Press-Hardened and Roll-Formed Lightweight Bumpers in Steels with Enhanced Strength

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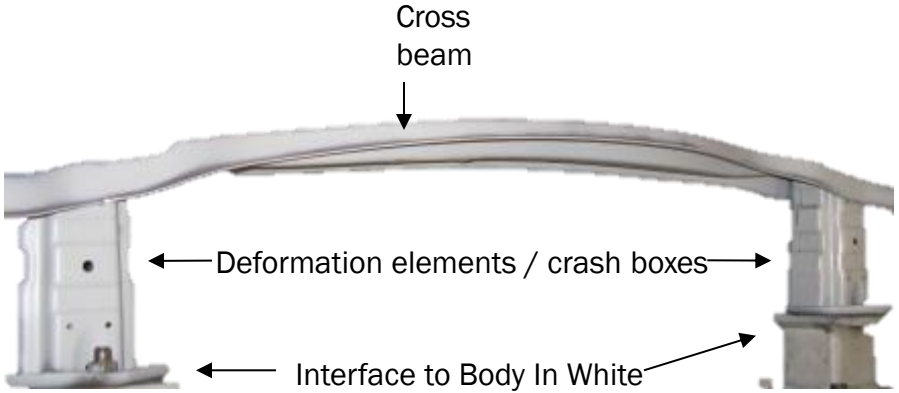
Gestamp

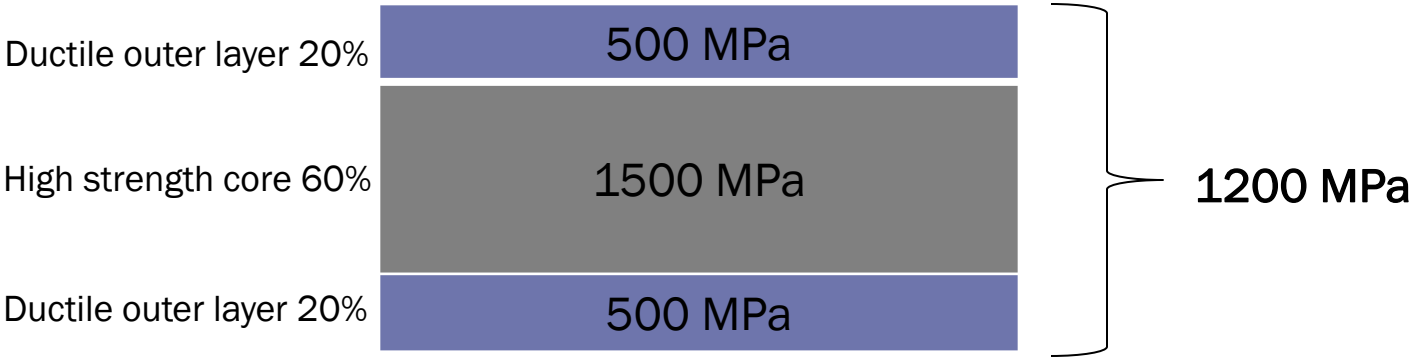
Abstract

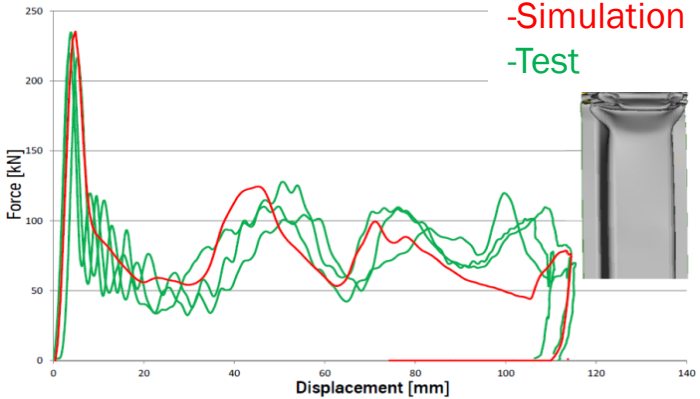
-Bumpers protect the BIW and external attributes in low speed collisions and contribute to crash safety in high speed collisions (transfer loads to the BIW).



