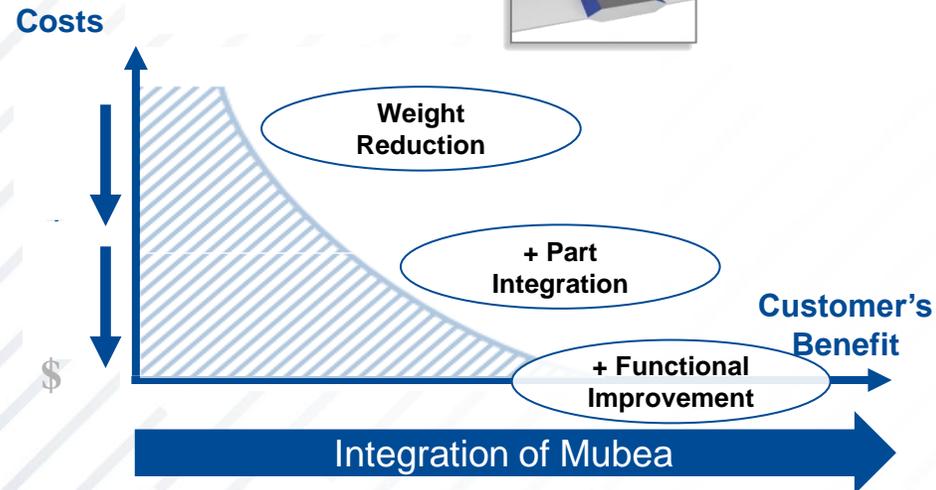
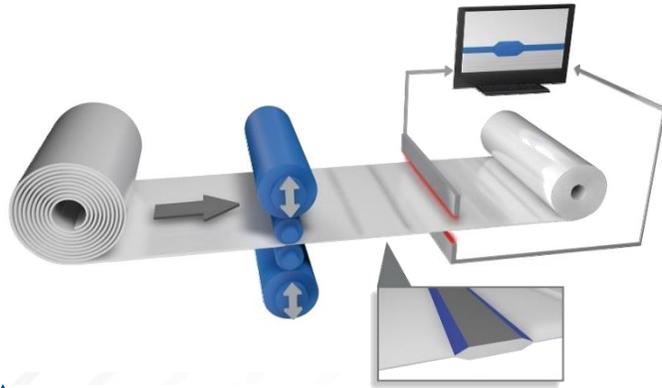


# GREAT DESIGNS IN **STEEL**

## NEW ADVANCEMENTS OF COLD FORMING **TRB® AHSS**

Markus Zoernack

Engineering Manager - Mubea Tailored Rolled Blanks



## Idea

- Lightweight parts with load and function-optimized material usage

## Implementation

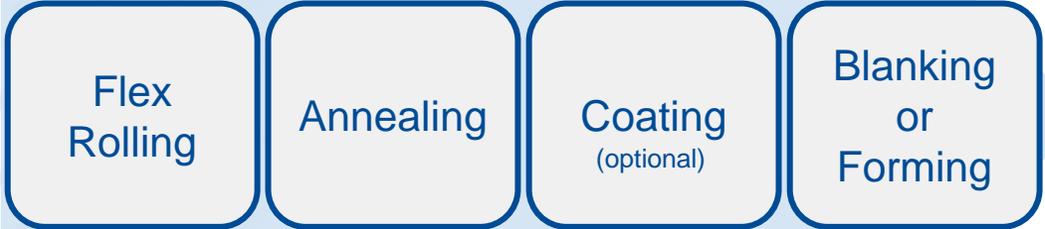
- Flexible Cold-Rolling Process
- Flat material with repeated, varying thickness runs and harmonious transition zones
- An increased number of thickness zones for an optimized TRB solution results in minimal lightweight cost

## Targets / Benefits

- Weight reduction
- Part integration
- Functional Improvement

# TRB® COLD FORMING VS. HOT FORMING

## Cold Form Material



## Hot Form Material



### Product portfolio:

Rectangular Blanks [TRB]

