GREAT DESIGNS IN STEEL

ACCRA® (Closed Section Hot Form Manufacturing) Technology Developments

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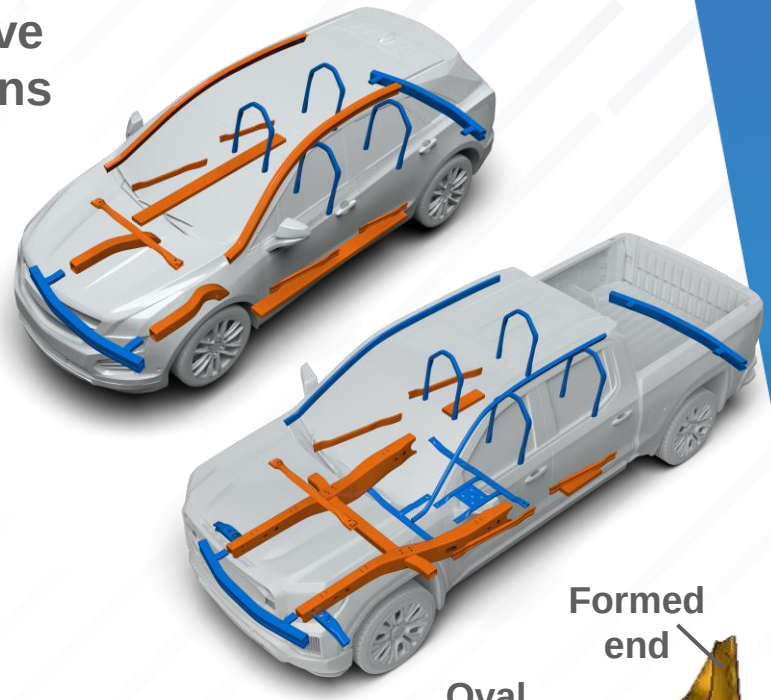
Multimatic

GDIS

Overview

Automotive applications



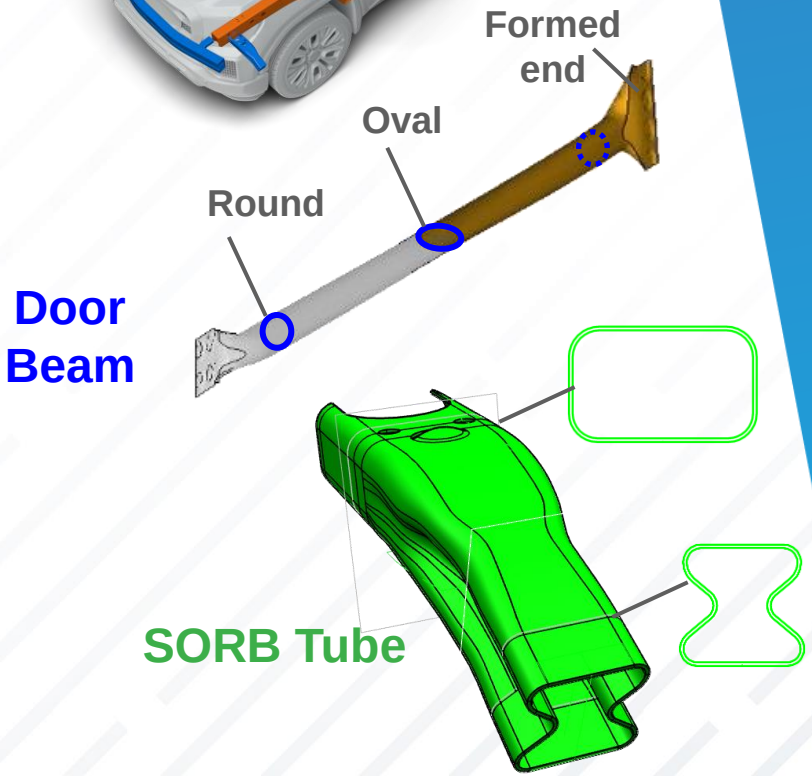
ACCRA® is a high-volume manufacturing process that forms an austenitized closed section boron steel blank in a closed die, which is rapidly water quenched to produce an Ultra-High Strength Steel (UHSS) component with complex geometry.

Form Fixture Hardening™ (FFH)

- Austenitized steel blank is formed and quenched in a closed die

Form Blow Hardening™ (FBH)

- A variation of FFH, where the blank is internally pressurized during forming, enabling more complex geometries with greater precision



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ACCRA® Benefits

Structural Efficiency / Design Freedom

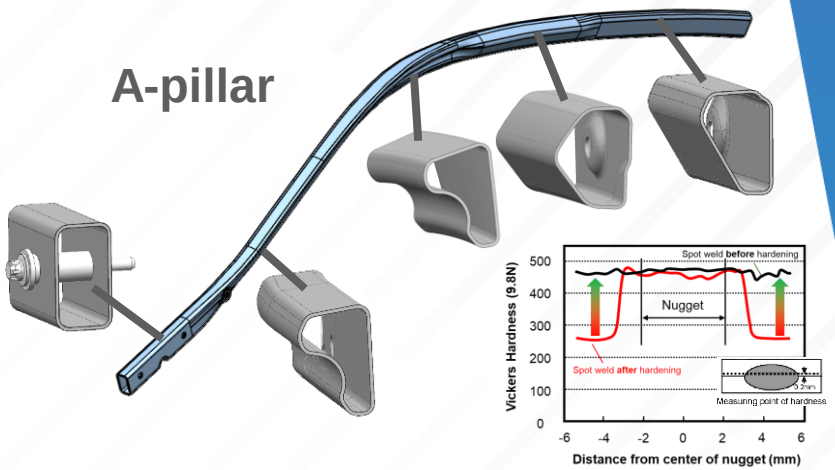
- Strength-driven UHSS closed section components and assemblies
- Freedom to vary section along the 3-D part length
- Elimination of residual stress and Heat Affected Zone (HAZ) after hot forming

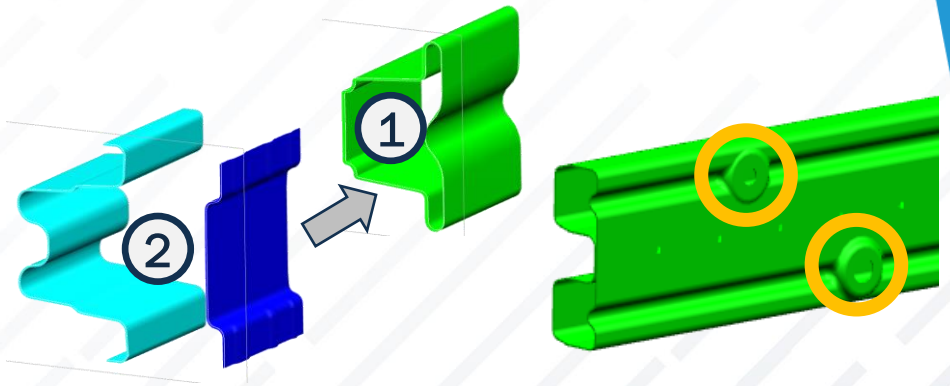
Superior Dimensional Stability

- Hot forming results in superior dimensional stability of complex components and assemblies compared to competing technologies

Cost Reduction Potential

- Integration of components and features
- Cost effective replacement for aluminum structures (e.g. bumpers, side sill reinforcements, door beams)

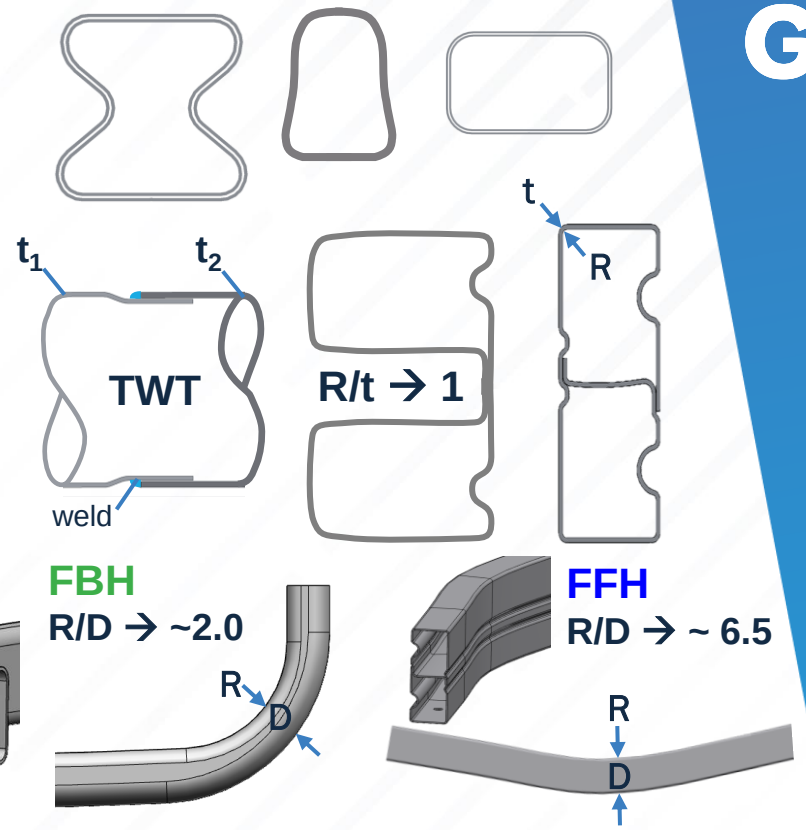




ACCRA® Benefits – Details

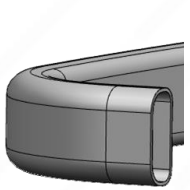
Geometry

- Complex hollow / multi-cell profile sections
- Variable cross-section shape and size along part length
- Multiple gauges possible via Tailor Welded Tubing™ (TWT)
- Local features, embosses and expansion (FBH)
- Tighter/3-D part and corner bend radii



