

Great Designs in

STEEL 2016

Advanced high strength steel technologies in the 2016 Volvo XC90

Henric Lindberg

System Attribute Leader – Body Structure
Volvo Car Corporation



Demand Nothing Less
www.autosteel.org



AGENDA

- Background
- The All-New Volvo XC90
- Material Mix & Hot-Forming
- Design Solutions & Attributes
- Summary





BACKGROUND

“Cars are driven by people. Therefore the guiding principle behind everything we make at Volvo is – and must remain – safety”

Assar Gabrielsson & Gustaf Larsson,
founders of Volvo (1927)

Vision

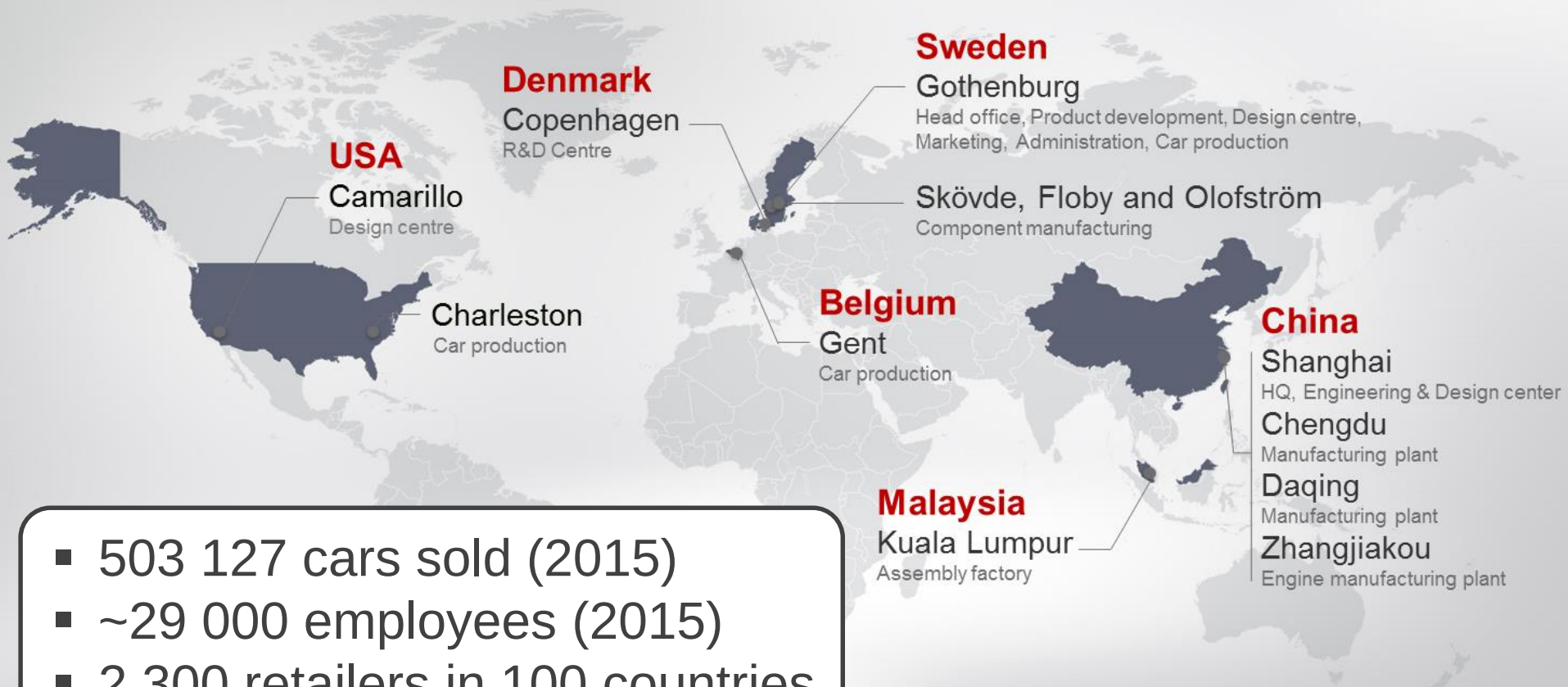
Design cars that should
not crash

Target 2020

Nobody should be killed
or seriously injured in a
new Volvo



BACKGROUND – OUR WORLD



- 503 127 cars sold (2015)
- ~29 000 employees (2015)
- 2 300 retailers in 100 countries

THE NEW VOLVO XC90 / A NEW GENERATION

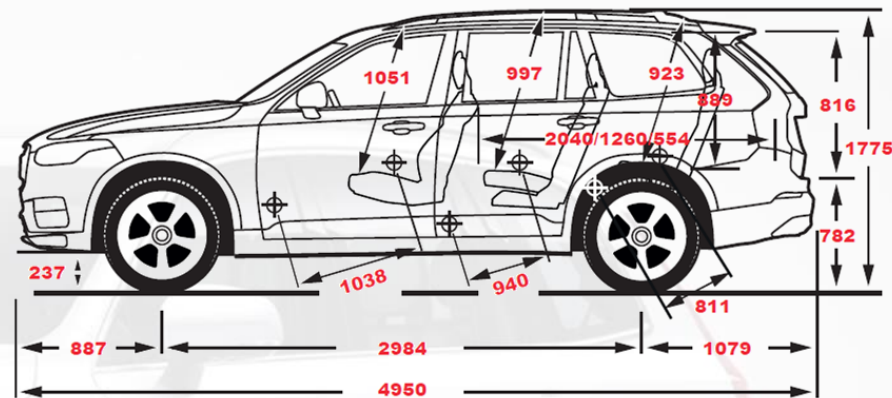


THE NEW VOLVO XC90 – MAIN DIMENSIONS



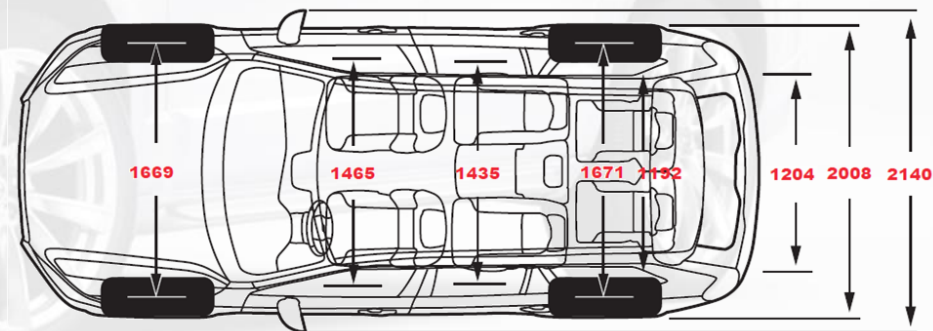
	XC90 Gen II	XC90 Gen I	Δ
Length	4950	4807	+143
Width	2008	1898	+110
Height	1775	1784	-9
WB*	2984	2857	+127

*) WB = Wheel base. All measurements are in mm.



Results

- Improved interior space
- Improved luggage space
- Improved design proportions



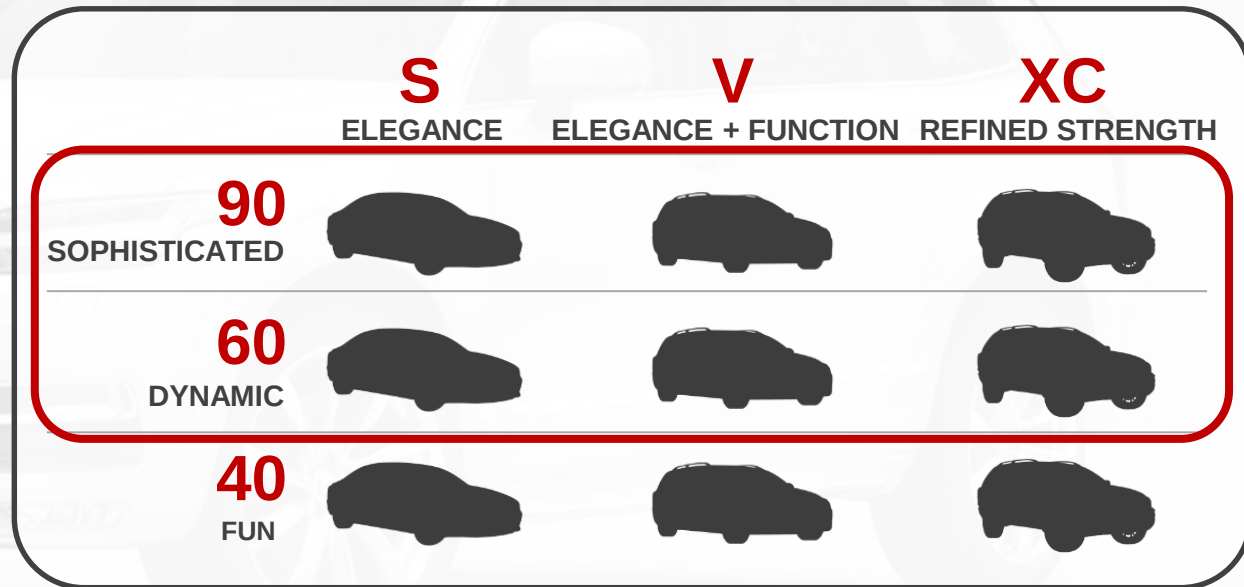
THE NEW VOLVO XC90 / A NEW GENERATION



- First out on the new Volvo architecture (SPA*)
- All-new vehicle from inside to outside
- Designed and produced in Sweden