-They are continuously improved through implementation of materials with enhanced strength, new design features, new manufacturing processes, reduction of number of components and reduction of package space.

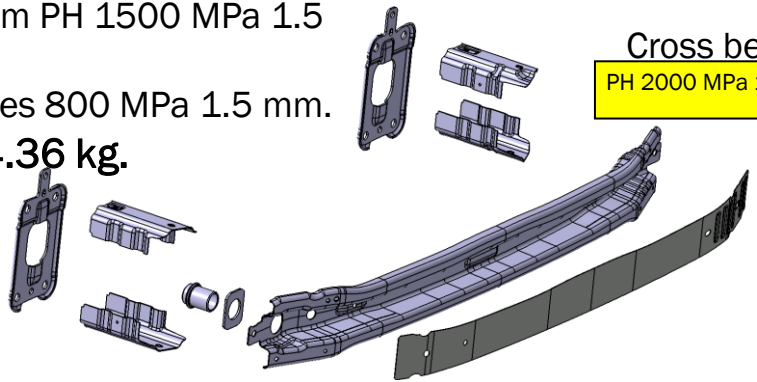
Press-Hardened Three-Layered Material for Deformation Elements



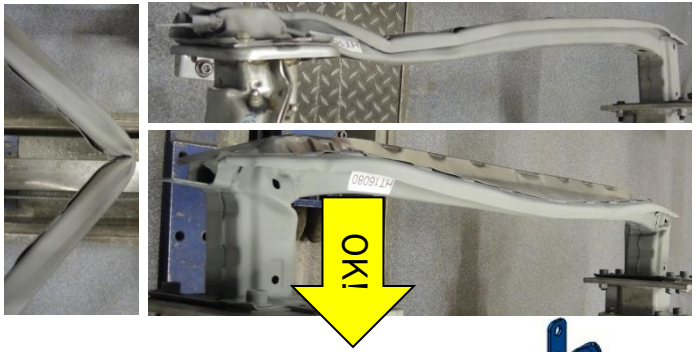


Press-Hardened Uncoated 2000 MPa Material for Cross Beams

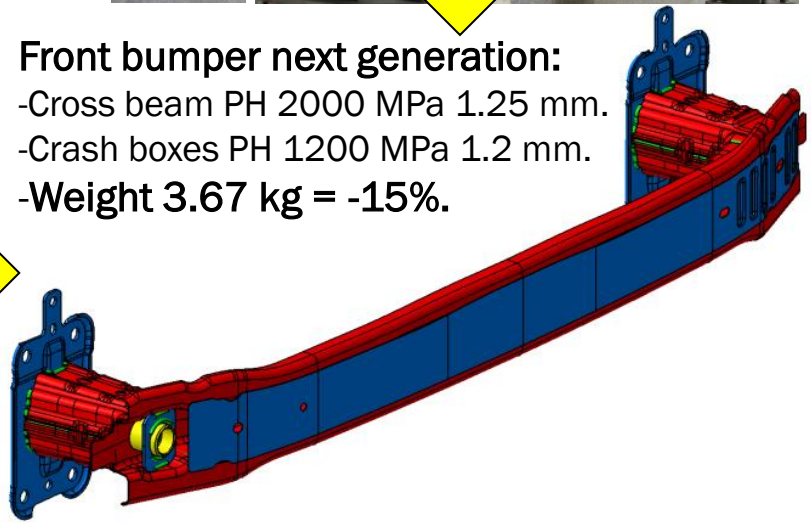
Front bumper:
-Cross beam PH 1500 MPa 1.5 mm.
-Crash boxes 800 MPa 1.5 mm.
-**Weight 4.36 kg.**



Cross beam
PH 2000 MPa 1.5 mm



Front bumper next generation:
-Cross beam PH 2000 MPa 1.25 mm.
-Crash boxes PH 1200 MPa 1.2 mm.
-**Weight 3.67 kg = -15%.**



Front bumper:
-Cross beam PH 1500 MPa 1.2 mm.
-Crash boxes 800 MPa 1.6 mm.
-**Weight 4.38 kg.**

