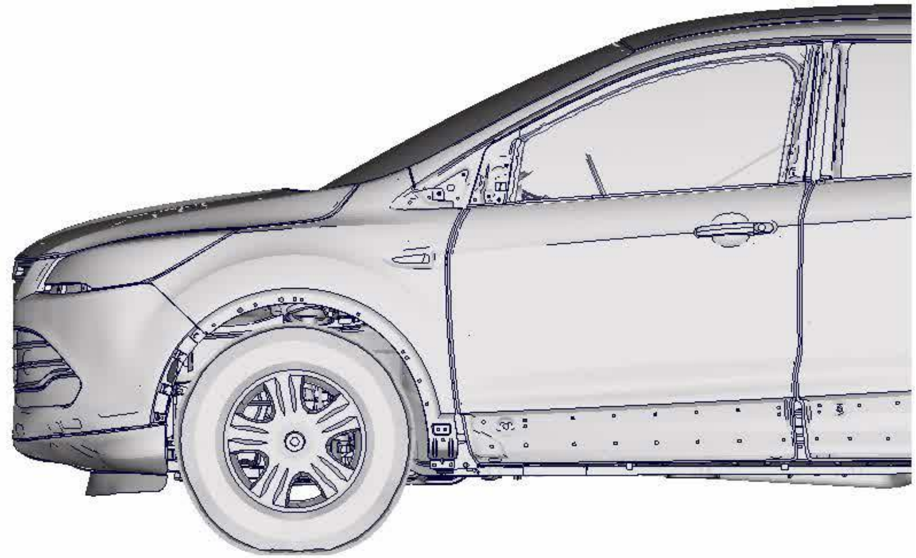
Press Hardened A-Pillar provides load path to the upper structure



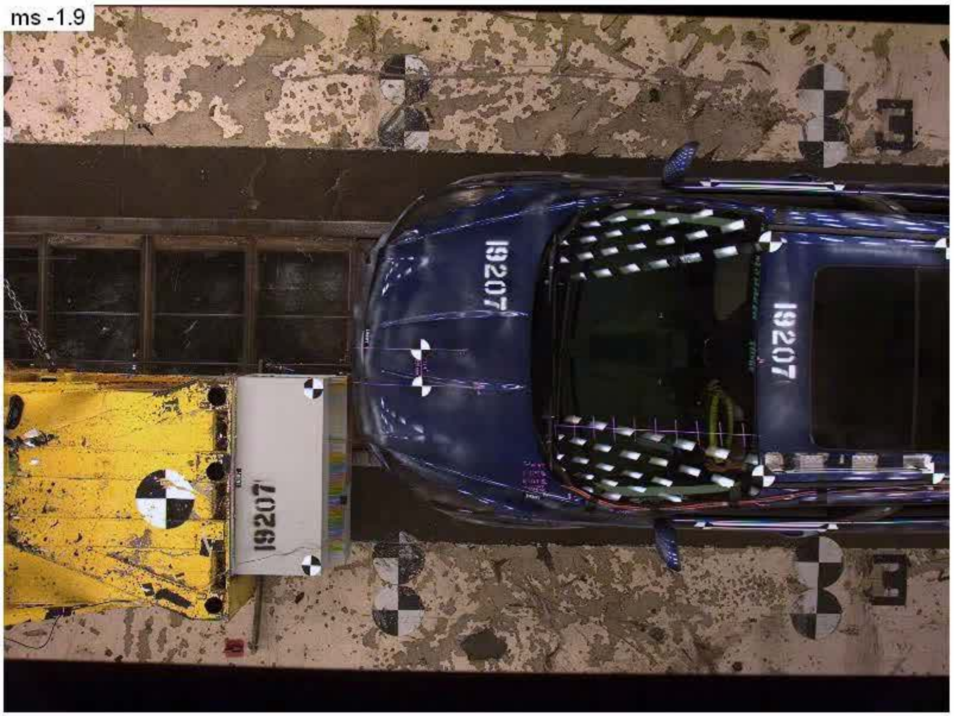
Press Hardened Rocker Reinforcement provides strength to manage high axial loads