The Promise

- Safety leadership
- Scandinavian design
- Class leading HMI**
- Class leading fuel efficiency



*) Scalable Product Architecture

***) HMI = Human Machine Interface

SPA / SCALABLE PRODUCT ARCHITECTURE



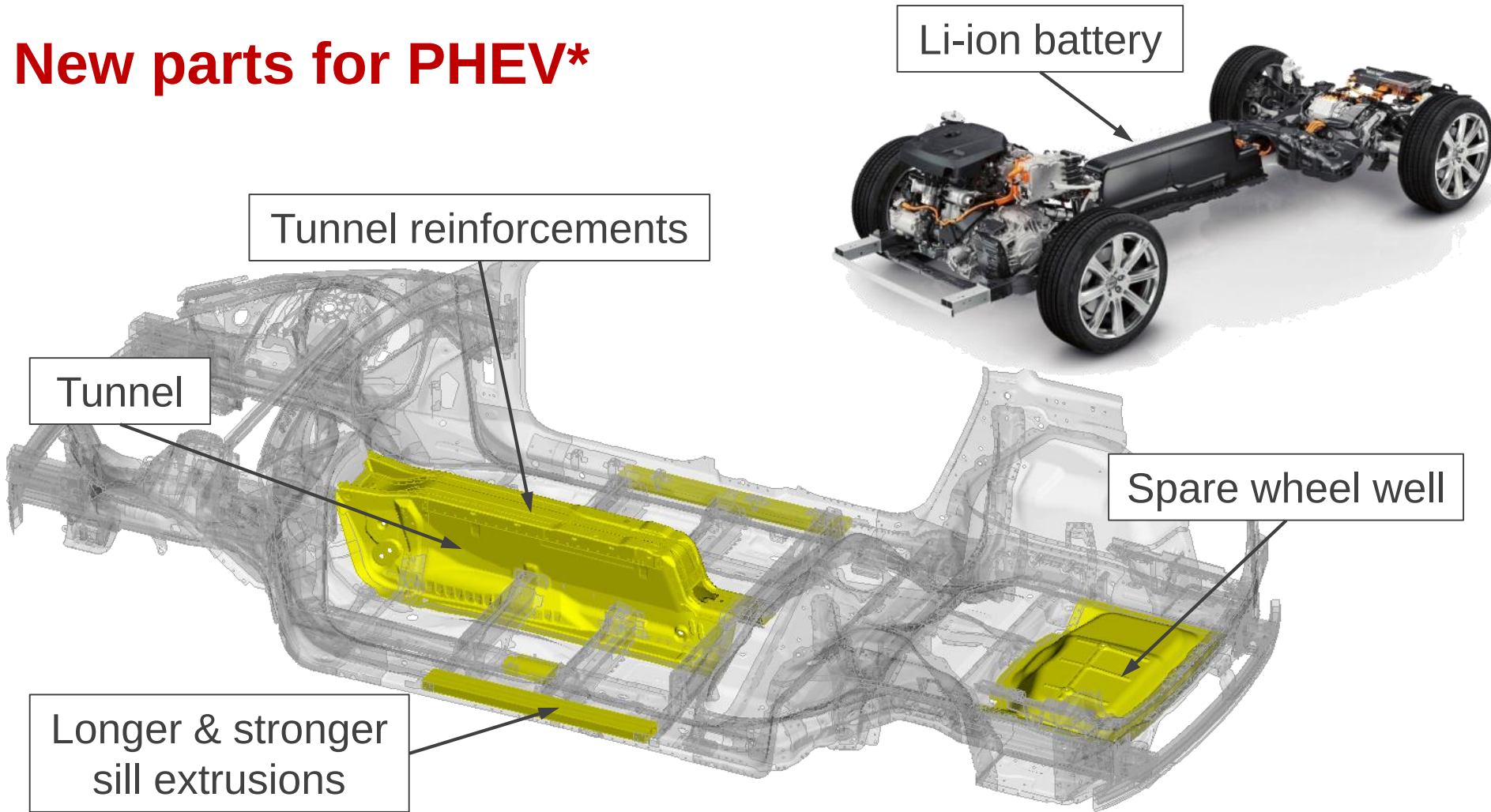
- Enables flexibility – only Heel-Point to wheel center is fixed
- Covers S60 to XC90 PHEV
- AWD, FWD and Twin Engine capability
- Spring and Air Spring suspension available



SPA / PHEV* ADAPTION



New parts for PHEV*



*) PHEV = Plug-In Hybrid Electrical Vehicle

No differences in the upper body

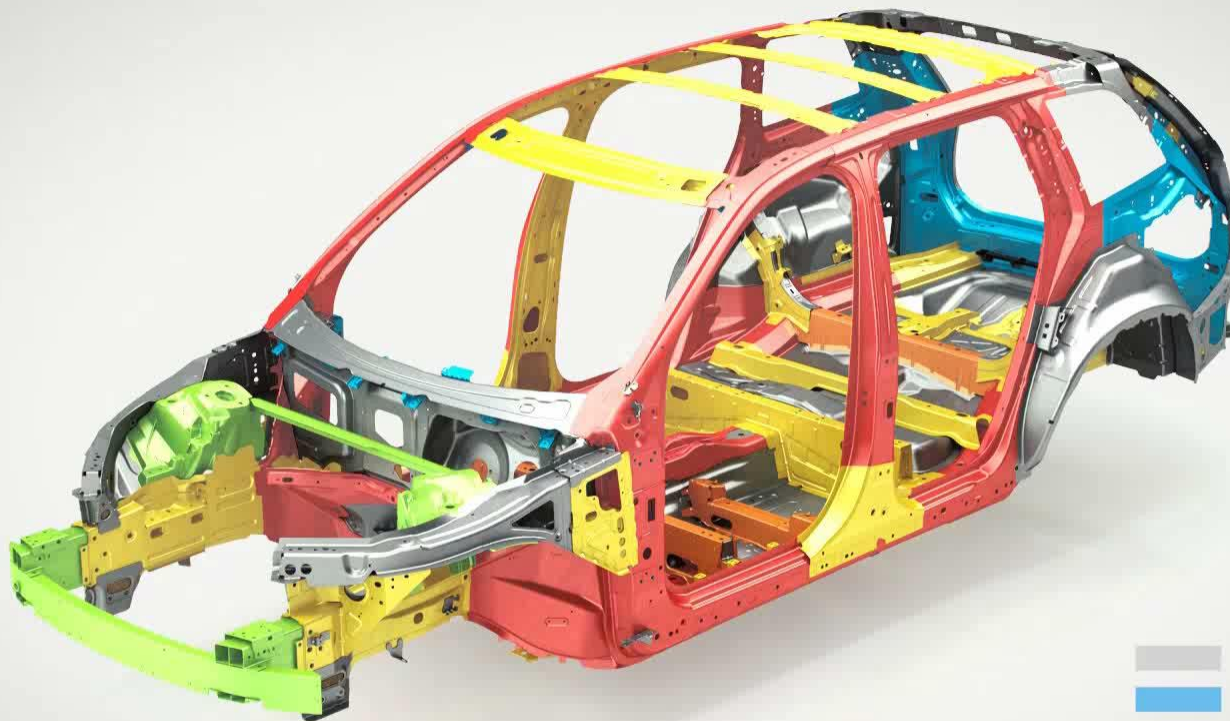
THE NEW VOLVO XC90



Material mix & Hot-Forming



MATERIAL MIX IN THE NEW VOLVO XC90

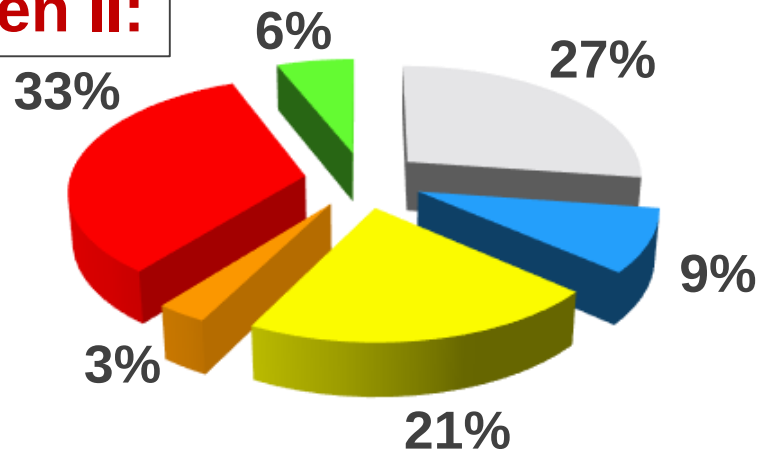


- Mild steel
- High strength steel
- Very high strength steel
- Extra high strength steel
- Ultra high strength steel
- Aluminium