Cross beam
PH 1500 MPa 1.2 mm

Roll-Formed M-Profile, Optimization Process

Objectives:

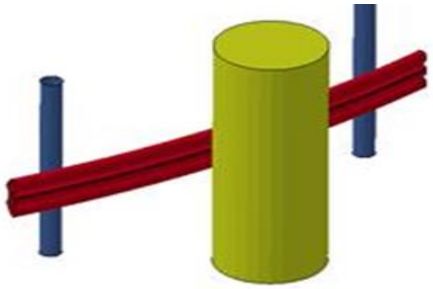
-Reduce weight of bumpers with roll-formed beams.
-Manage high speed crash w/o rupture of materials or welds.
-Fulfill world wide low speed crash requirements.
-Investigate new materials with higher strength.

Solution:

-Beam section with modularity possibility and press-hardened crash boxes.

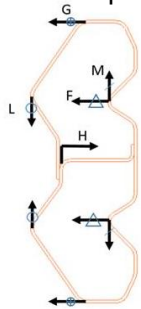
Simulation set-up

-Three point bending.



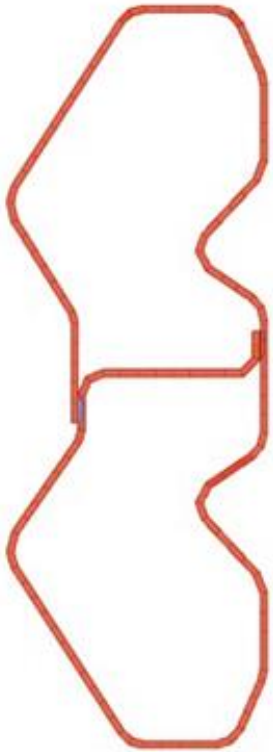
Variables

-Dimensional variations.
-Automatic optimization.



M-profile

-10.4% higher energy absorption / mass unit than benchmark beam.



Front Bumper, Roll-Formed M-Profile, Press-Hardened Crash Boxes

Front bumper:

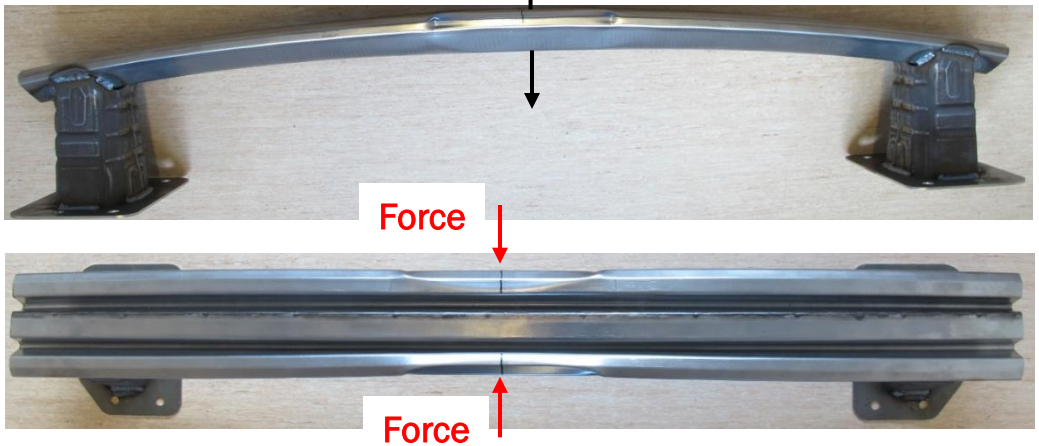
-Cross beam 1200 MPa 1.2 mm.

-Crash boxes PH 1200 MPa 1.2 mm.

-**Weight 6.37 kg = -13%** (compared to benchmark bumper).