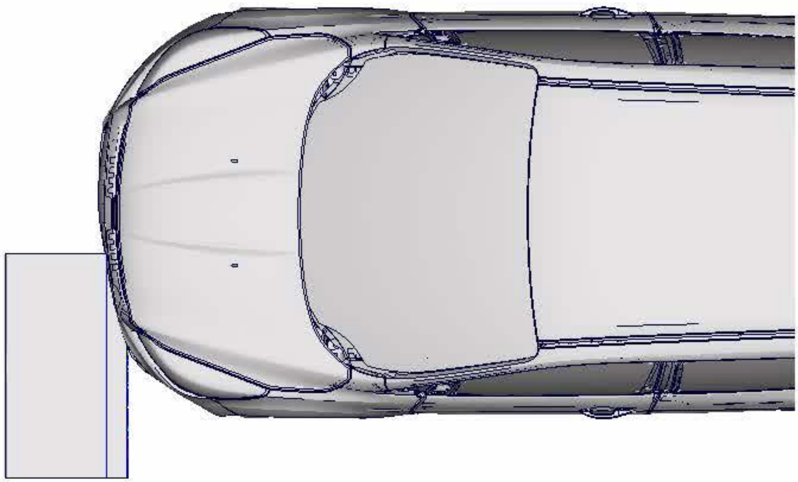
Front Rail utilizes "S-Brace" concept and AHSS to manage load distribute them to the Rocker and Tunnel Runner.