Tailor Shaped Blanks [TRS]

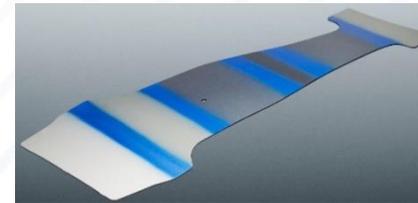
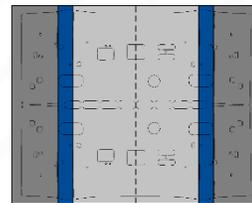
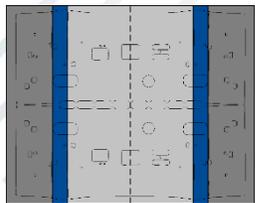
Cold Stampings & Assemblies [TRP-C]

### Product portfolio:

Rectangular Blanks [TRB]

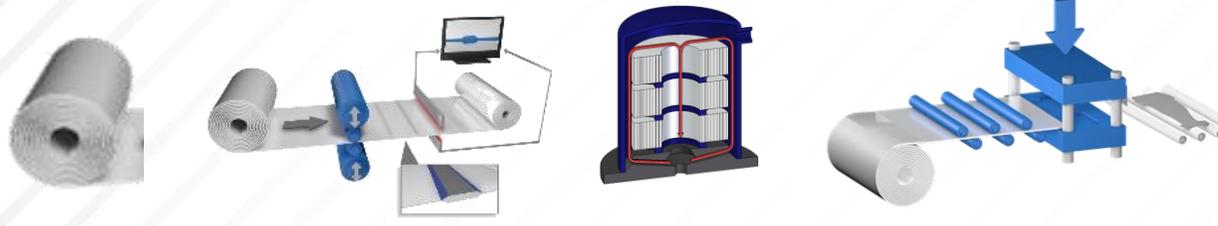
Tailor Shaped Blanks [TRS]

Hot Stampings & Assemblies [TRP-H]