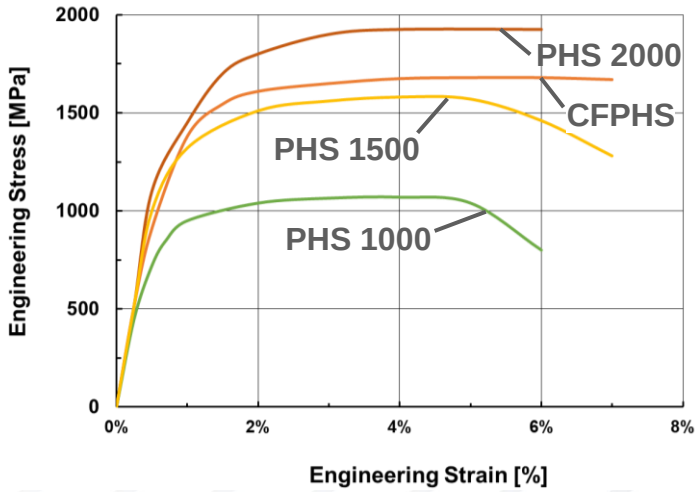
Materials & performance

- Standard PHS material grades (1000, 1500, 1800 MPa) including Coating-Free PHS (20MnCr)
- Rapid quench → fine grain martensite → stronger
- No residual stress in bends or HAZ in profile lap and butt welds after hot forming



Appearance

- Visible “show” surfaces possible



ACCRA® Closed Section Hot Forming

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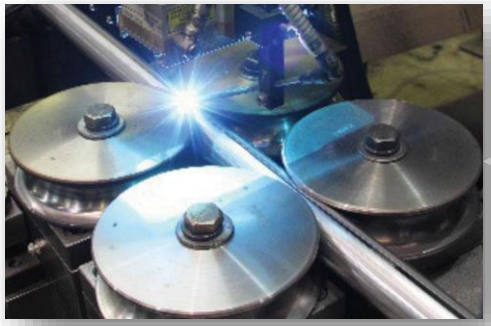


Hot Form Steel*

Closed Section Blank

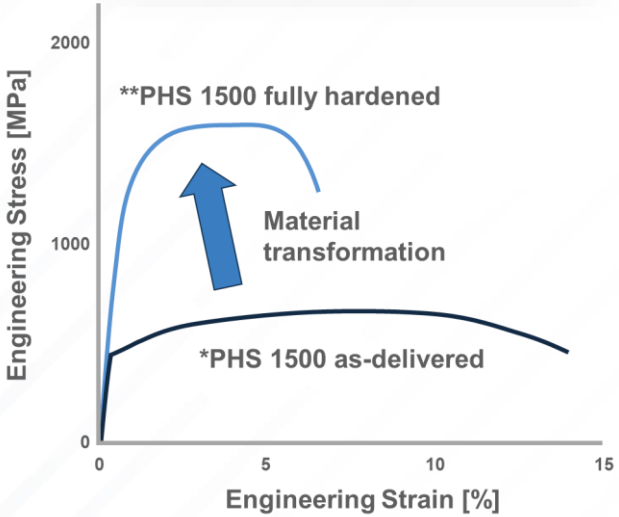
Heating

Austenitization

Form Blow Hardening

Form Fixture Hardening

FBH



Quenching**

FFH

Laser Trimming

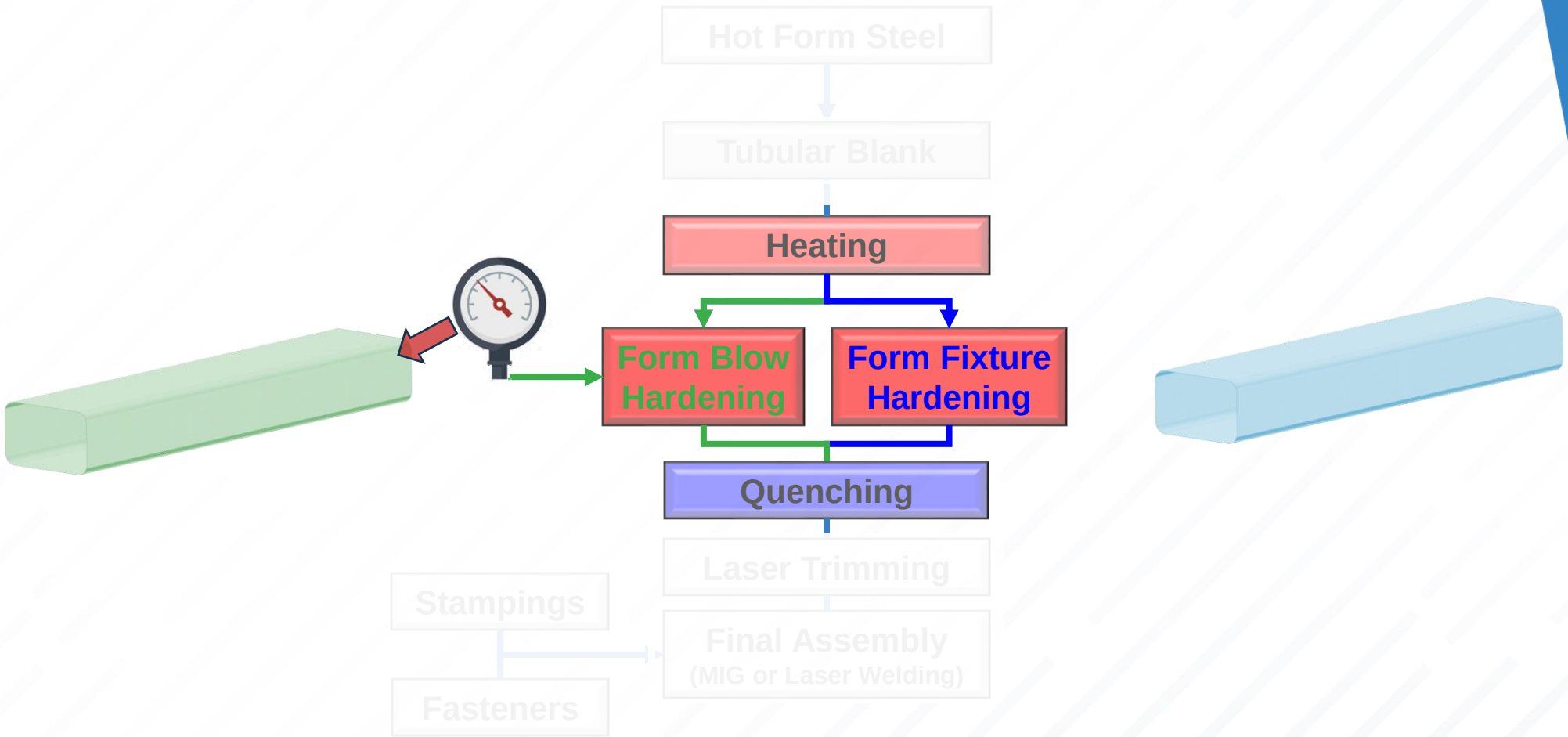
Stampings

Fasteners

Final Assembly
(MIG or Laser Welding)