Frontal Impact

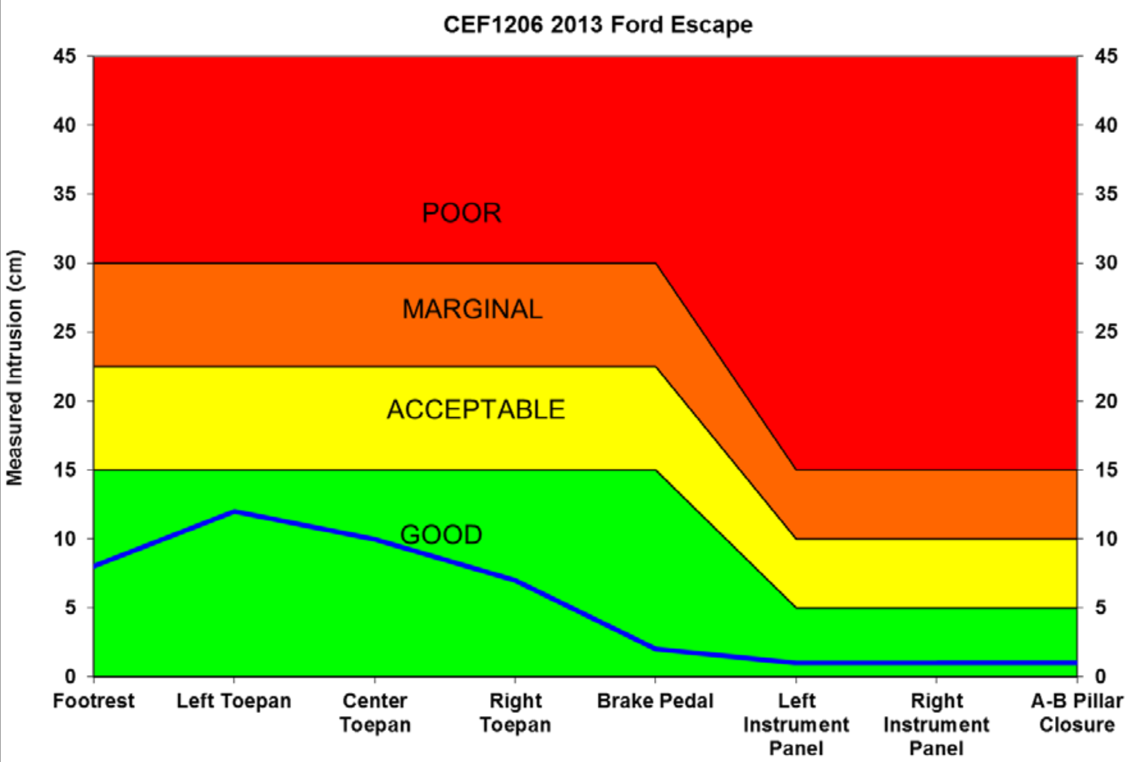


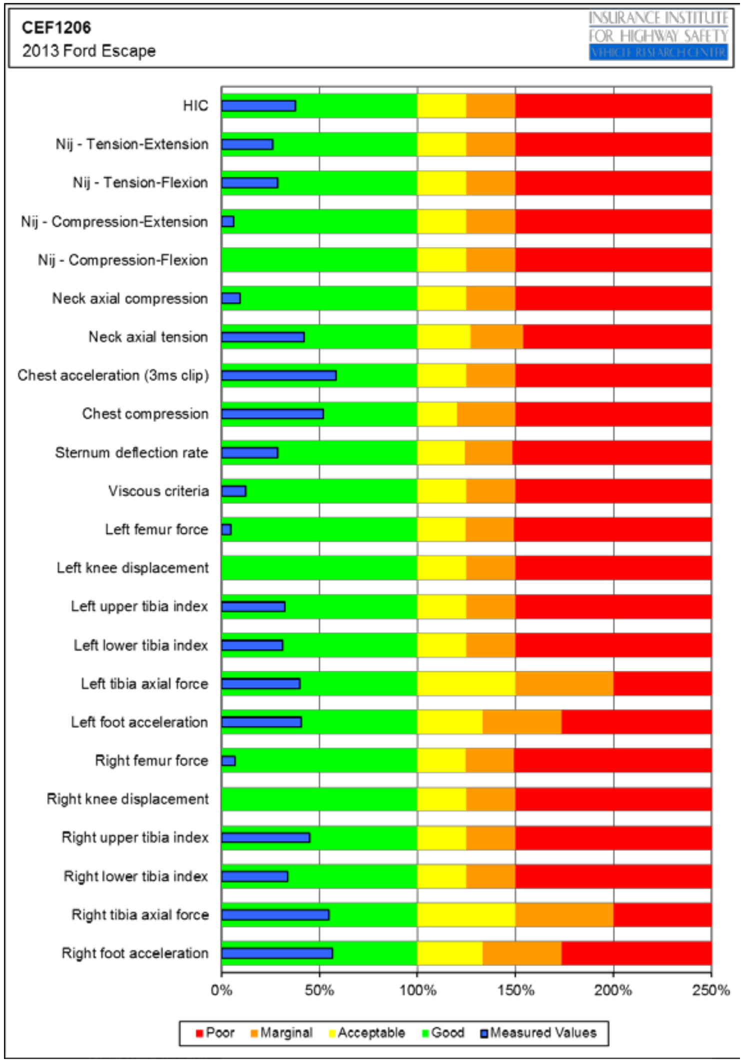
Frontal Offset





Offset Performance



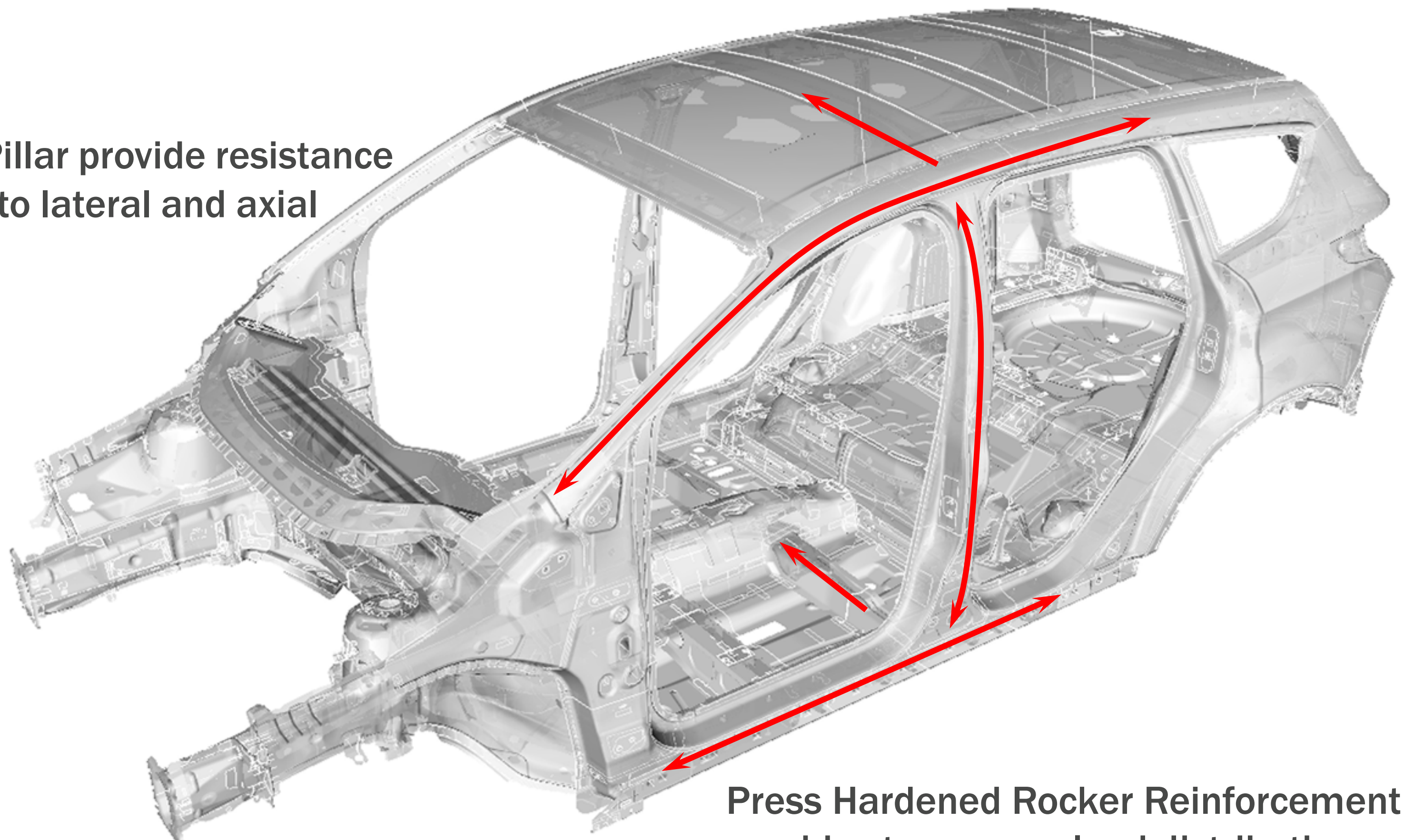


Load Path – Roof Strength & Side Impact