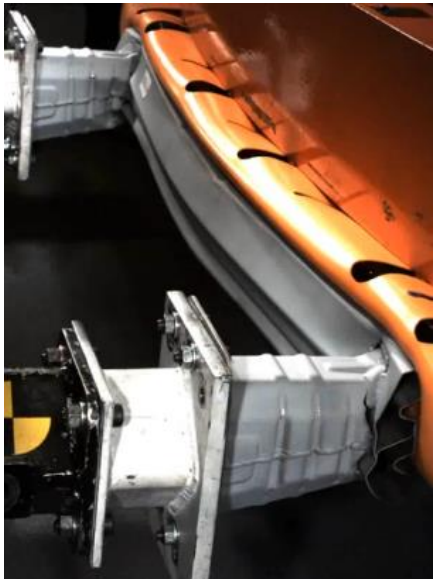
Modularized:

Section depth increased by 10 mm.



Front Bumper, Roll-Formed M-Profile, Press-Hardened Crash Boxes

IIHS O/U 10.5 km/h



-12% lower barrier intrusion and 15% lower beam deflection, with modularized beam, compared to the benchmark front bumper

Center pole , Intrusion 460 mm

AZT 16.0 km/h, 40% Offset Barrier

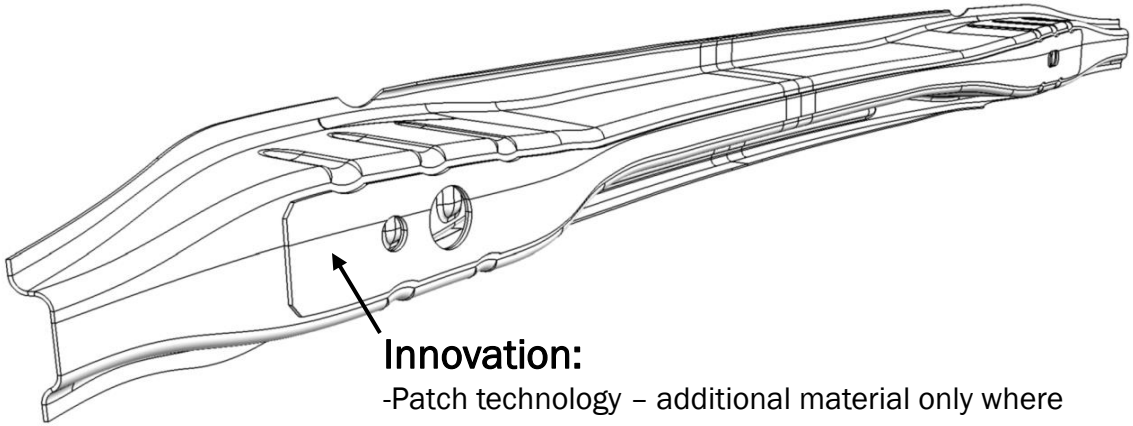
Compact Rear Bumper with Improved High Speed Performance

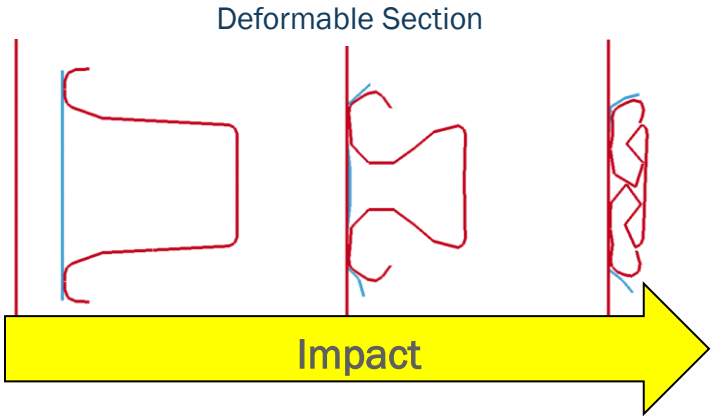
Objectives:

-Reduce the necessary package space for rear bumpers.
-Manage high speed crash without rupture of materials or welds.
-Fulfill world wide low speed crash requirements.
-Investigate new press hardening materials with higher strength.

Solution:

-Implement patch technology on press hardened beam with deformable section.





Innovation:

-Patch technology – additional material only where needed.
-For improved high speed crash performance.