Hot Form-Steel → Roll Forming → Heating → Hot Forming → Quenching

ACCRA® FBH vs. FFH



ACCRA® FBH vs. FFH

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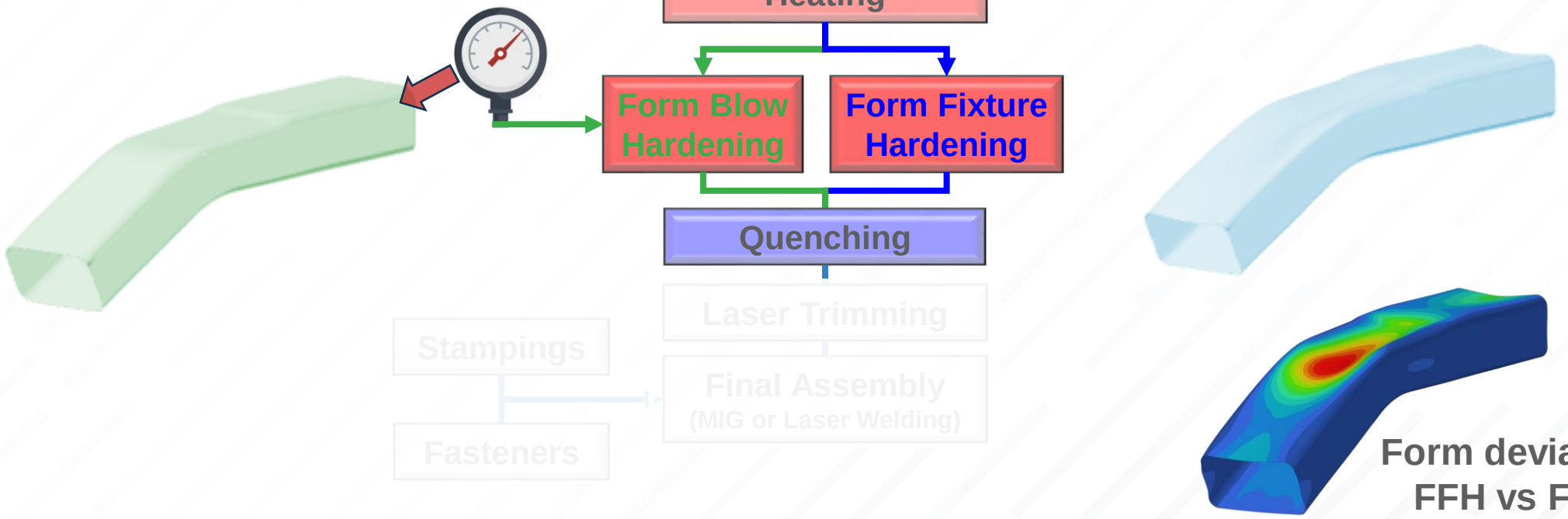
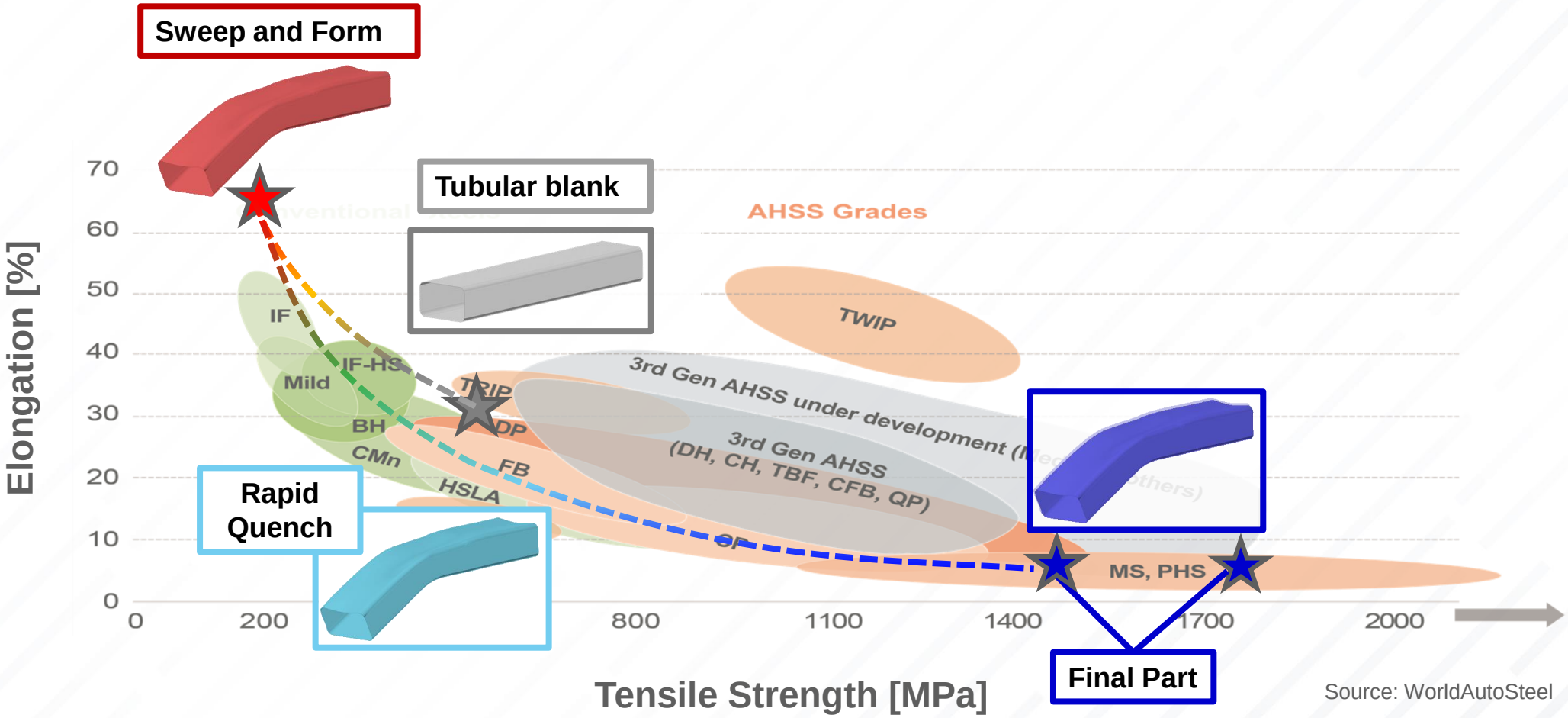


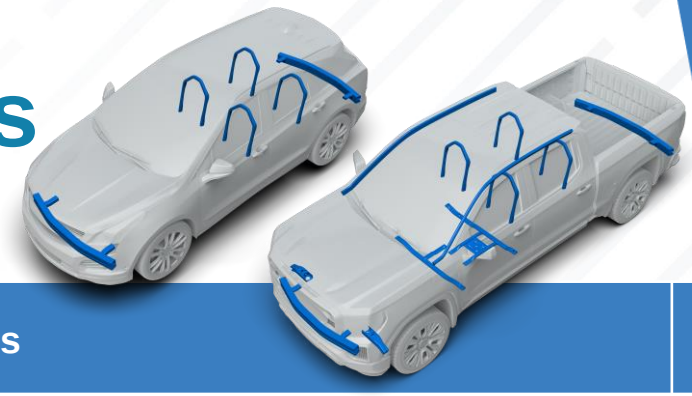
Form deviation
FFH vs FBH

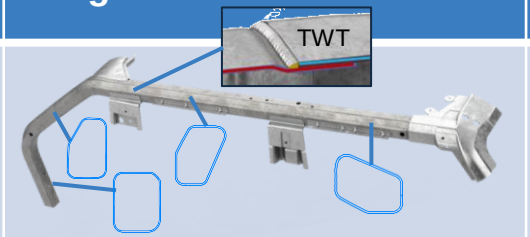
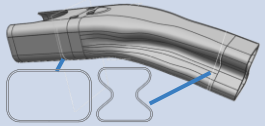
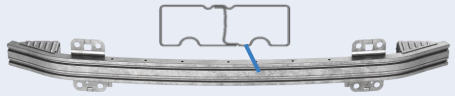
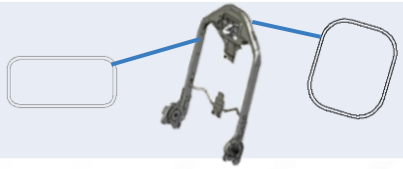
ACCRA® Material Transformation



Source: WorldAutoSteel

ACCRA® Production Applications



Category	Product	Image	Conventional Technologies	Benefits	Process
Upper structures	A-pillar / roof rail / cant rail assys		S&W	• 1-pc UHSS variable section TWT tube w/ local features / mass reduction • Dimensional accuracy • Appearance areas (open air roof)	FBH
Underbody / Lower structures	Skid plates		S&W	• UHSS variable section tubular assy • Impact protection / mass reduction	FFH
	SORB structures		S&W	• 1-pc complex UHSS closed section shape • Intrusion mitigation / mass reduction	FBH
	Bumper structures		AL extrusion, S&W	• 1-pc swept UHSS closed 2-cell section • Similar mass vs AL w/ cost reduction	FFH
Closures	Door beam		PHS	• UHSS variable section tube • Mass reduction with multiple attachment and section shape options	FFH
Interior	Seat back frames		Hydroform, tube bending	• Dimensional accuracy • UHSS variable section tube • Mass reduction	FBH

SORB = Shallow Offset Rigid Barrier S&W = Stamped and Welded TWT = Tailor Welded Tube

ACCRA® Recent Developments

High industry interest: Converting aluminum structures to ACCRA® to achieve significant cost reduction at equivalent performance and similar mass

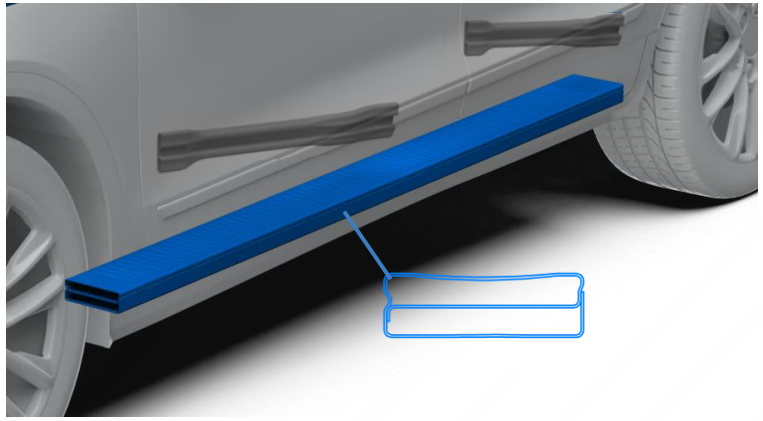
[GDIS 2023]