Press Hardened A-Pillar manages load to Front Hinge Pillar and Rear of the Body Side

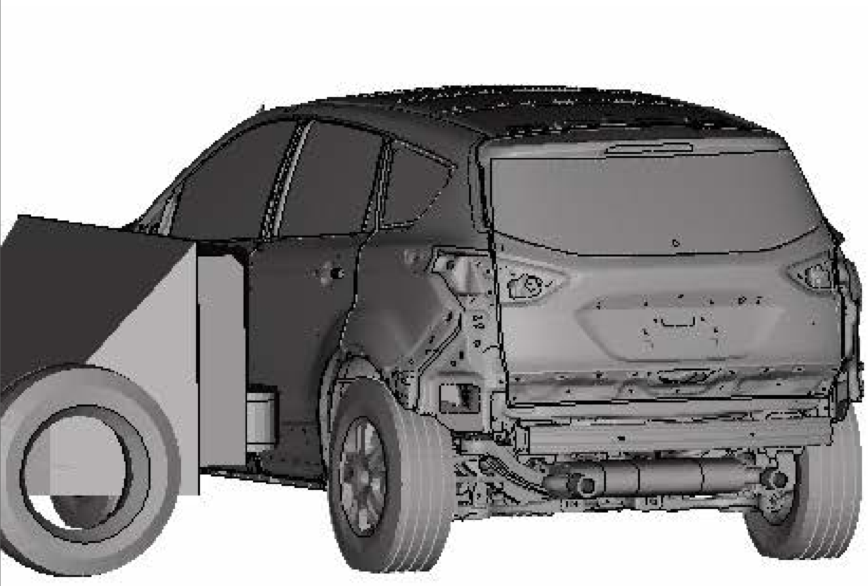
Press Hardened Roof Bow provides path for cross vehicle load sharing

Tailor Rolled B-Pillar provide resistance to buckling due to lateral and axial loads