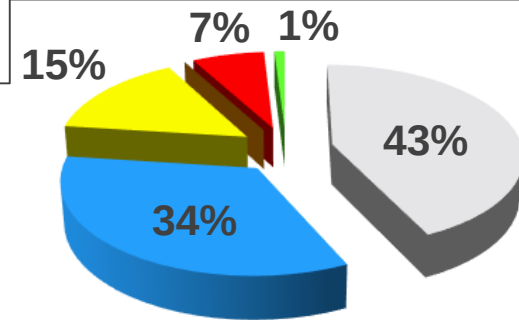


MATERIAL MIX IN THE NEW VOLVO XC90

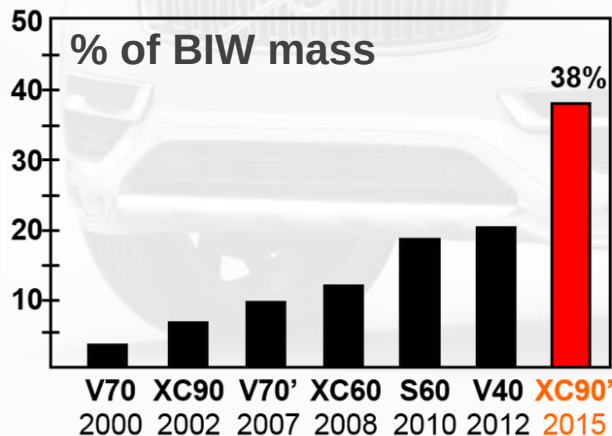
Gen II:



Gen I:



Hot-formed steel



Remarks:
Boron steel 33%
Hot-formed steel 38%

- Mild steel
- High strength steel
- Very high strength steel
- Extra high strength steel
- Ultra high strength steel
- Aluminium

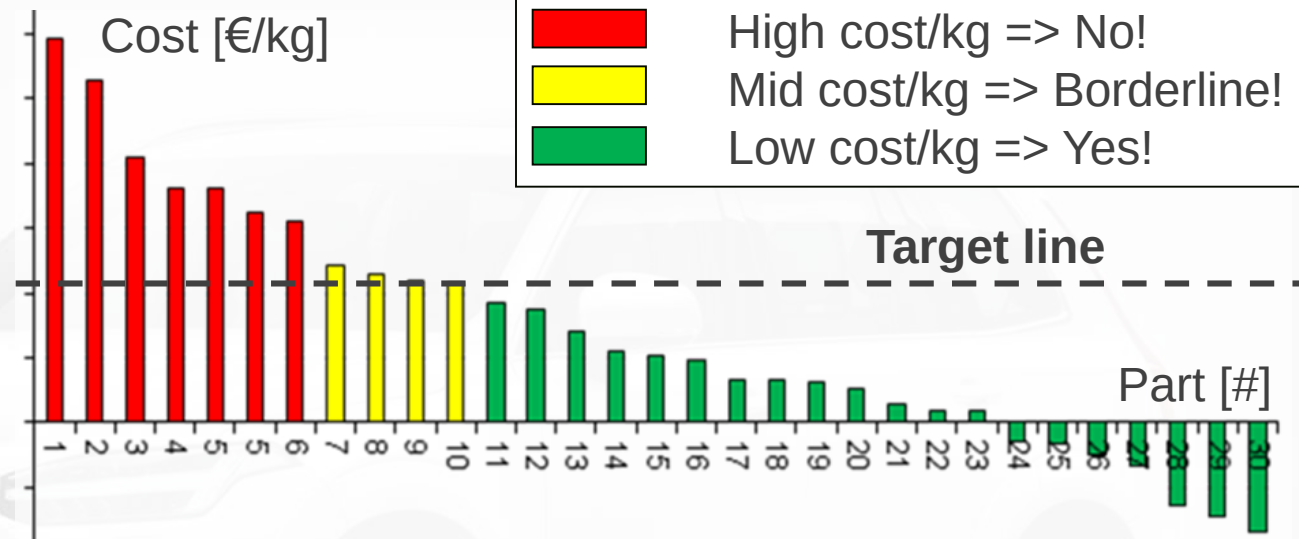
HOT-FORMED STEEL

Why hot-formed steel?

- Strength
- Mass reduction
- Formability for complex shapes
- Cost

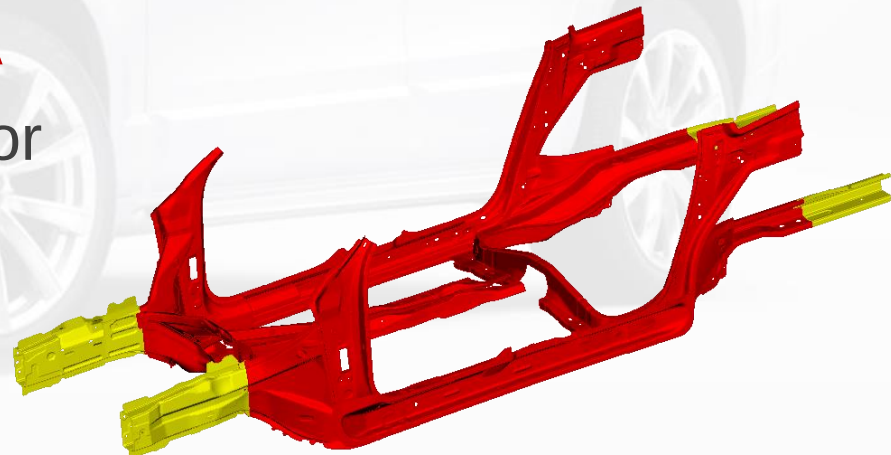
Conclusion

- High cost/kg => No!
- Mid cost/kg => Borderline!
- Low cost/kg => Yes!



Change introduced in SPA

- Hot-formed steel also in the floor
- Further new techniques with hot-forming
- In-house production introduced



HOT-FORMING TECHNIQUES USED

An overview of the different hot-forming techniques in the new Volvo XC90:

New!

Tailor Welded Blanks (TWB)



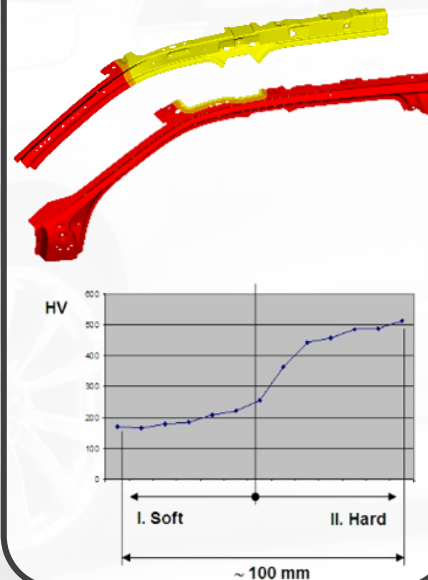
New!

Tailor Rolled Blanks (TRB)

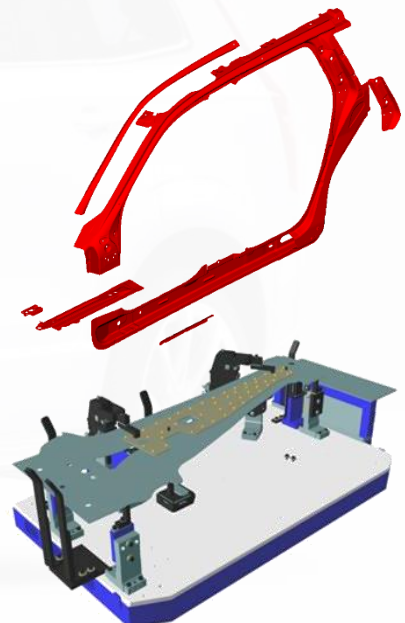


Partially new!