Bumpers with Deformable Beam Section

Ford Focus

Range Rover

BMW 1-series

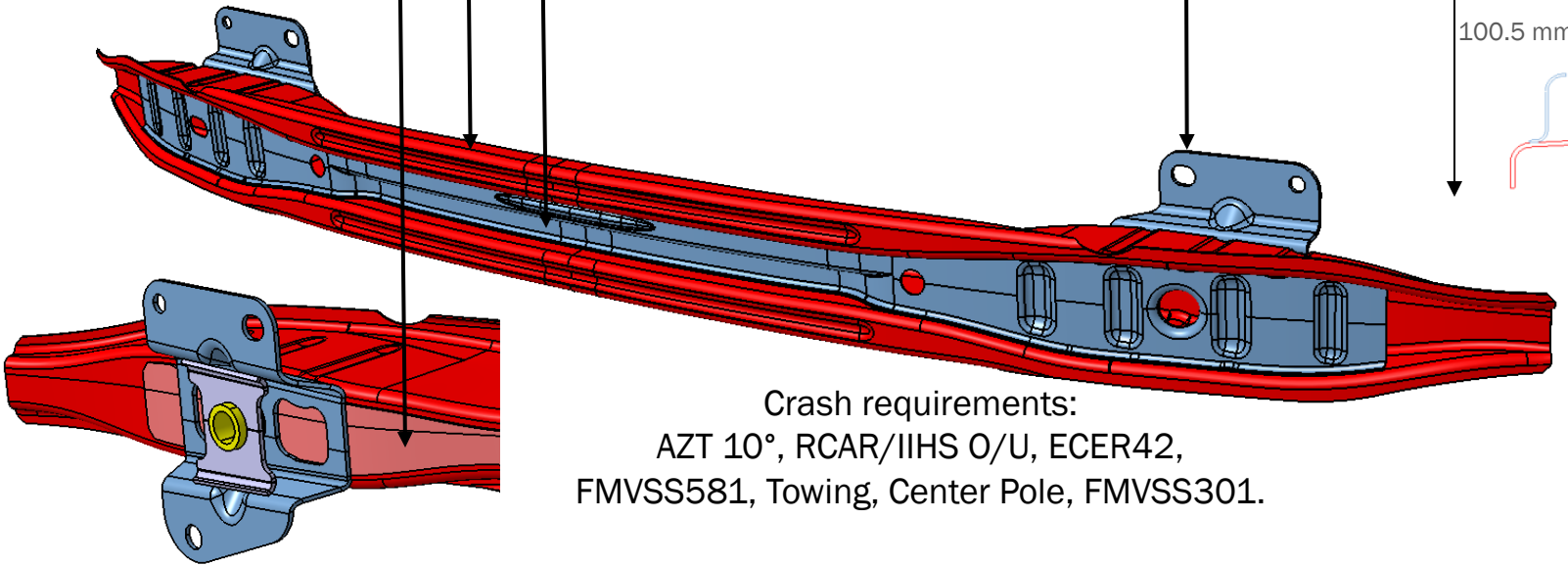
Opel Adam

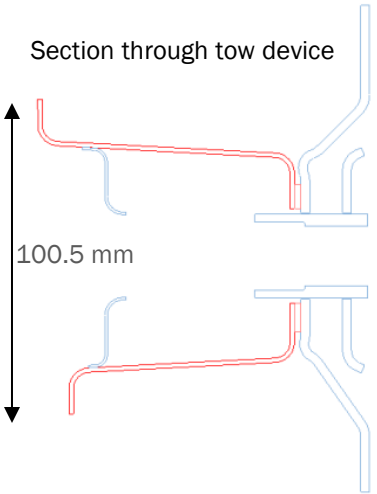
Compact Rear Bumper, Design Concept

Rear bumper:

-Cover plate 800 MPa 0.7 mm.
-Cross beam PH 2000 MPa 1.4 mm.
-Patch PH 2000 MPa 2.0 mm.
-**Weight 5.235 kg**.

-Mounting brackets 700 MPa 2.8 mm.
-Towing bracket 700 MPa 2.8 mm.
-Tow tube 200 MPa.