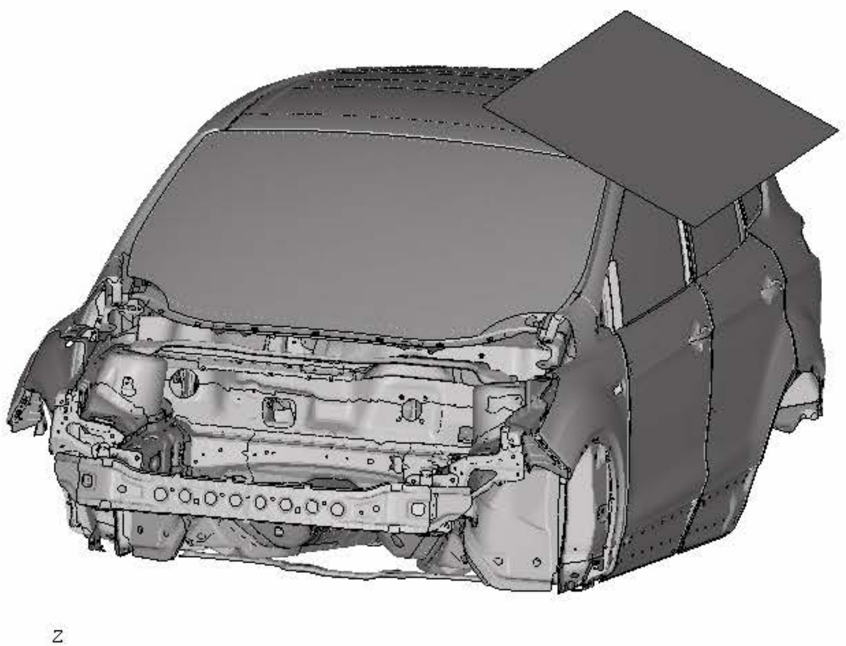


Press Hardened Rocker Reinforcement provides transverse load distribution

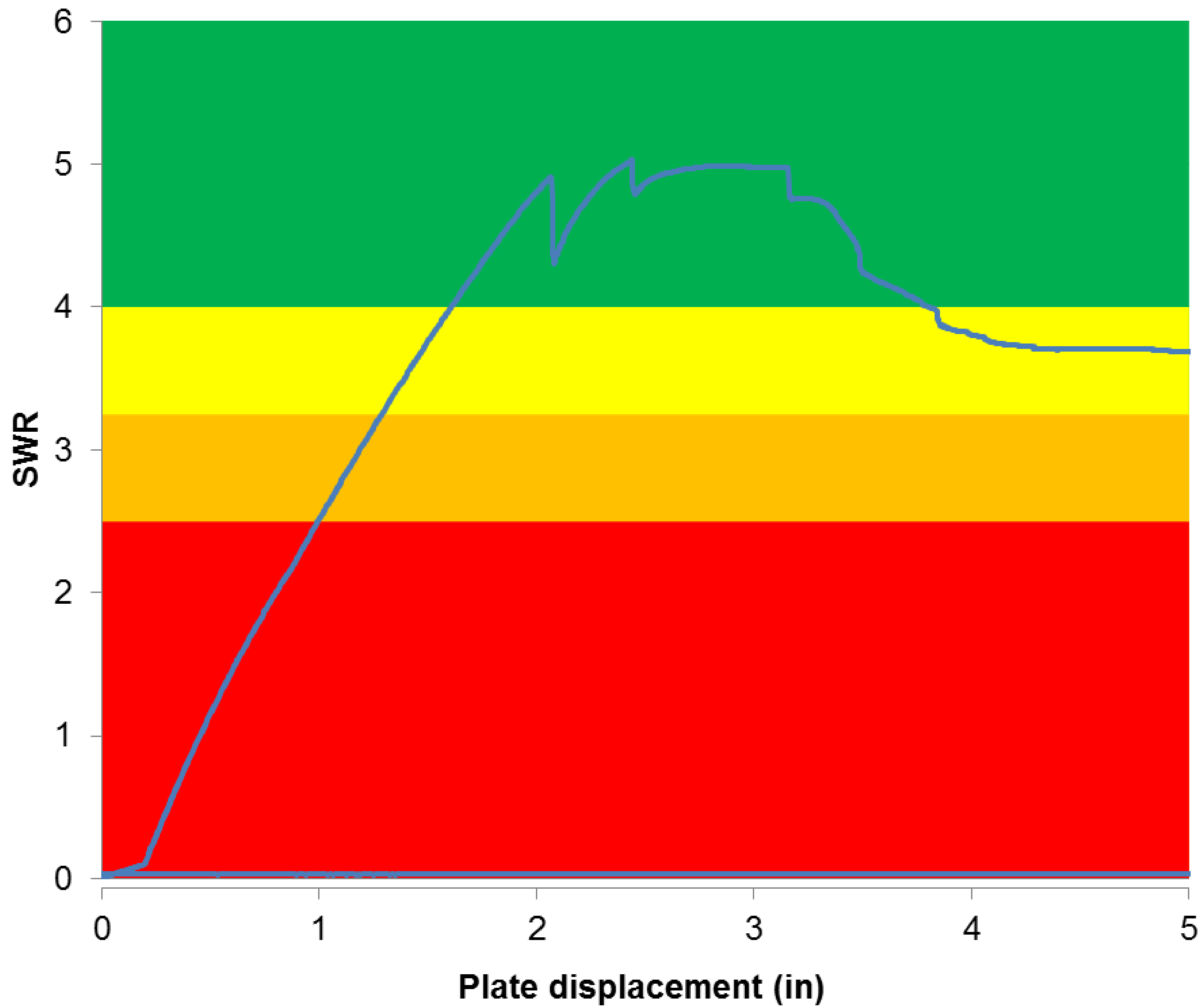
Side Impact



Roof Strength



Roof Strength



Thank You for your Attention