# TRB® TAILORED PROPERTIES PRINCIPLE

## Conventional TRB process flow



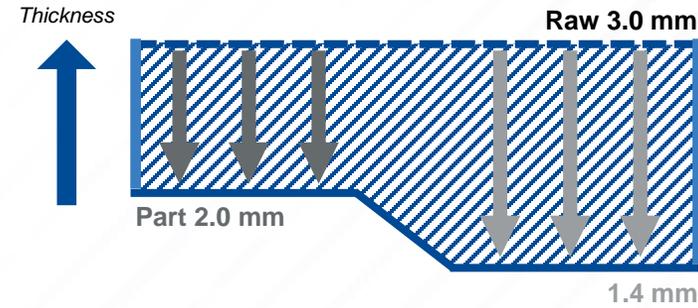
Raw Material  
Grade 90 **x 3.0 mm**

Flex Rolling

Batch Annealing

Blanking / Forming

## Homogeneous mechanical properties CR500LA TRB



## Conventional TRB process flow



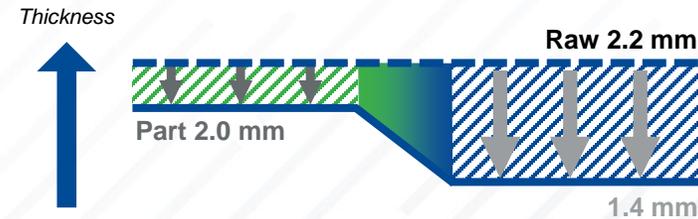
Raw Material  
Grade 90 **x 2.2 mm**

Flex Rolling

Batch Annealing

Blanking / Forming

## Tailored properties CR500/700LA TRB



-  full recrystallization → 500MPa
-  no recrystallization → 700MPa

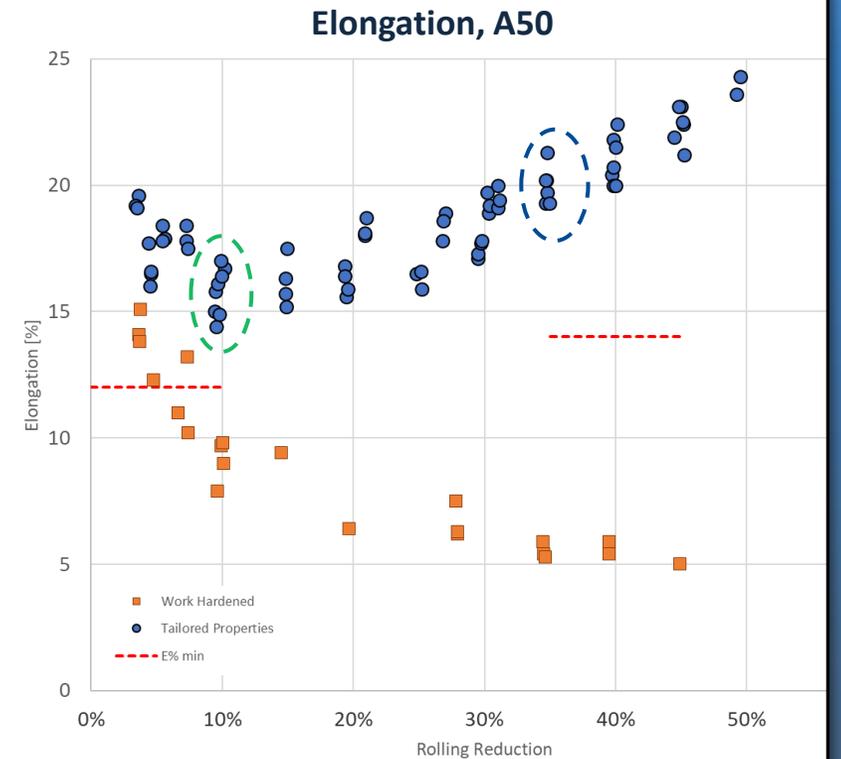
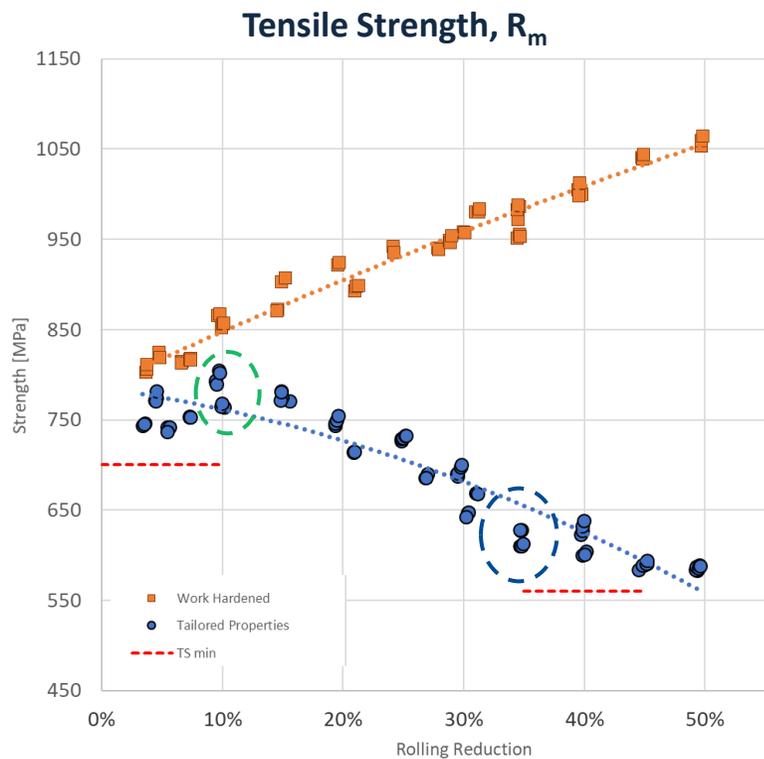
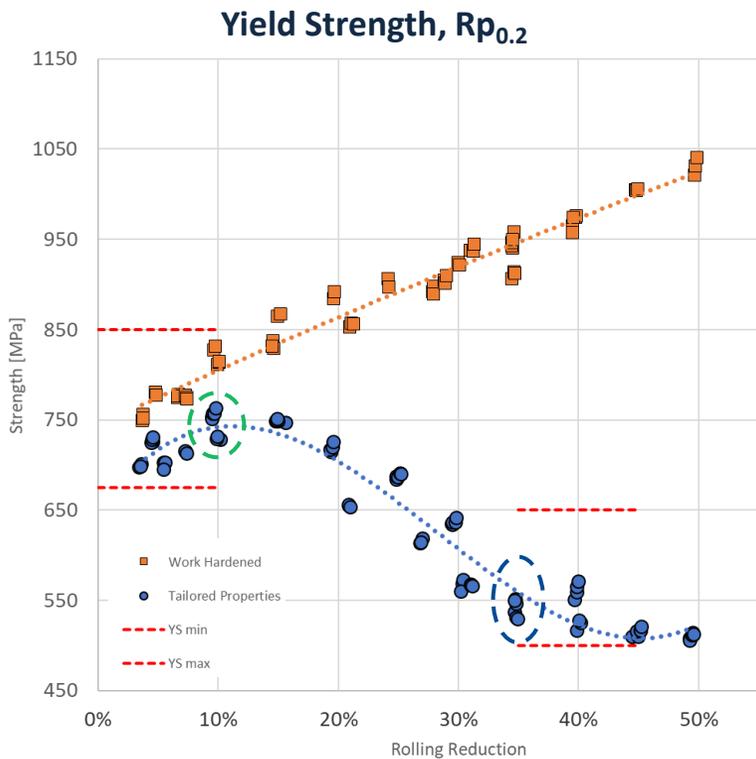
# TRB® TAILORED PROPERTIES RESULTS