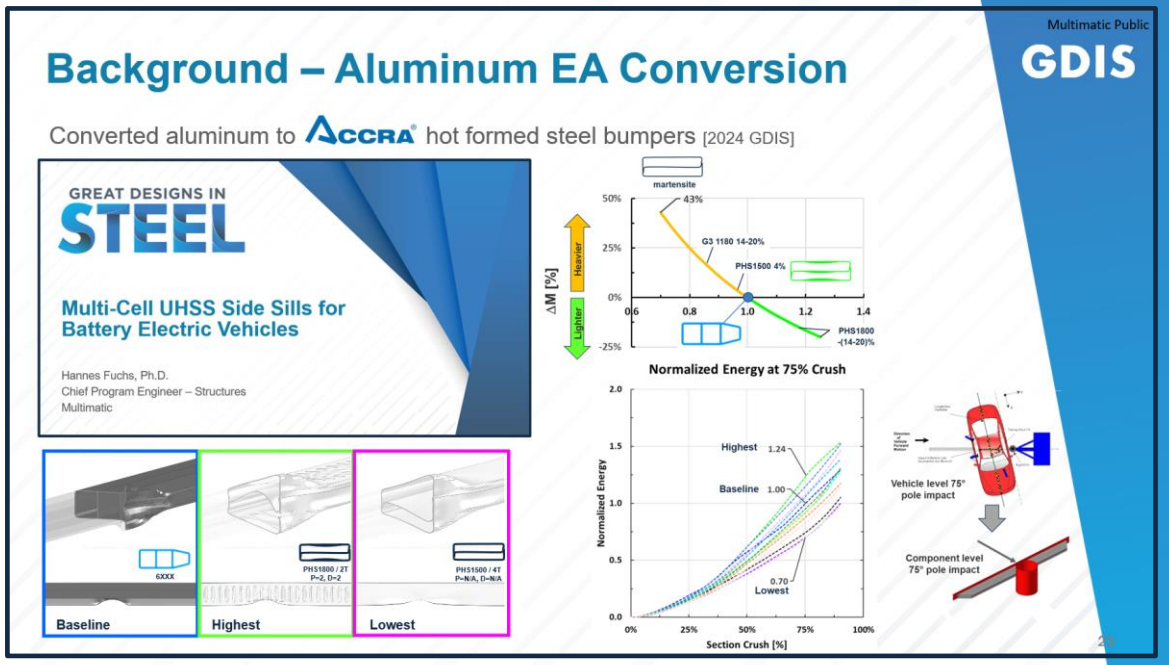
Bumpers

- Replaces 6XXX & 7XXX extruded aluminum
- Complex roll-form boron steel beam sections including AHSS crush cans, and/or SORB tubes

ACCRA® Recent Developments

High industry interest: Converting aluminum structures to ACCRA® to achieve significant cost reduction at equivalent performance and similar mass



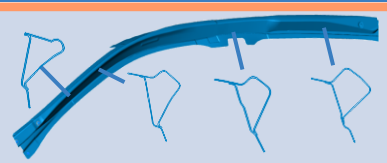
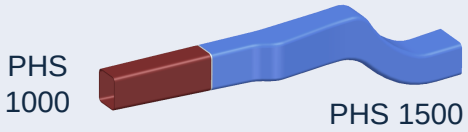
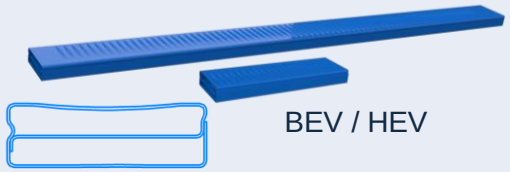


[GDIS 2024]

Side sill energy absorbers

- Replaces 6XXX extruded aluminum
- Complex roll-form boron steel beam sections with continuous embossments
- Highly tunable performance

ACCRA® Promising Applications

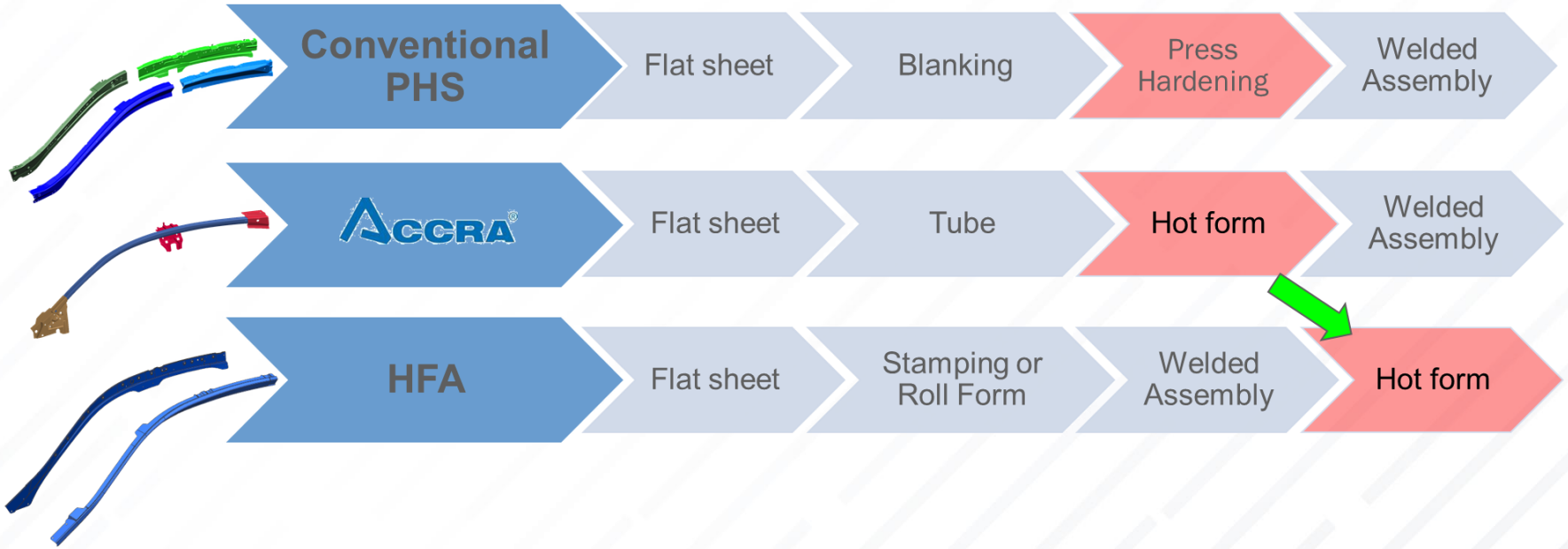
Category	Product	Image	Conventional Technologies	Benefits	Process
Upper structures	A-pillar / roof rail / cant rail assys		Multi-pc S&W, PHS	• 1-pc UHSS complex closed section • Large section change w/ HFA • Dim. accuracy / mass & cost	HFA+ FFH / FBH
Underbody / Lower structures	Longitudinal rails		Multi-pc S&W, PHS	• Multi-material TWT / UHSS variable section tubes • Parts integration / mass reduction	FBH
	SORB structures		Multi-pc S&W AHSS	• Integrated 1-pc complex UHSS closed section shape • Parts integration / mass reduction	FBH
	Side sill/ battery protection		6XXX AL extrusion, MS roll form, S&W	• 1-pc UHSS closed multi-cell section • Highly tunable EA performance • Similar mass vs AL @ significant cost reduction @ dim. accuracy	FFH
Closures	Door beam		S&W PHS, Hydroform	• UHSS variable section tube • Mass reduction with multiple attachment and section shape options	FFH

SORB = Shallow Offset Rigid Barrier S&W = Stamped and Welded TWT = Tailor Welded Tube HFA = Hot Form Assembly

ACCRA® Hot Form Assembly (HFA) Concept

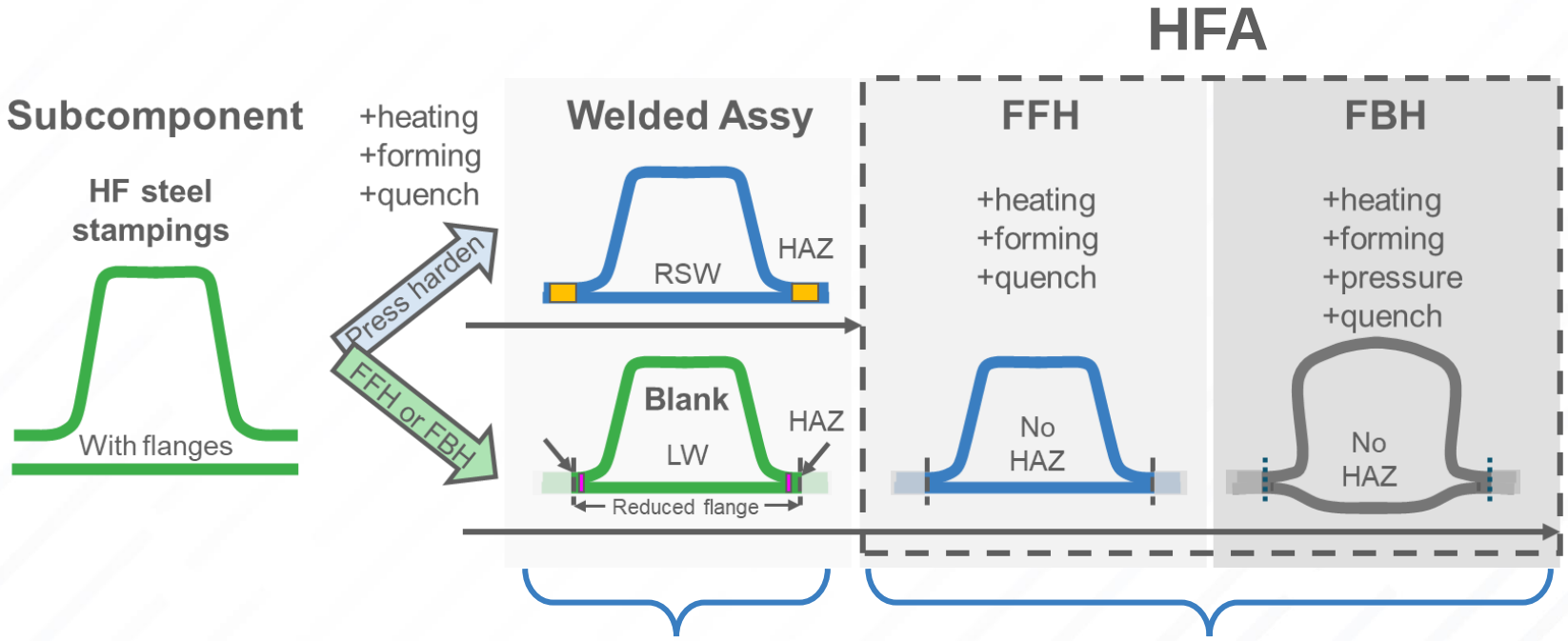
Motivation: Improve the ease of assembly, dimensional integrity, and performance of conventional AHSS/PHS stamped & welded safety structures