Tailored Tempering (Soft Zone)



Patch Technology

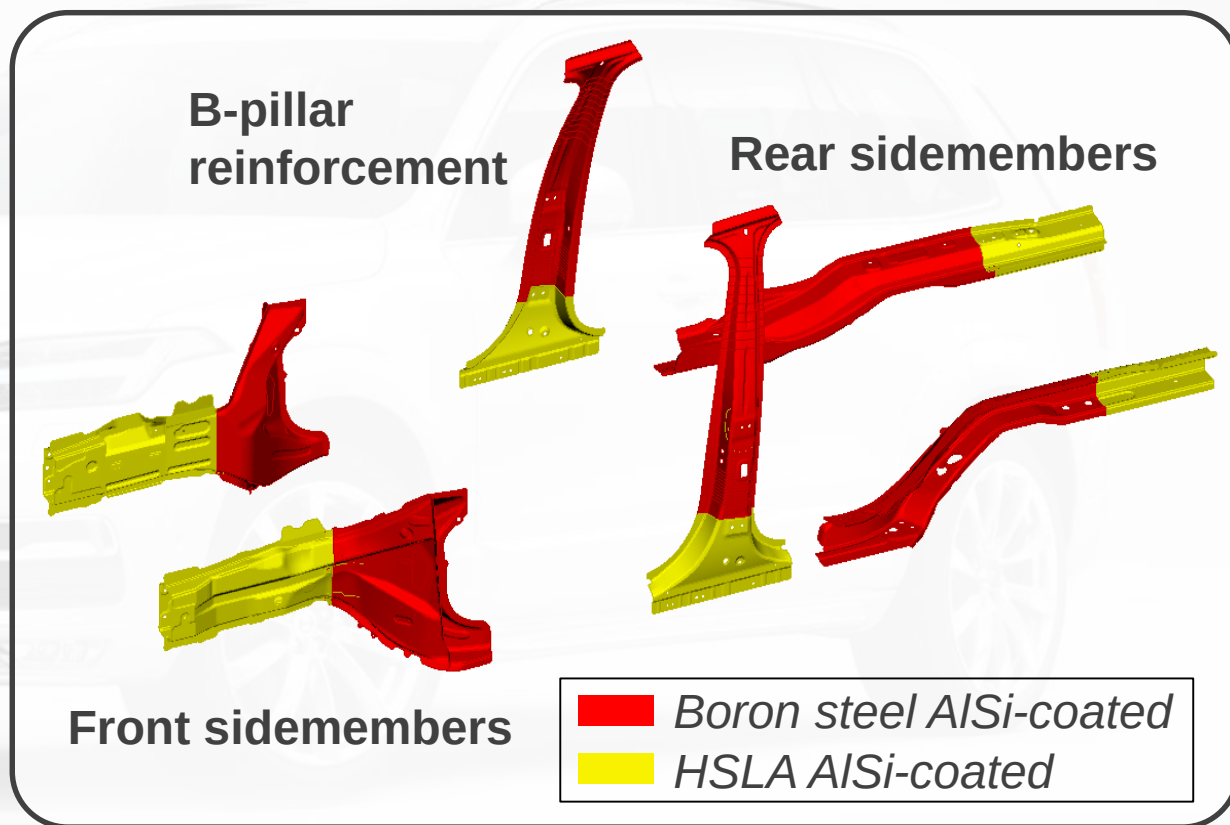


DESIGN SOLUTIONS WITH HOT-FORMING

Tailor Welded Blanks (TWB) in Sidemembers and B-pillar reinforcement:

Driver

- Front sidemember – front offset crash
- B-pillar – side barrier impact
- Rear sidemember – rear offset crash
- Mass

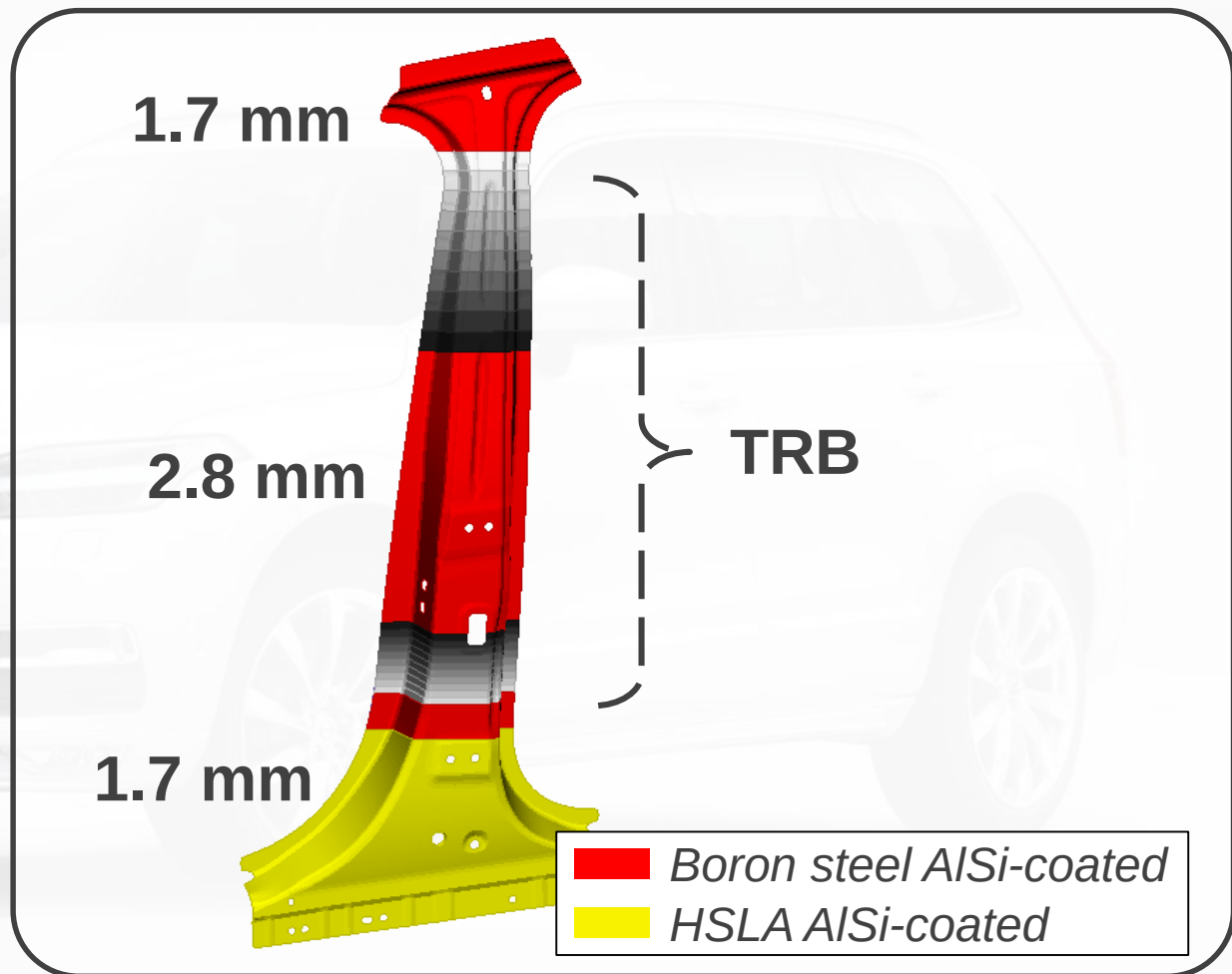


DESIGN SOLUTIONS WITH HOT-FORMING

Tailor Rolled Blanks (TRB) in B-pillar reinforcement:

Driver

- Side barrier impact
- Mass
- Cost

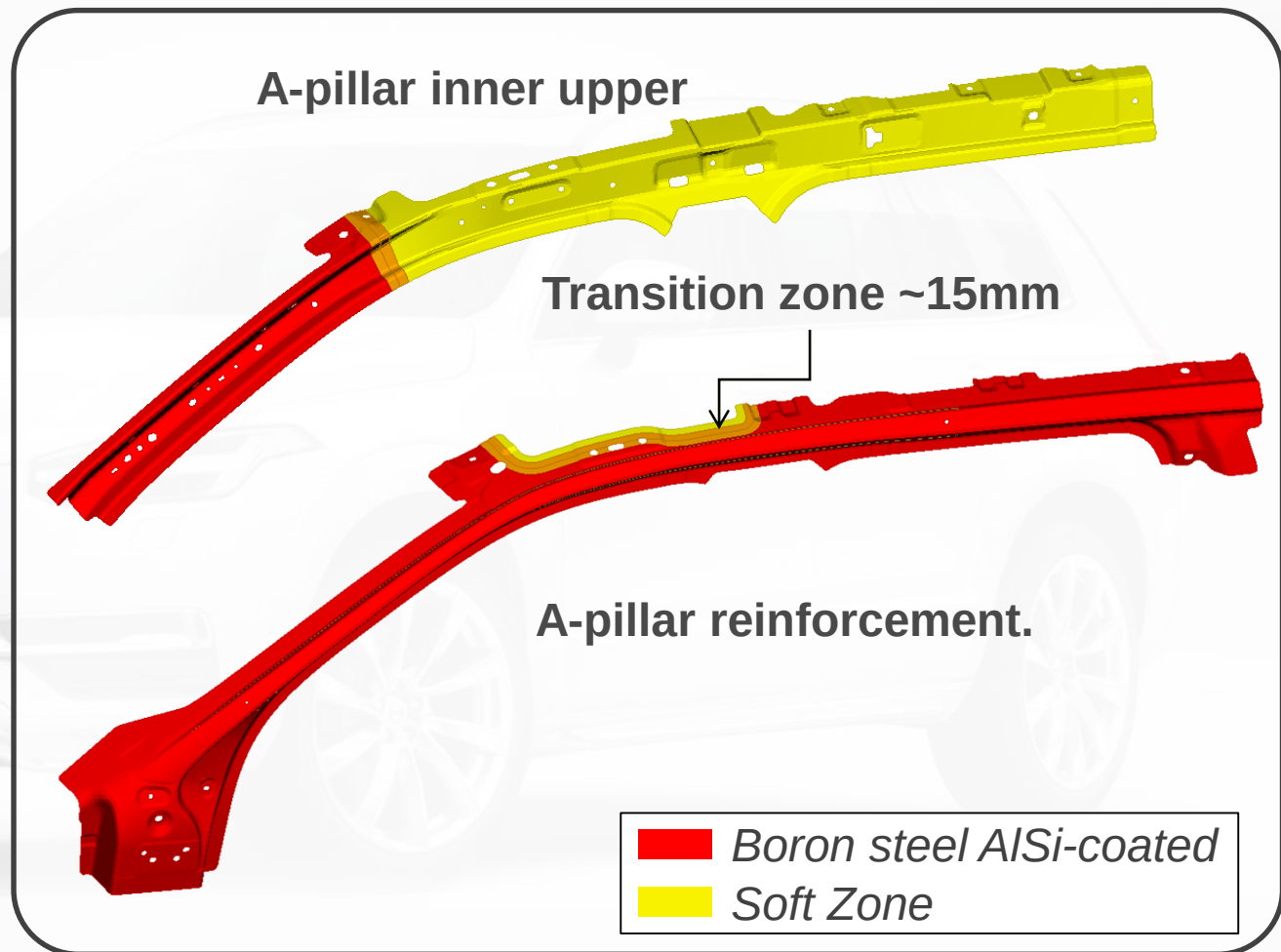


DESIGN SOLUTIONS WITH HOT-FORMING

Tailor Tempering (Soft Zone) in A-pillars:

Driver

- Side pole impact
- Mass

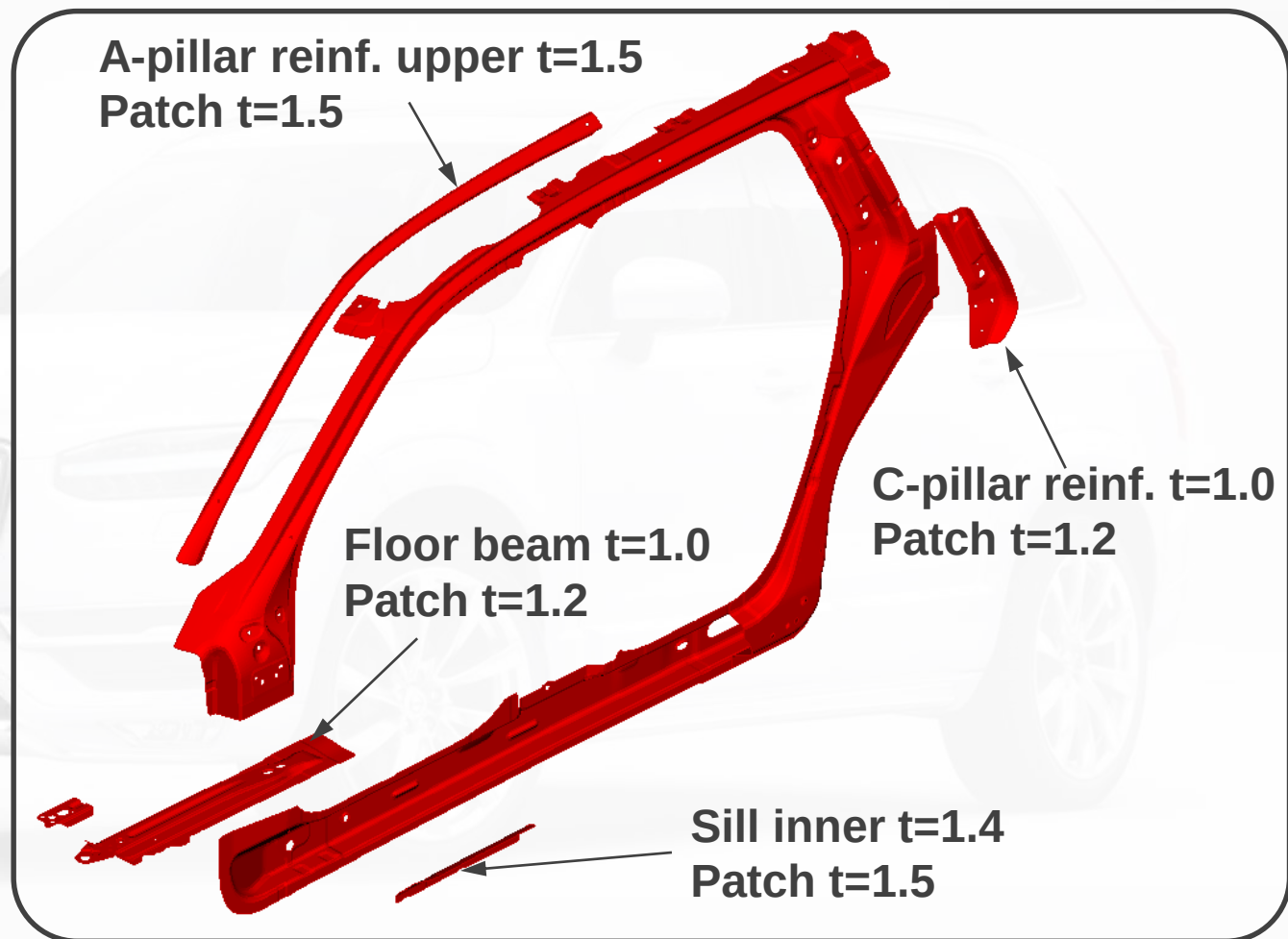


DESIGN SOLUTIONS WITH HOT-FORMING

Reinforcement with patch:

Driver

- Belt pull
- Front crash
- Side pole impact
- Mass



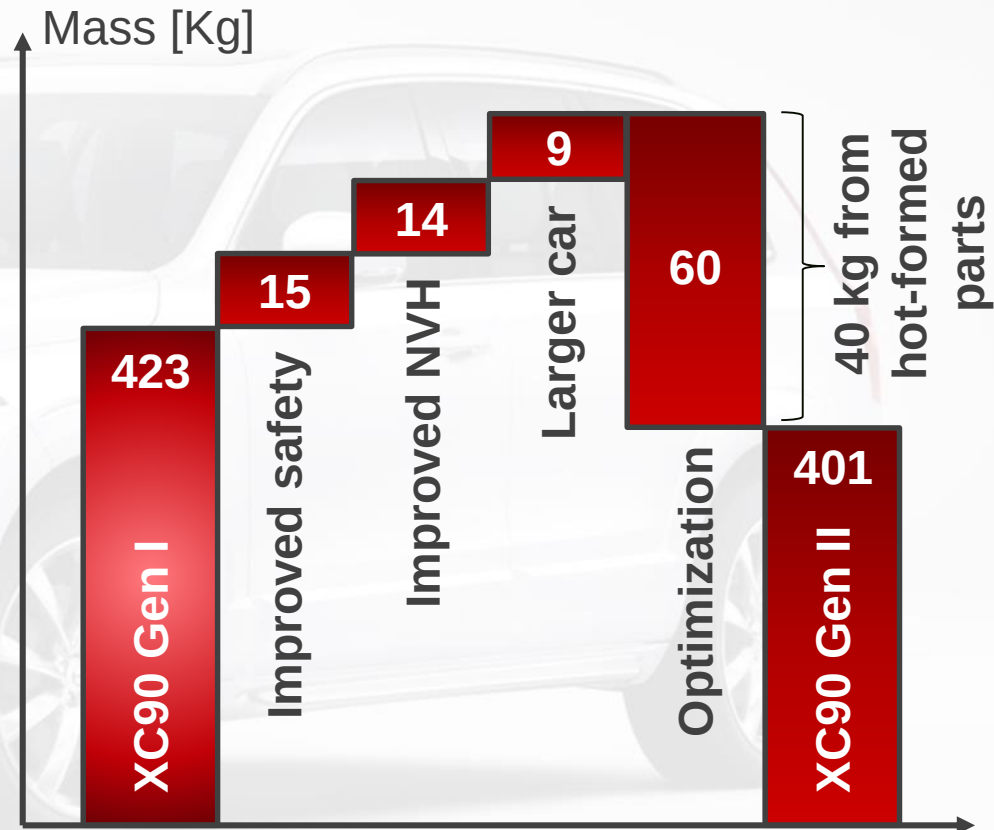
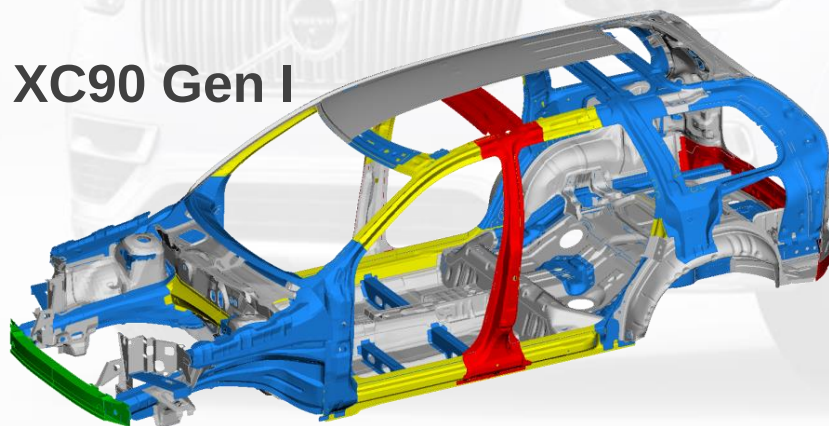
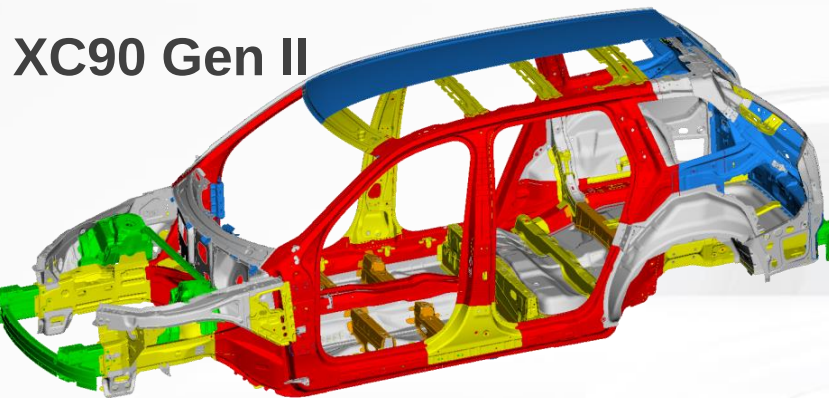
THE NEW VOLVO XC90



Design principles and attributes



MASS WALK – VOLVO XC90



GLOBAL STIFFNESS

Structural principles

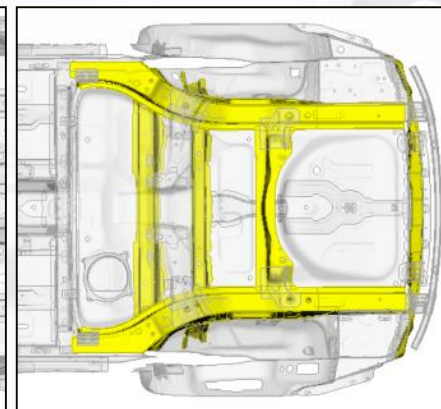
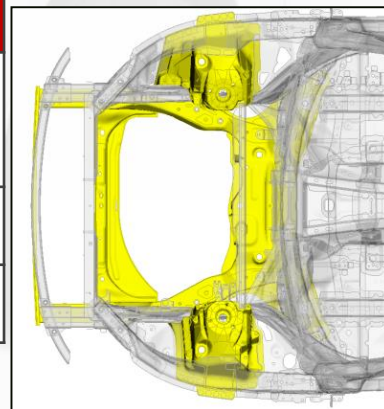
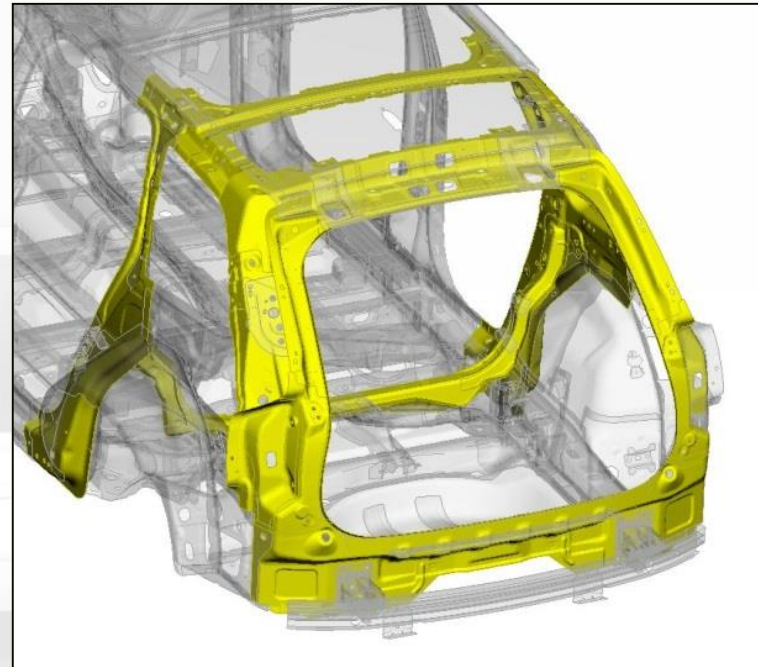
- Stiff ring structures
- Stiff spring tower
- Bolted front subframe
- Lateral floor crossmembers
- Sidemembers with high sections