## Crash Resistance

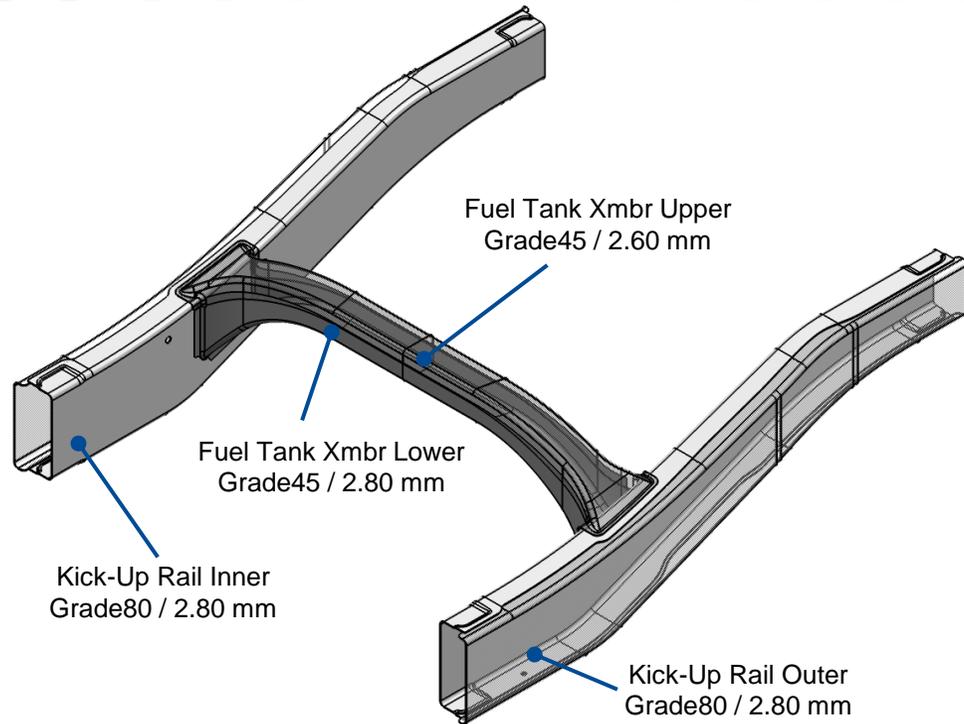
- High Gauge → Skim passed, properties similar to hot rolled raw material