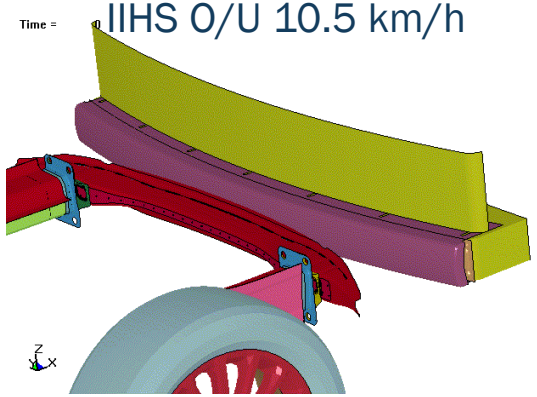




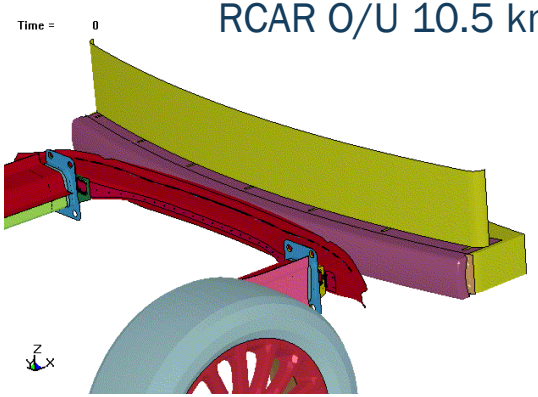
Crash requirements:
AZT 10°, RCAR/IIHS O/U, ECER42,
FMVSS581, Towing, Center Pole, FMVSS301.

Compact Rear Bumper, Low Speed Performance

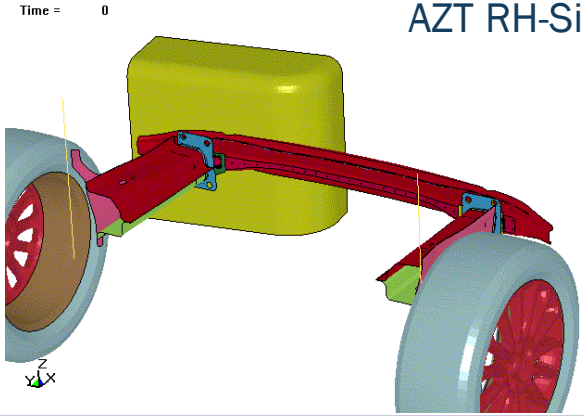
IIHS O/U 10.5 km/h

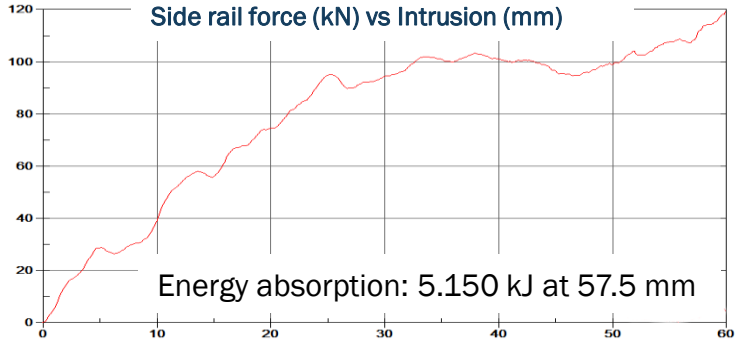


RCAR O/U 10.5 km/h



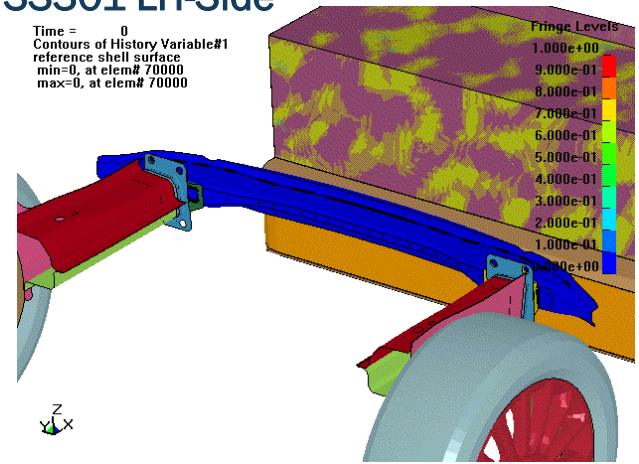
AZT RH-Side 16.0 km/h (1400 kg barrier, 40% offset)