Performance BIG*

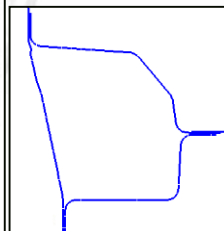
Global stiffness

	XC90 Gen II	XC90 Gen I	Δ
K_{TG} [kNm/deg]	25.0	21.4	+3.6
1 st mode [Hz]	37	34	+3

*) BIG = Body In Grey, KTG = Global Static Torsional Stiffness



Rear side member



DESIGN PRINCIPLES – ATTACHMENT STIFFNESS

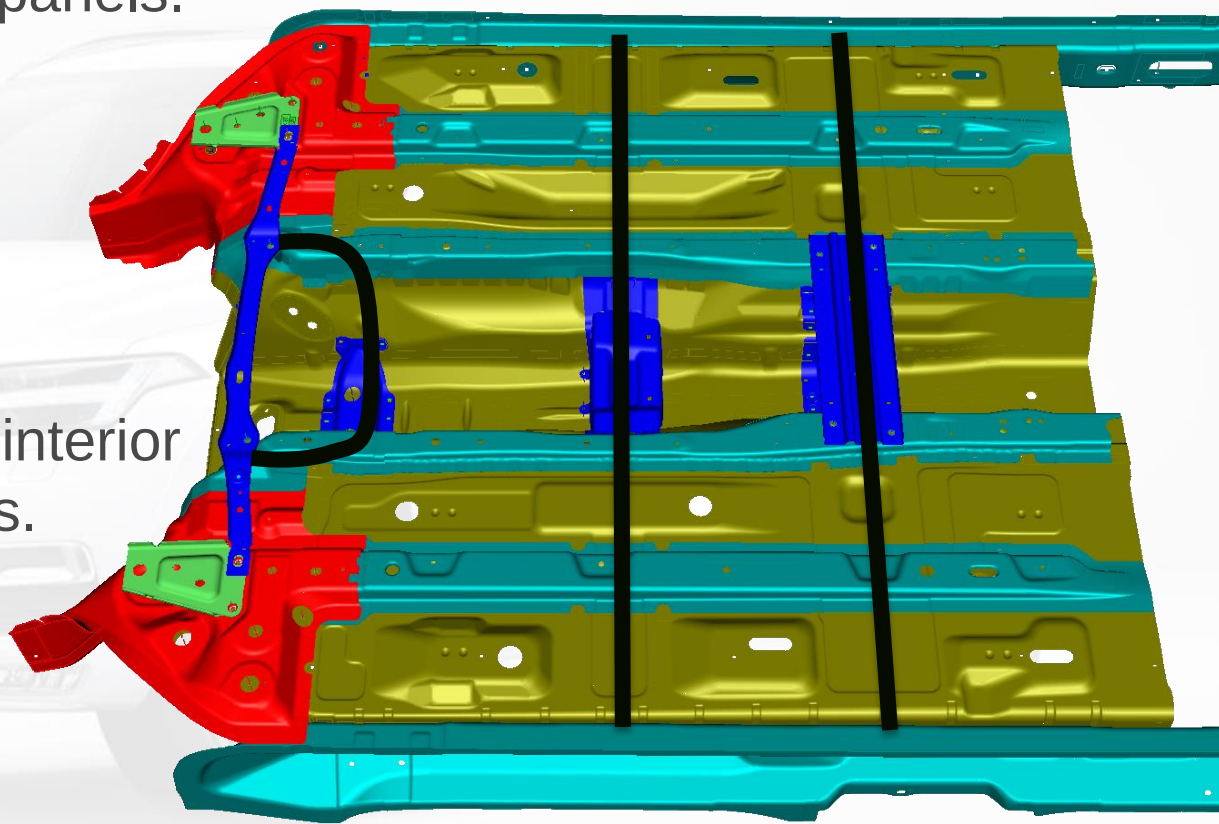


Structural principles:

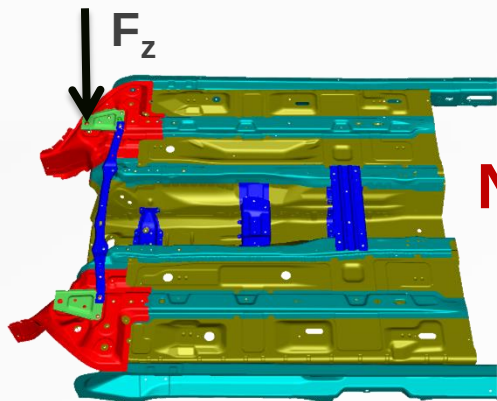
- Floor and tunnel - thin panels.
- Large connecting reinforcements
- Subframe attachments
- Longitudinal members.
- Transversal members.
- Crossmembers on the interior side to close load paths.

Driver

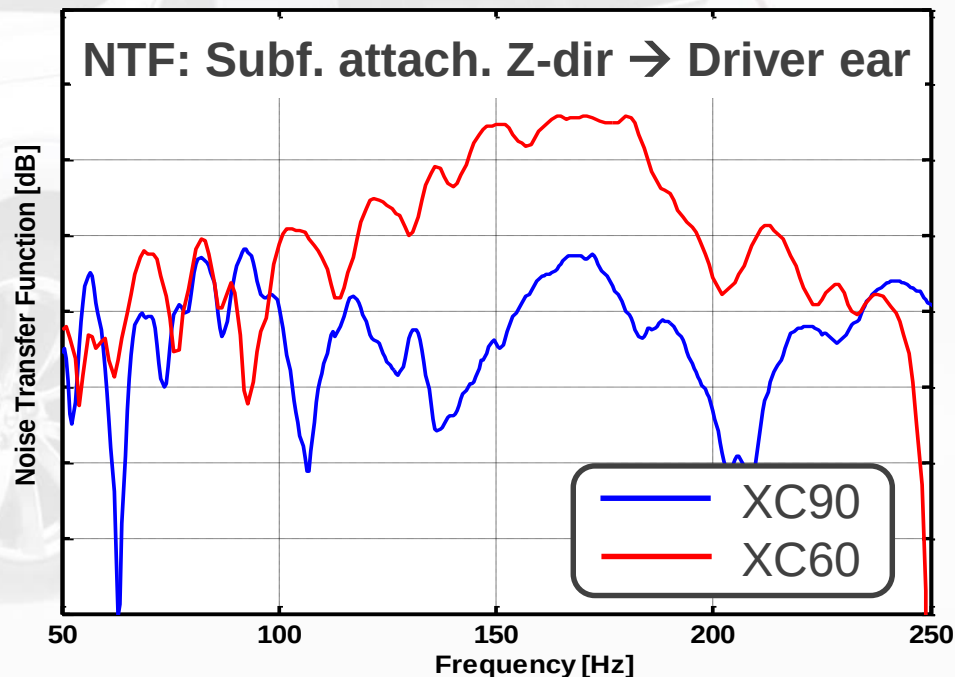
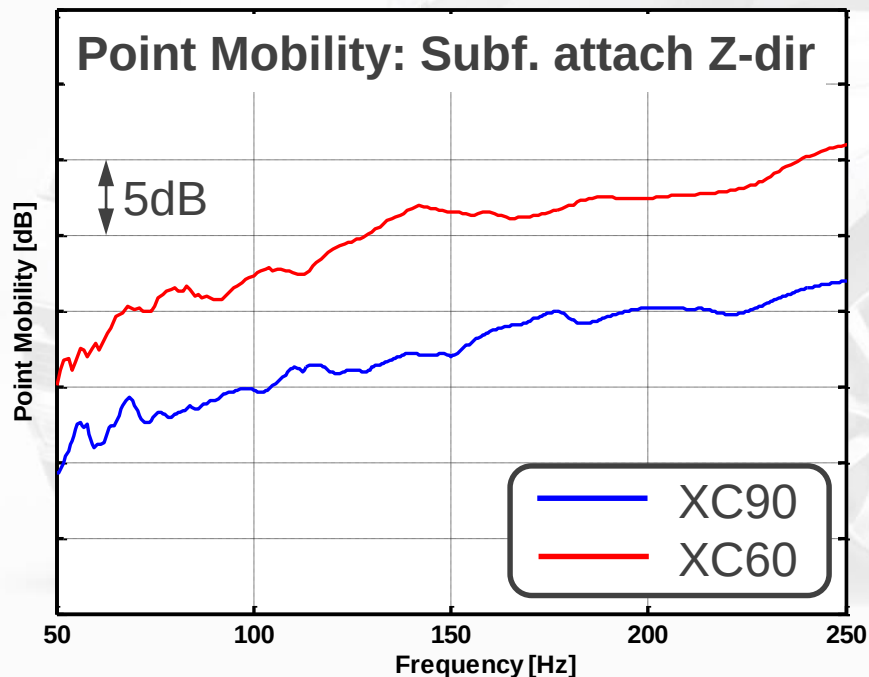
- NVH
- Durability
- Driving dynamics



DESIGN PRINCIPLES – ATTACHMENT STIFFNESS



NVH-performance of chassis attachment point
→ Substantial performance increase!

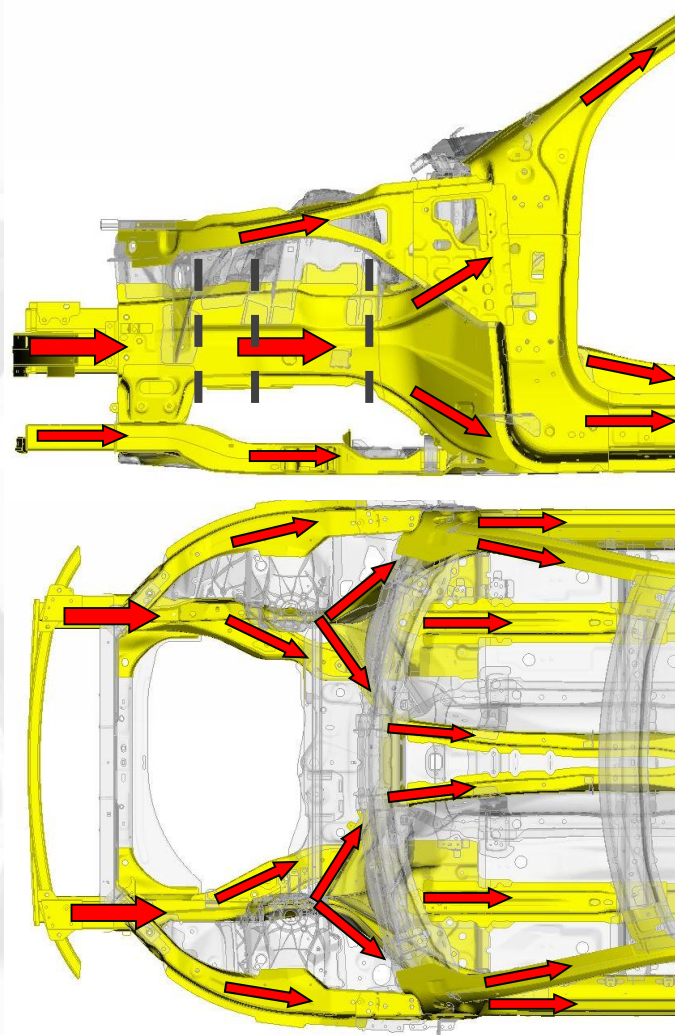


DESIGN PRINCIPLES – FRONT STRUCTURE



Structural principles

- Crash optimized E/W-engine installation
- Multiple load paths
- Lower load path for compatibility
- Pre-determined deformation modes (bend lines)
- Safety cage designed for overload