## Energy Absorption

- Low Gauge → Standard rolling reduction, properties similar to typical tailor rolled grades



# TP TRB®: POTENTIAL APPLICATIONS



Reference monolithic Kick-Up Rail Inner

## Ladder Frame Rails and Cross Members

- Lightweight parts with load and function-optimized material usage

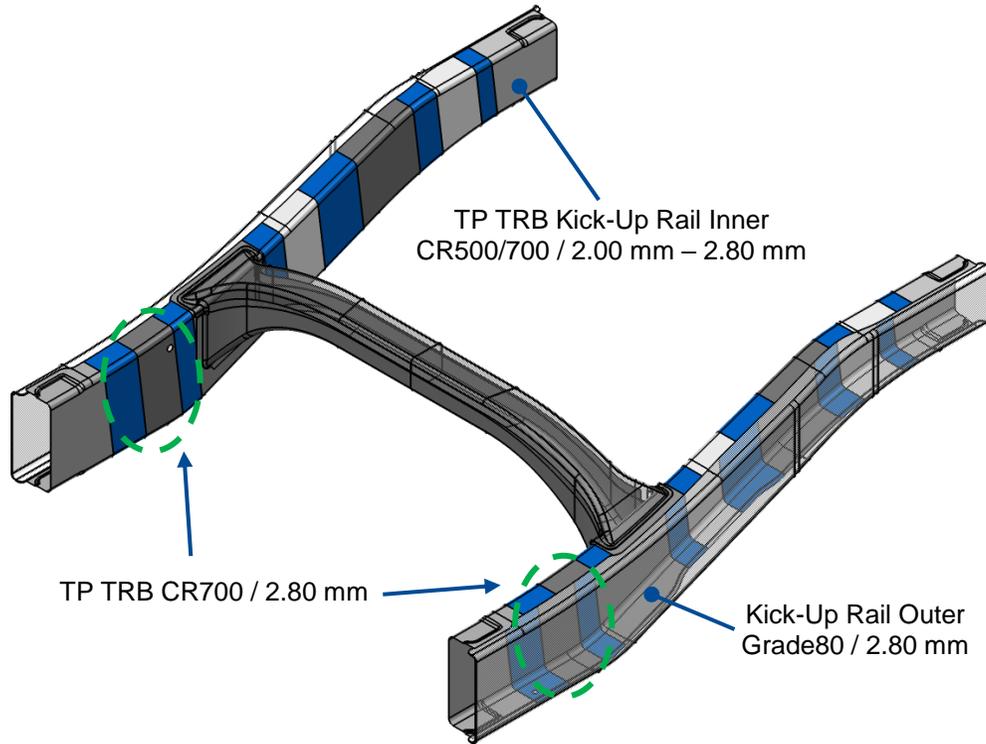
## Implementation

- 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

# TP TRB®: KICK-UP RAIL INNER



Tailored Properties TRB Kick-Up Rail Inner

## TP TRB® Kick-Up Rail Inner

- Material change to CR500/700LA TRB
- Thickness difference min. 2.20 mm to max. 3.00 mm

## Objective

- Improve crash kinematic
- Keep fuel tank area save → no deformation
- Keep attachment areas thick
  - To improve durability
  - To improve weldability