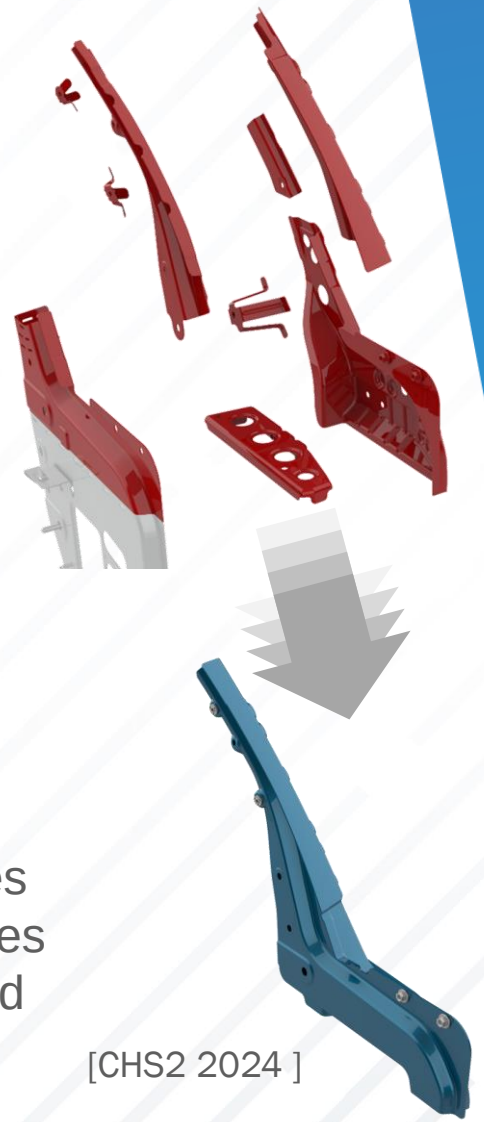
- Parts integration w/ 0, 1T, or 2T flange configurations
- Excellent assembly level tolerances
- Achieve large section size changes vs. tubular
- Elimination of HAZ and/or adhesives



Hot Form Assembly (HFA) Concept

Concept: Similar to a PHS assembly, HFA features a closed section built up blank that is welded in the unhardened condition, and is subsequently hot formed as a 1-pc assembly using either FFH or FBH





- Parts integration / flange configurations options
- Large section size changes vs. tubular

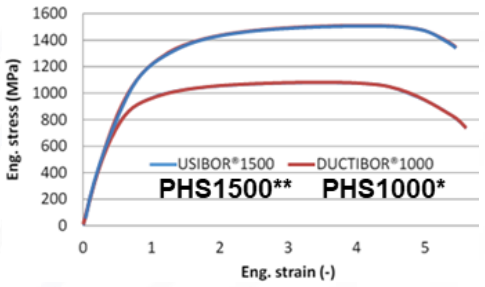
- Excellent assembly level tolerances
- Elimination of HAZ and/or adhesives
- Increased section length of line and greater precision (via FBH)

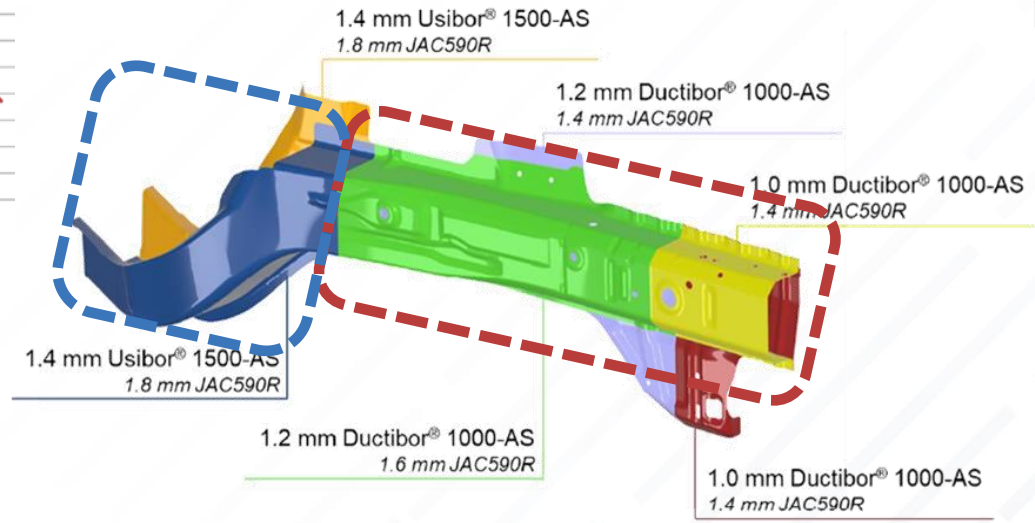
[CHS2 2024]

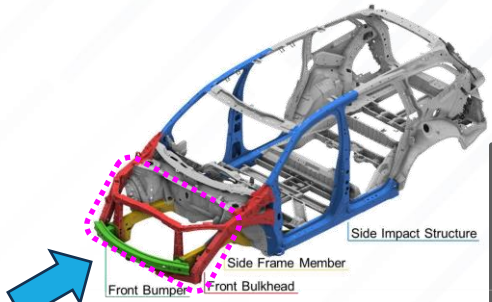
TWT Crash Rail

Motivation: Lightweighting of steel crash structures

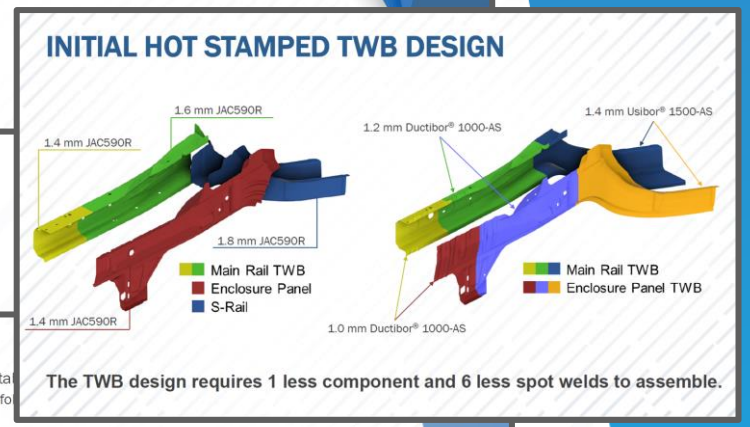
- Typical AHSS stamped & welded (S&W) construction
- Concept study for lightweight S&W PHS tailor welded blank for mass reduction based on PHS1000 and 1500
  - Predicted 27.6% mass reduction with similar performance
  - Successful axial crush of PHS1000

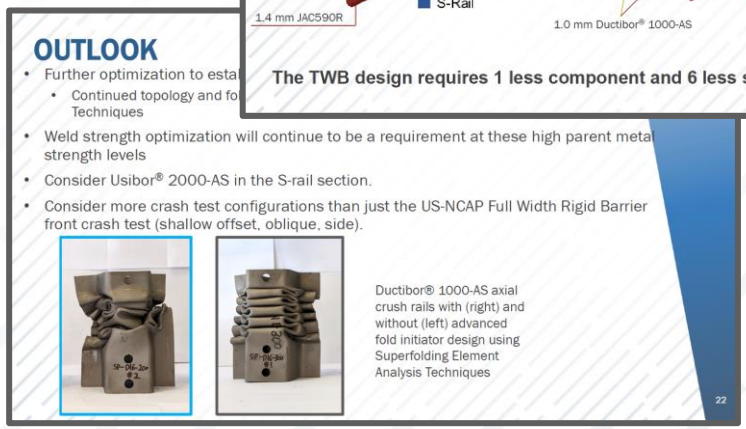






[2021 GDIS]