DESIGN PRINCIPLES – SMALL OVERLAP

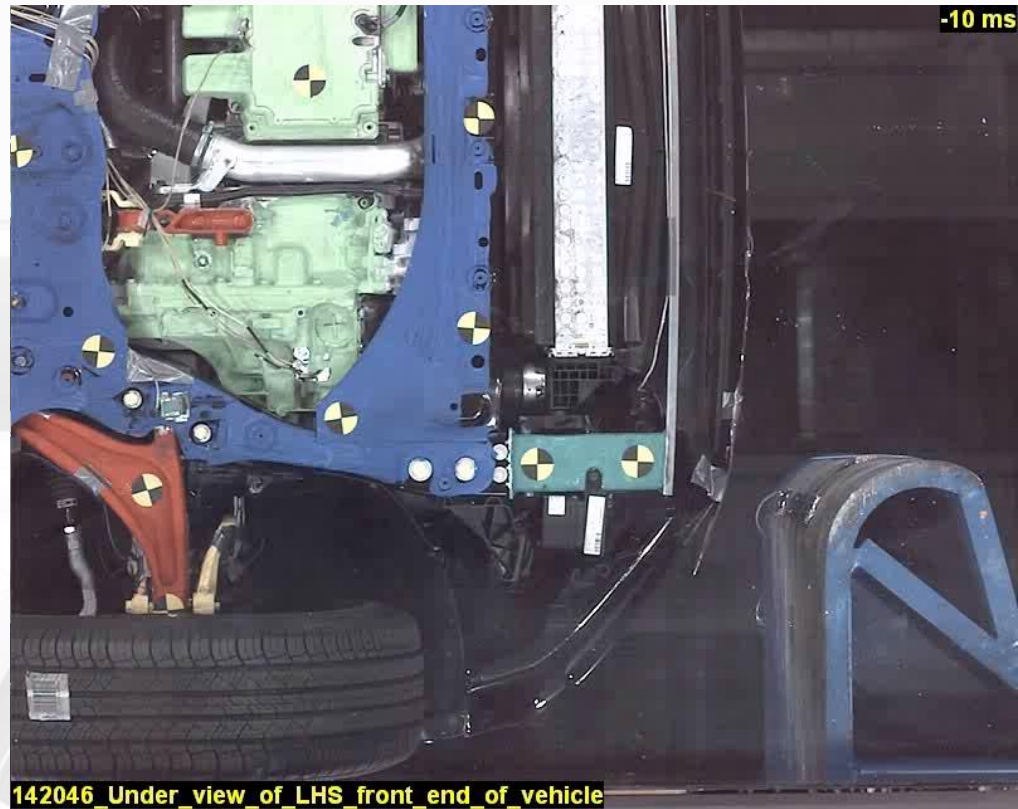
Structural principles

Same basic principles since the early 1990s*:

- Slide away from obstacle
- Strong safety cage
- Restraint systems adapted for small overlap

Performance

- Low structural deformations on all models
- IIHS TOP SAFETY PICK on all current models
- Example: IIHS Small overlap, 40 mph, 25% overlap



(*) Planath, I., Norin, H., Nilsson, S, "Severe Frontal Collisions with Partial Overlap – Significance, Test Methods and Car Design", SAE Technical Paper 930636, 1993

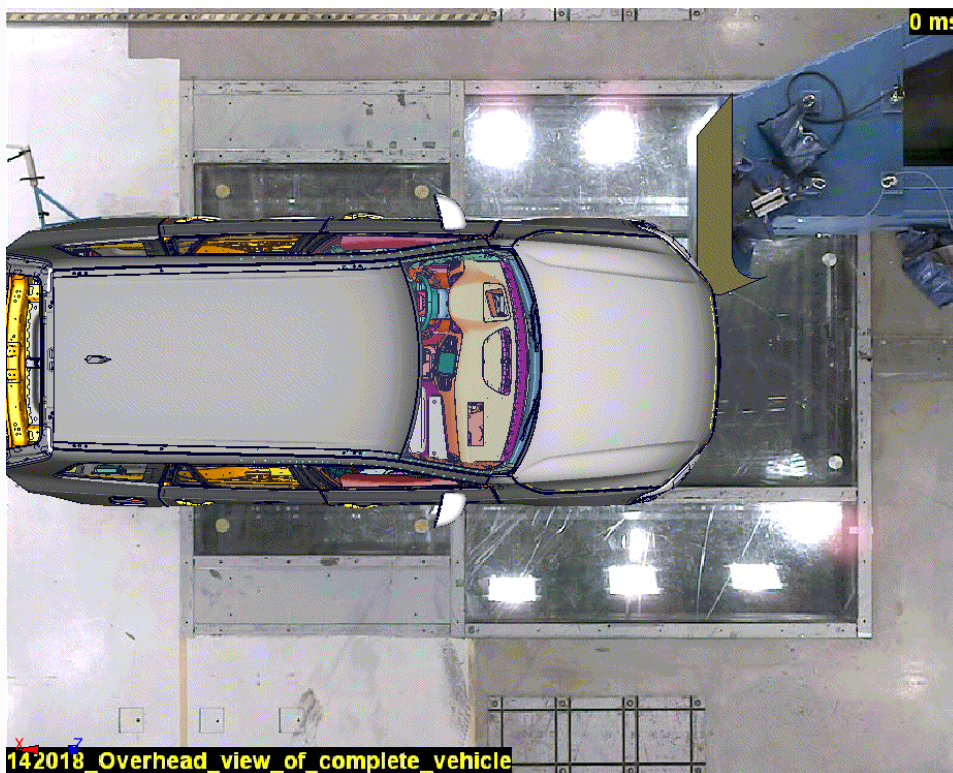
L. Jakobsson et. al. (2013) Severe Frontal Collisions with Partial Overlap - Two Decades of car Safety Development, SAE International, 2013-01-0759

DESIGN PRINCIPLES – SMALL OVERLAP



CAE

TEST



THE NEW VOLVO XC90



Summary





THE NEW VOLVO XC90 – SUMMARY

- SPA – A brand new generation of architecture
- Body structure with mass efficient concepts and extensive use of Advanced High-Strength Steel
- 38% hot-forming steel to meet safety demands and enable mass saving with approximately 40 kg
- Volvo in-house production of hot-forming steel, with first supply to the new XC90
- Increased body stiffness both global and local for NVH and driving performance – Stronger, stiffer, larger & lighter!
- One of the safest car in the world!

THE NEW VOLVO XC90



Acknowledgements



THE NEW VOLVO XC90 – ACKNOWLEDGEMENTS



All-Wheel Drive Car of the Year - SUVs over EUR 50.000 | Auto Bild Allrad reader poll | Germany | 2016

Best in class overall

Best Car of the Year | The Year's Best SUV Imports | Fitch IHS | Germany | 2016

Best SUV | SUVs | 50,000 - 120,000 | Austria's Best Cars | Austria | 2016

Most innovative new Car of the Year | MARCUS | Austria | 2016

EuroNCAP – 2016

Best Luxury Car | Luxury Car of the Year | Autocar | USA | 2016

Best Imported Large SUV | Auto Motor & Sport Reader Poll | Germany | 2016

Car of The Year Safety Award | what Car? | UK | 2016

Vehicle of the Year | CNET | USA | 2016

Top Safety Pick

SUV of the Year | Luxury | USA | 2016

Truck of the Year | Detroit Free Press | USA | 2016

Car Of The Year | Teknikens Värld | Sweden | 2016

IIHS – 2015

Driver's Choice - Best Luxury Car | Motor Week | USA | 2016

Driver's Choice - Best of the Year | Motor Week | USA | 2016

Best Cars of the Year | Autoblog.com | USA | 2016

Winner in 'Large 4x4 and SUV' category | The Sunday Times | UK | 2016

SUV of the Year | Motor Trend | USA | 2015

North American

Large SUV of the Year | Auto Express | UK | 2015

Car Of The Year | Auto Express | UK | 2015

Truck of the Year – 2016

Best Big SUV | Auto Motor & Sport | Germany | 2015

Car of the Year | Large SUVs | Germany | 2015

Best of the Best Product Design Award | Red Dot Awards | Germany | 2015

THE NEW VOLVO XC90



THANK YOU FOR YOUR ATTENTION!