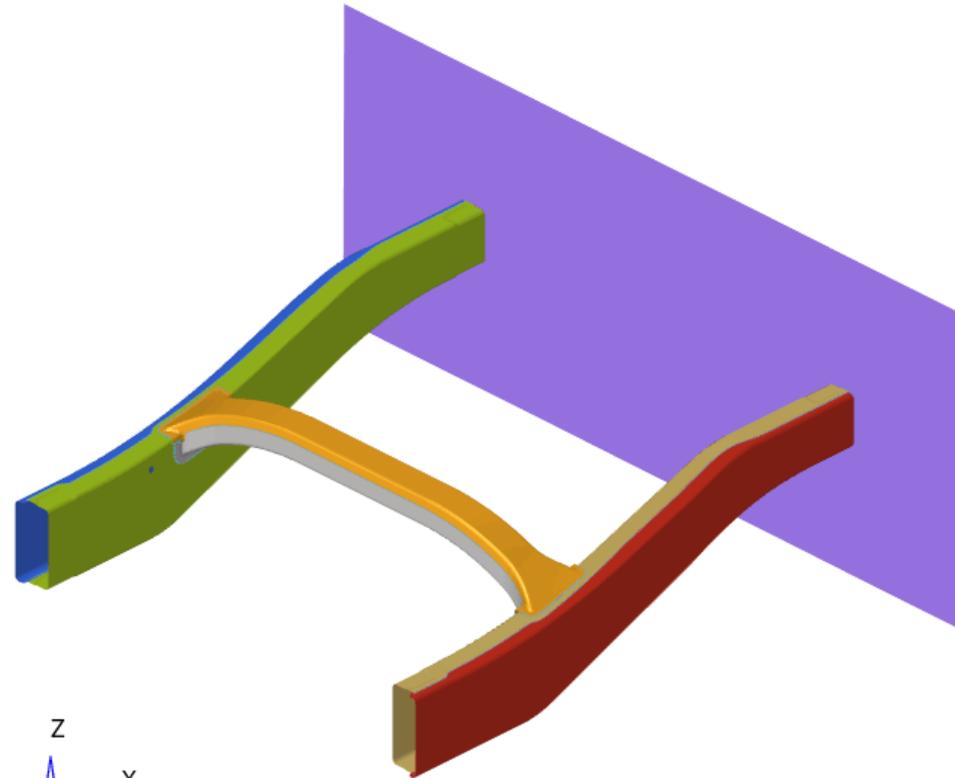
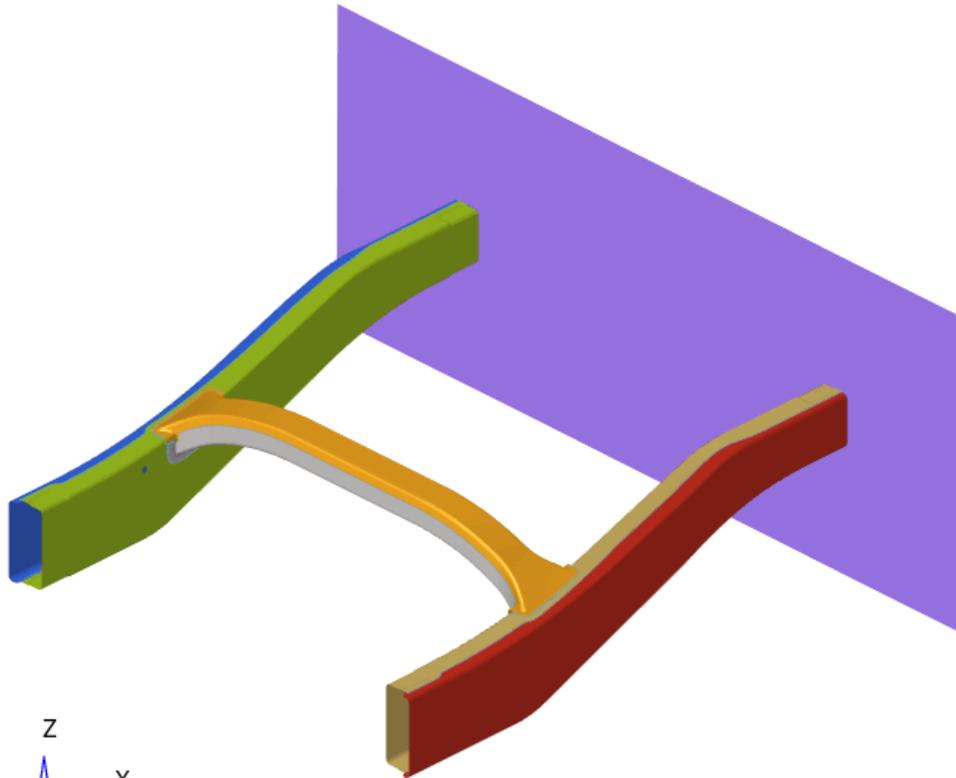
## Optimization setup