ACCRA® TWT Crash Rail

Motivation: Lightweighting of steel crash structures

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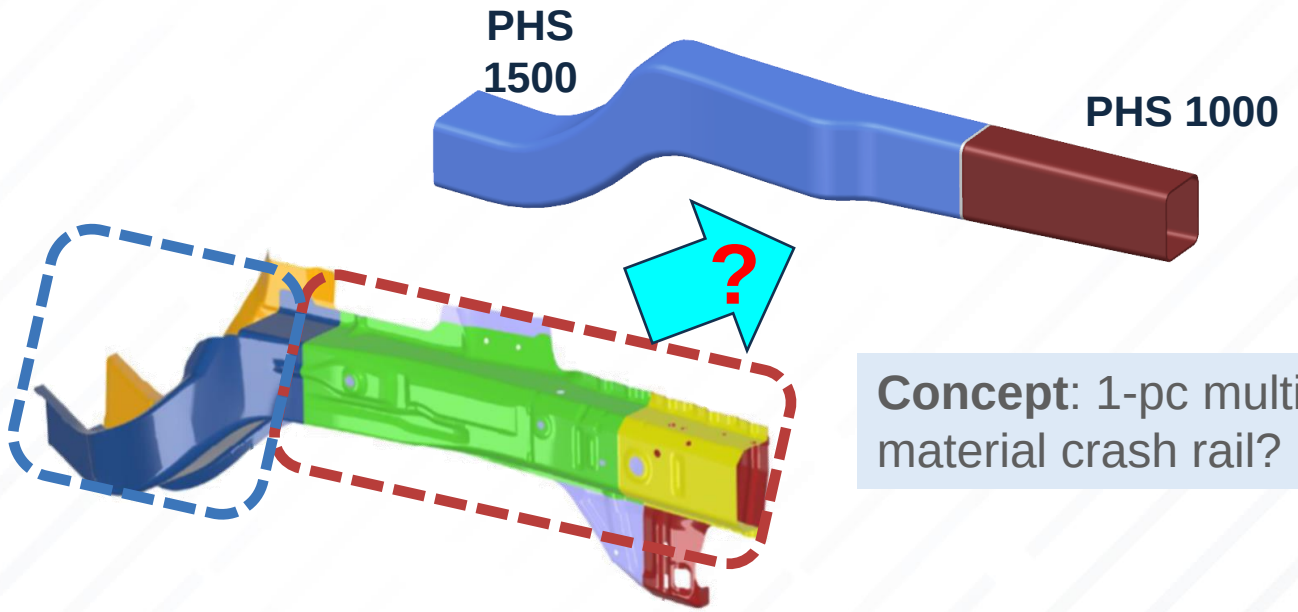
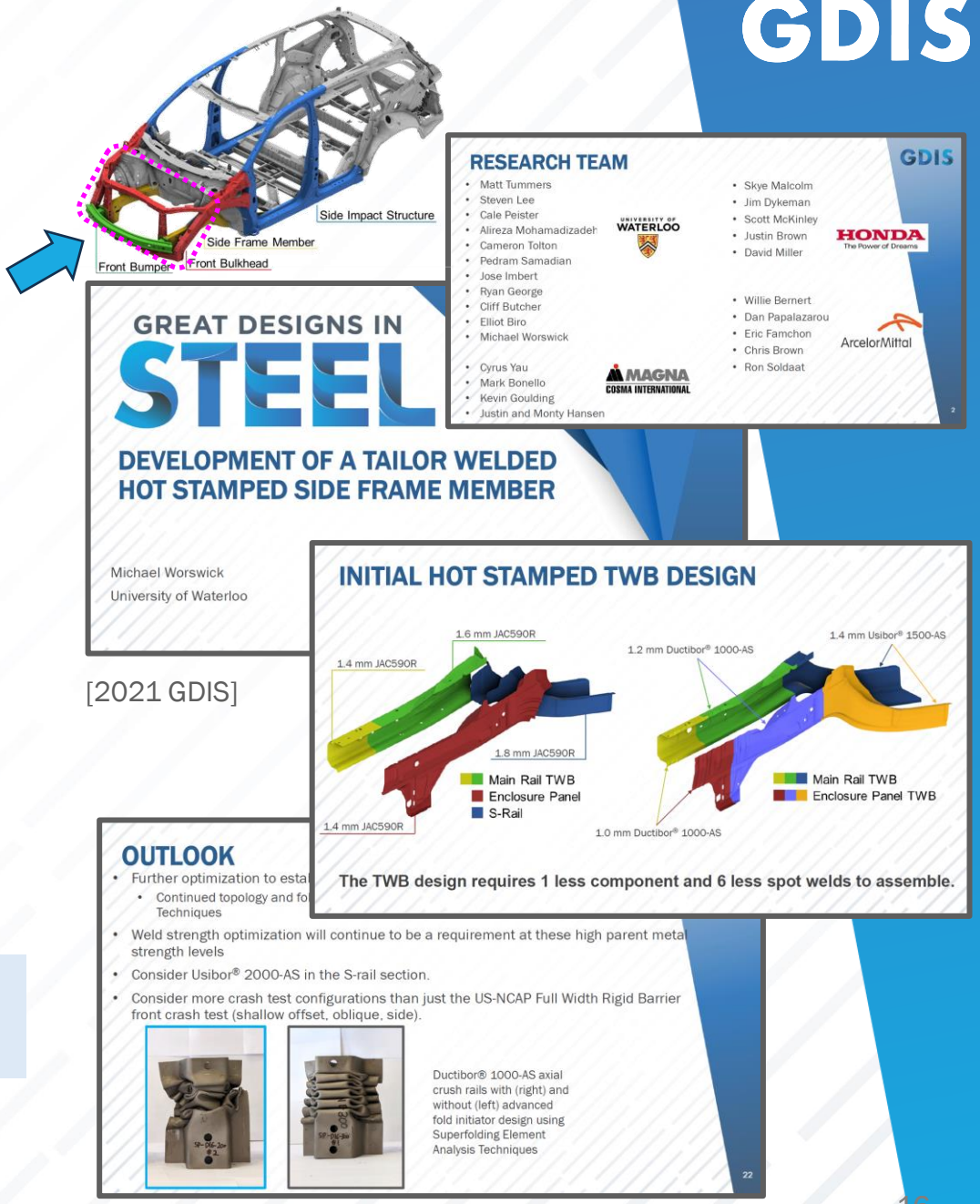
- Concept study for lightweight S&W PHS tailor welded blank for mass reduction based on PHS1000 and 1500
  - Predicted 27.6% mass reduction with similar performance
  - Successful axial crush of PHS1000

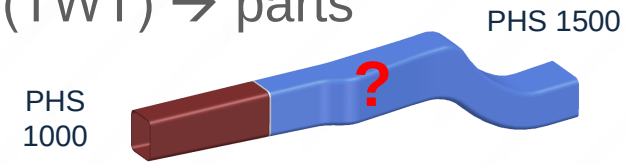


Concept: 1-pc multi-material crash rail?

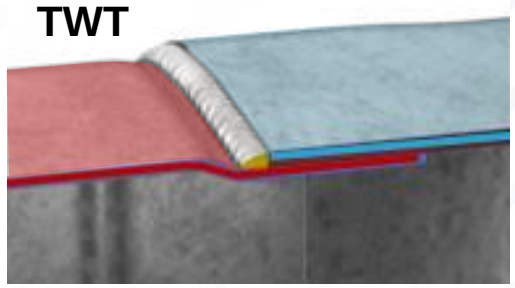


ACCRA® TWT Crash Rail

Concept: Multi-material tubular crash rail based on Multimatic's Tailor Welded Tube (TWT) → parts integration / mass reduction