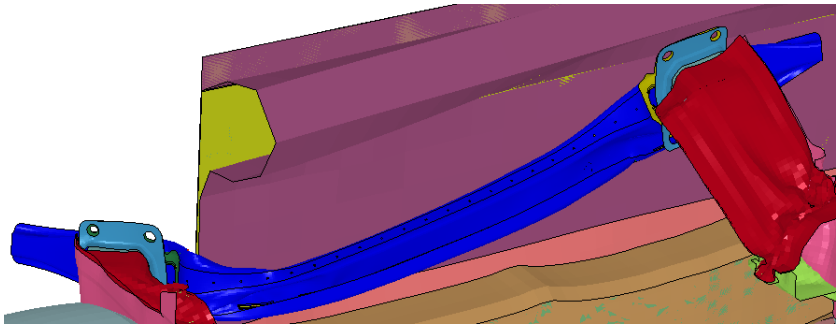




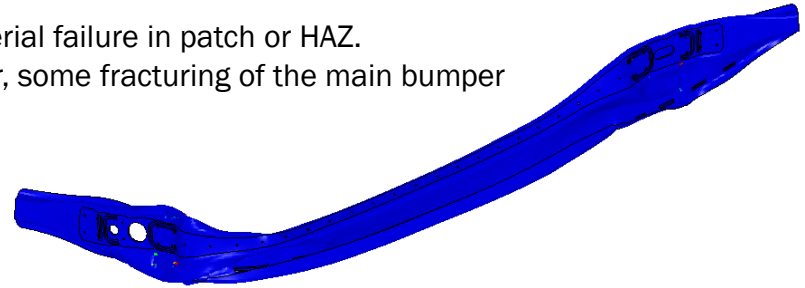
Compact Rear Bumper, High Speed Performance

FMVSS301 LH-Side





-No material failure in patch or HAZ.
-However, some fracturing of the main bumper beam.



Summary

Front bumper, press-hardened beam and crash boxes

A beam in press-hardened un-coated quality with ~2000 MPa tensile strength is good for crash applications, as are crash boxes in press-hardened three-layered 1200 MPa material.

Using these materials can reduce the weight of a present front bumper by ~15%.

Front bumper, roll-formed beam, press-hardened crash boxes

A beam with roll-formed M-profile in 1200 MPa is 10.4% lighter than benchmark roll-formed beam.

The M-profile is possible to modularize, in order to increase the bending stiffness and/or adapt to fit with the package requirement.

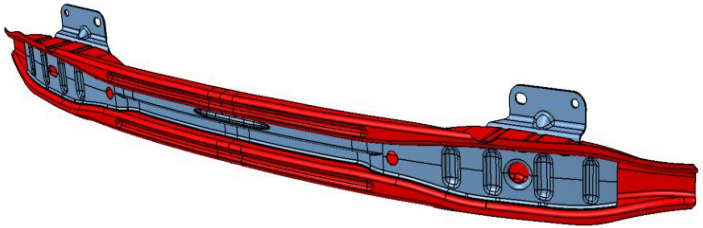
A beam with M-profile in 1200 MPa material and crash boxes in press-hardened 1200 MPa material is 13% lighter than benchmark bumper and still deliver superior crash performance.

Rear bumper, press-hardened beam with patch

A beam in press-hardened un-coated quality with ~2000 MPa tensile strength.

The bumper fulfills world-wide low speed crash requirements.

The bumper beam only experiences minor material failure in high speed impacts. The patch, including heat-affected zones, remain completely intact.



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