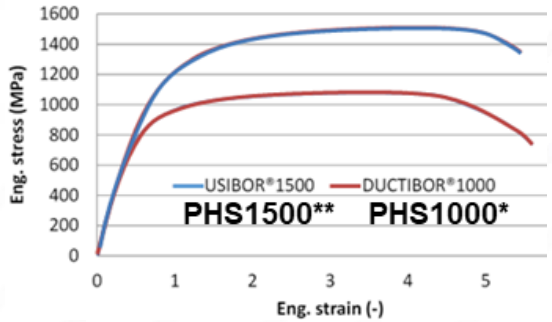


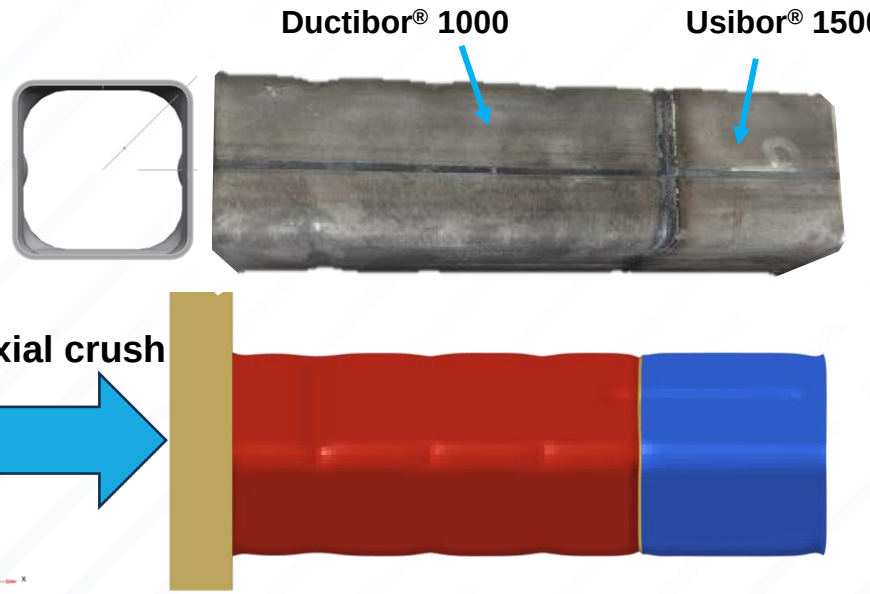
substitute for TW PHS S&W construction



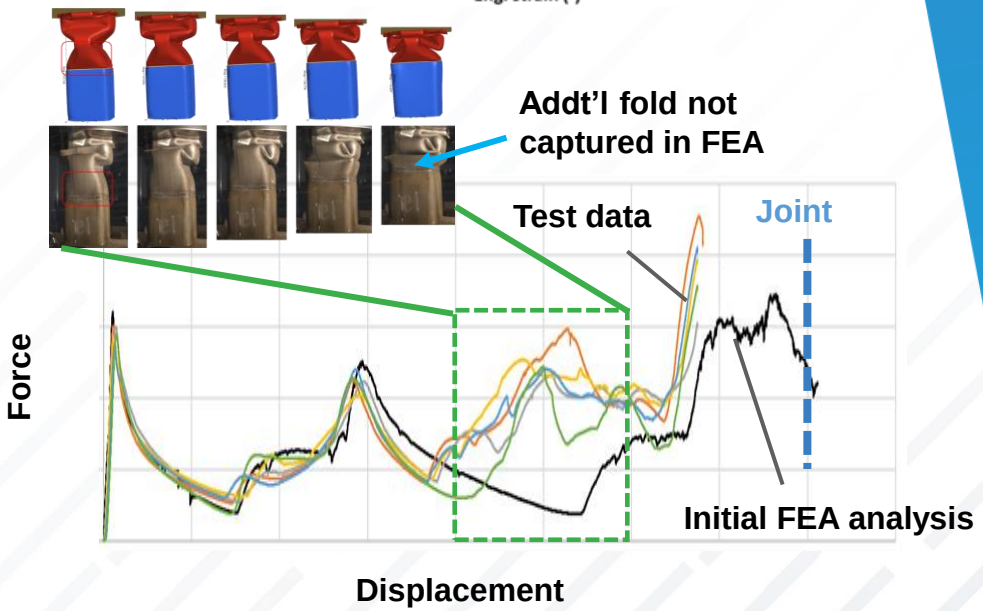
Concept validation

- Swaged & welded TWT blanks manufactured
- Parts manufactured using ACCRA® FBH
- Axially crush tested & compared to simulation
- ☑ Demonstrated manufacturing and performance feasibility





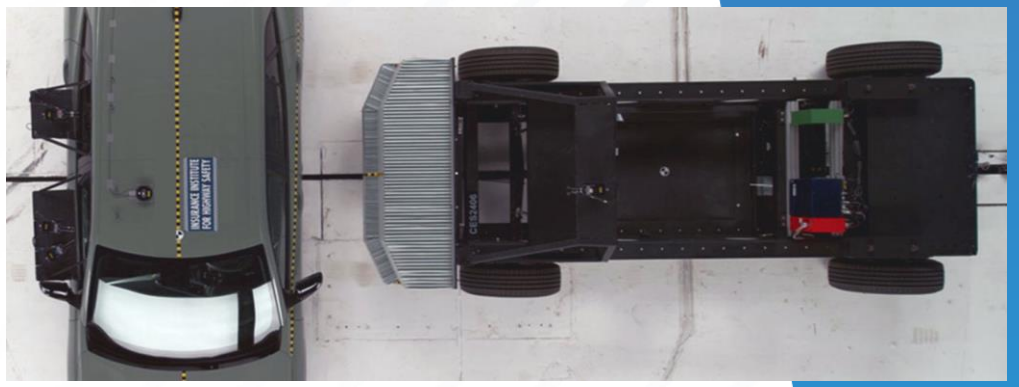
Swaged / welded joint



IIHS2.0 Side Impact Door Beams

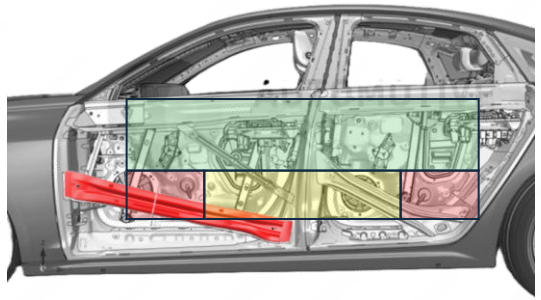
Motivation: +82% impact energy has increased structural demands on door, door beams, and BIW door ring, resulting in increased mass to mitigate intrusion

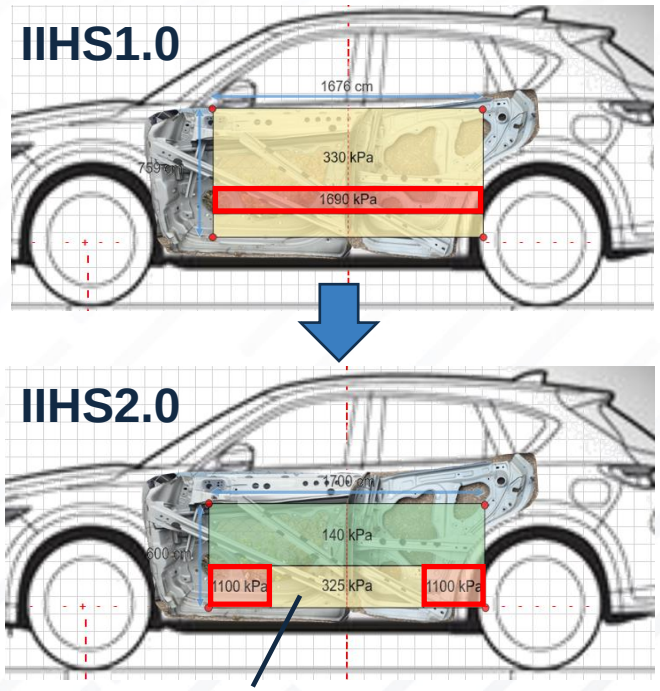
- Affected vehicles exhibit increased door intrusion resulting from a low side sill height relative to the barrier
- ICE/BEV/HEV sedans and small/medium SUVs



Example:
ICE sedan

[Doors & Closures 2024]





Barrier zone crush pressures

IIHS2.0 Side Impact Door Beams

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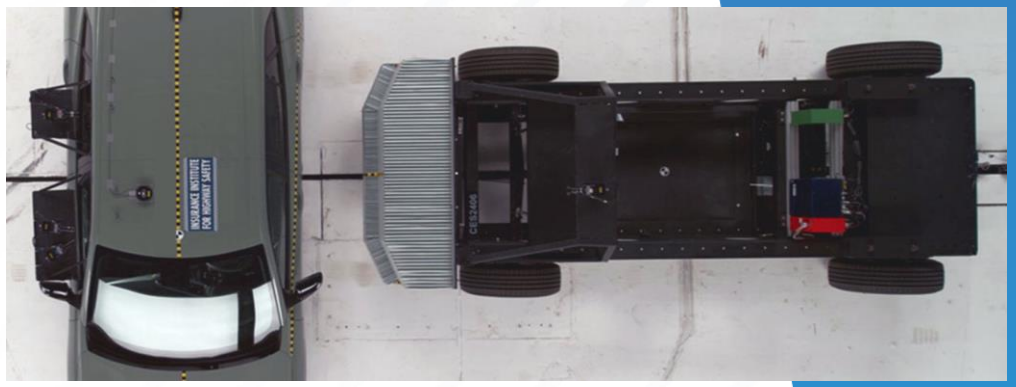
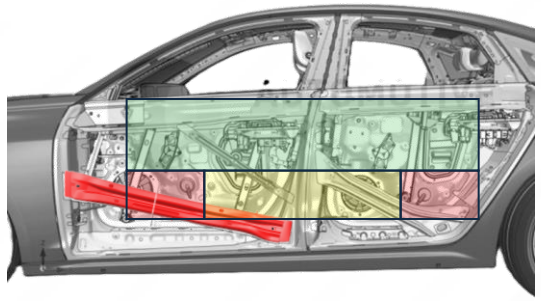


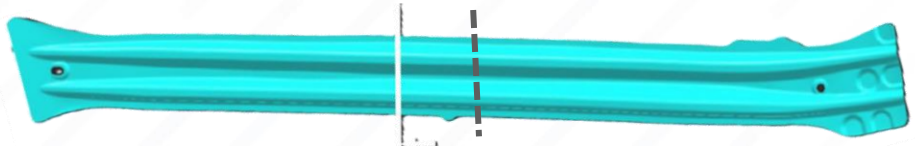
Example:
ICE sedan

[Doors & Closures 2024]



Mitigation ➔ +130% force, +160% energy, +50% stroke, +2.2kg mass (145%)

IIHS1.0



Stamped: 1.3mm CR590Y980T-DP @ 1.5kg

IIHS2.0

Hydroformed: 2.0mm DP590Y980T @ 3.7kg

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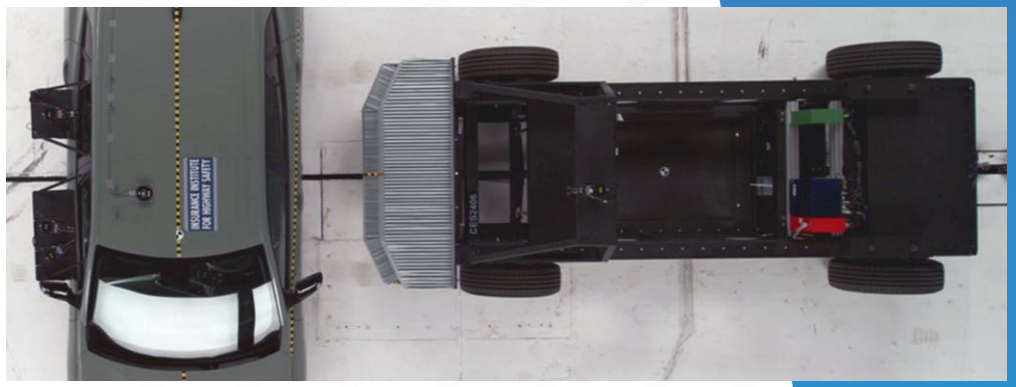
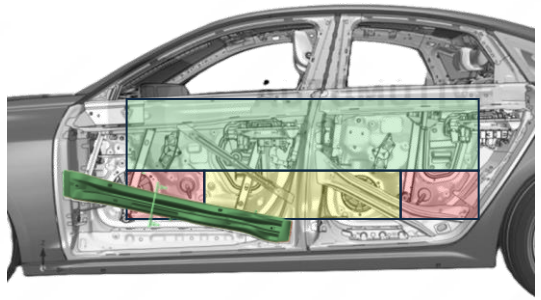


Example:
ICE sedan

[Doors & Closures 2024]



Est'd 25-30% (~1kg) reduction

IIHS2.0

1.4mm PHS1500 @ 2.6 - 2.8kg

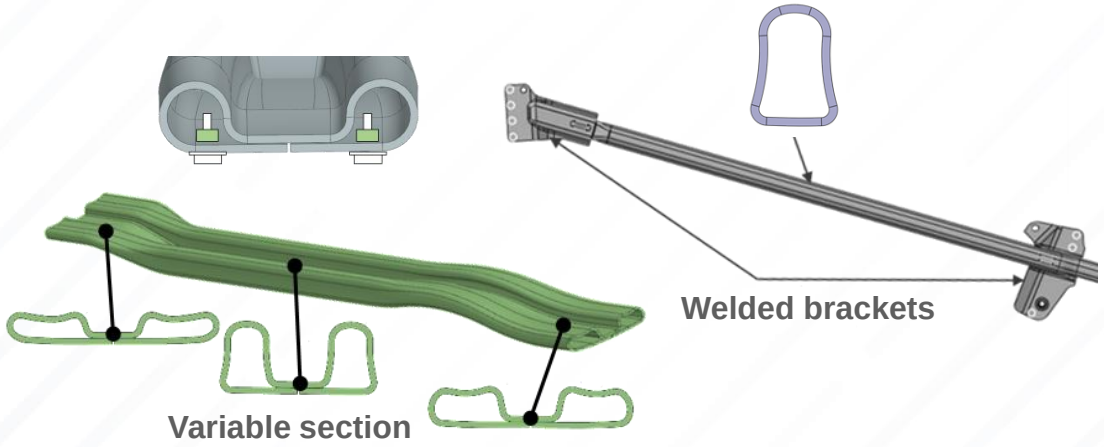
ACCRA® IIHS2.0 Side Impact Door Beams

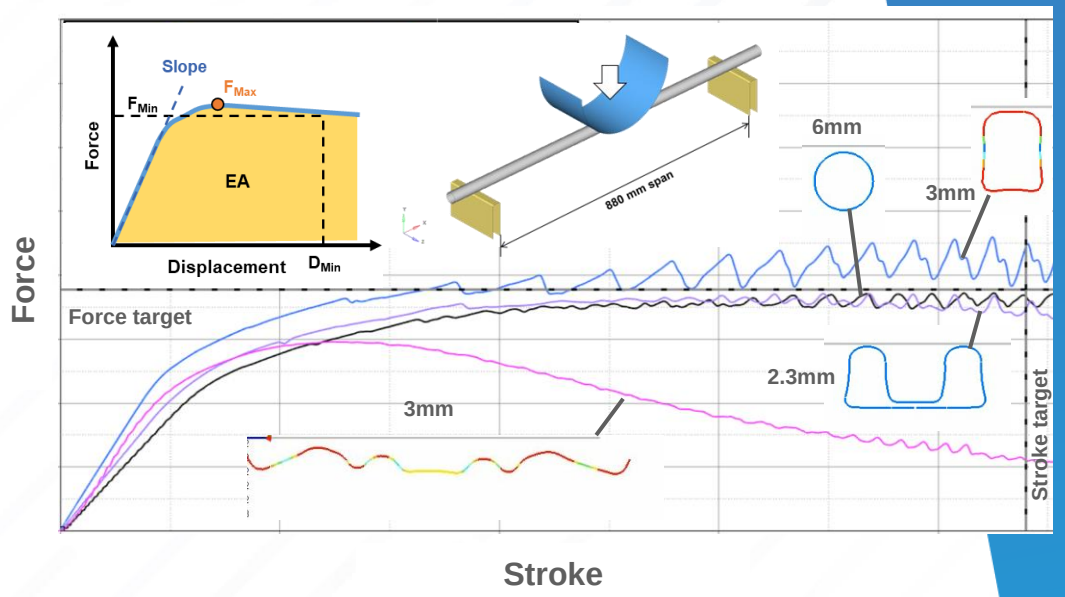
Concept: Mitigate mass increase with more efficient closed section designs vs. conventional solutions → cost effective mass reduction

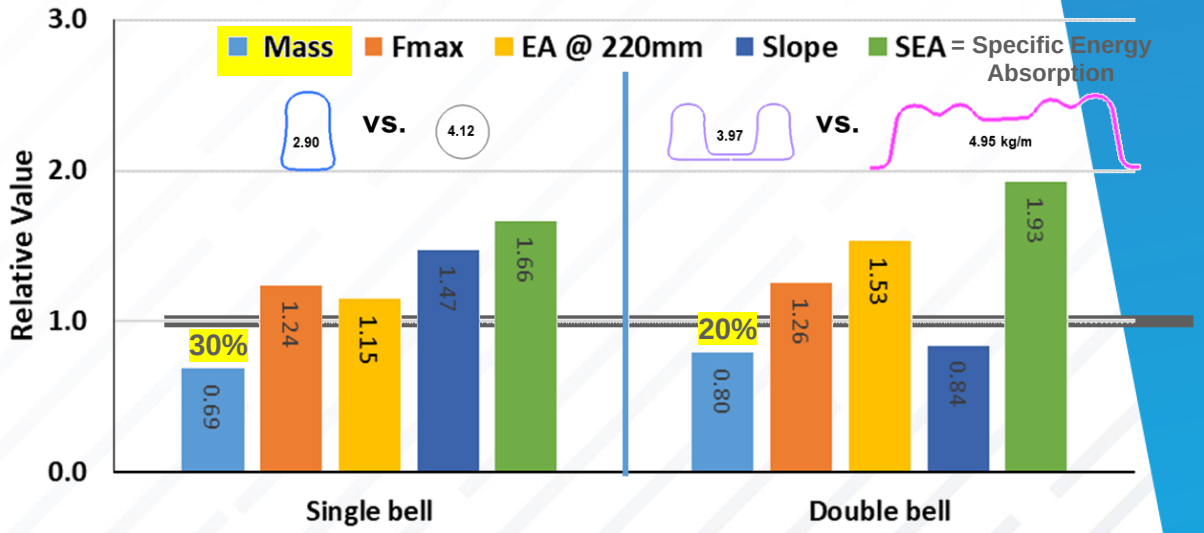
Concept validation

- Component level 3-pt bend performance
- Demonstrated efficiency of ACCRA® single and double bell sections vs round tube and PHS sections

☑ Demonstrated improved mass efficiency with equal or better performance







ACCRA® design & joining concepts

Summary

- ACCRA® FFH™ and FBH™ process variants are used in high volume automotive production to manufacture a wide range of strength-driven UHSS tubular structural components and assemblies
- Key benefits vs. conventional technology structures include
  - Mass efficiency / design freedom
  - Superior dimensional stability
  - Cost reduction through parts & feature integration
- Significant cost reduction has been realized replacing extruded aluminum OEM structures with equivalent performance and similar mass to ACCRA®
- Promising applications for exploring cost and mass reduction opportunities
  - A-pillar and cant rail HFA concept
  - Longitudinal rail crash structures & IIHS2.0 door beams

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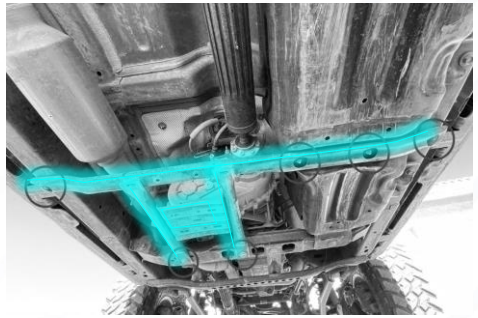
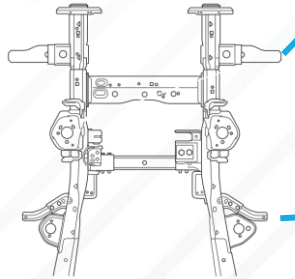
Thank You…



ACCRA®



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