- Simple Clip-Model of Kick-Up Rails and Fuel Tank Xmbr Assy
- Load case: Rear Impact full overlay with rigid plate
- Optimization of reaction force and average crush resistance

# TP TRB®: POTENTIAL APPLICATIONS

Baseline

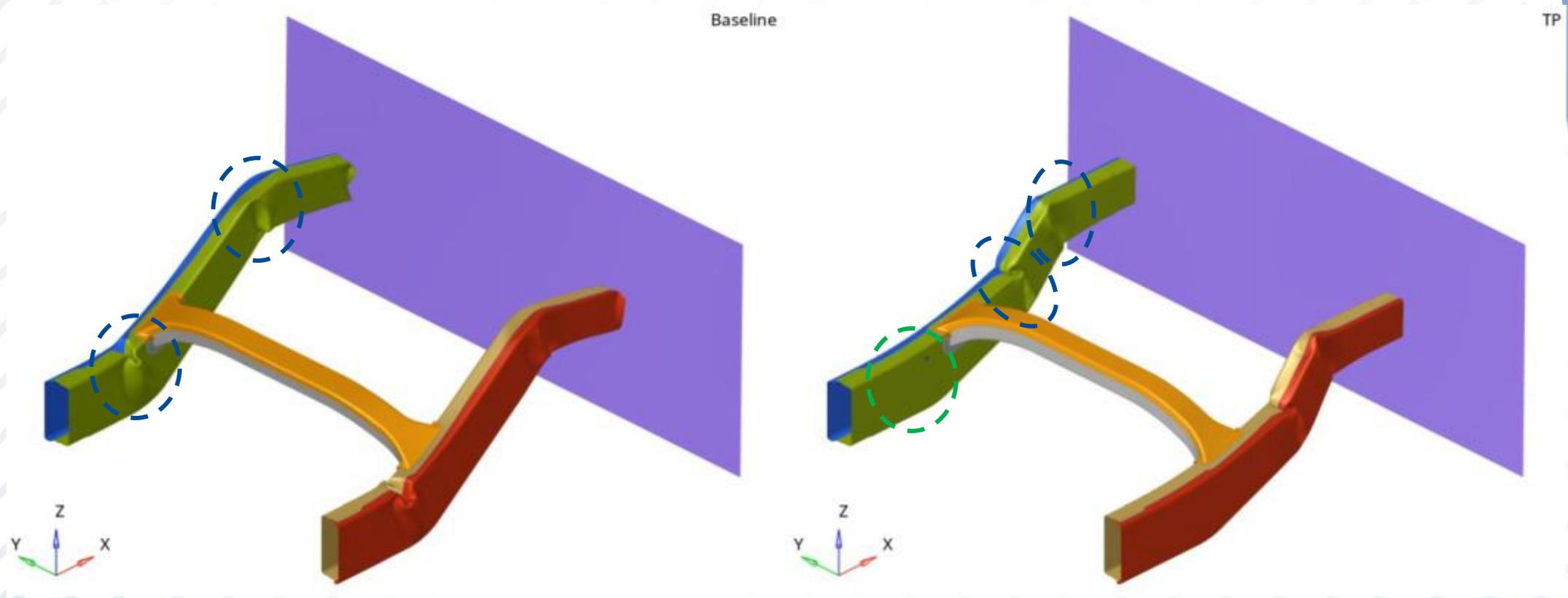
TP



Reference monolithic Kick-Up Rail Inner

Tailored Properties TRB Kick-Up Rail Inner

# TP TRB<sup>®</sup>: POTENTIAL APPLICATIONS

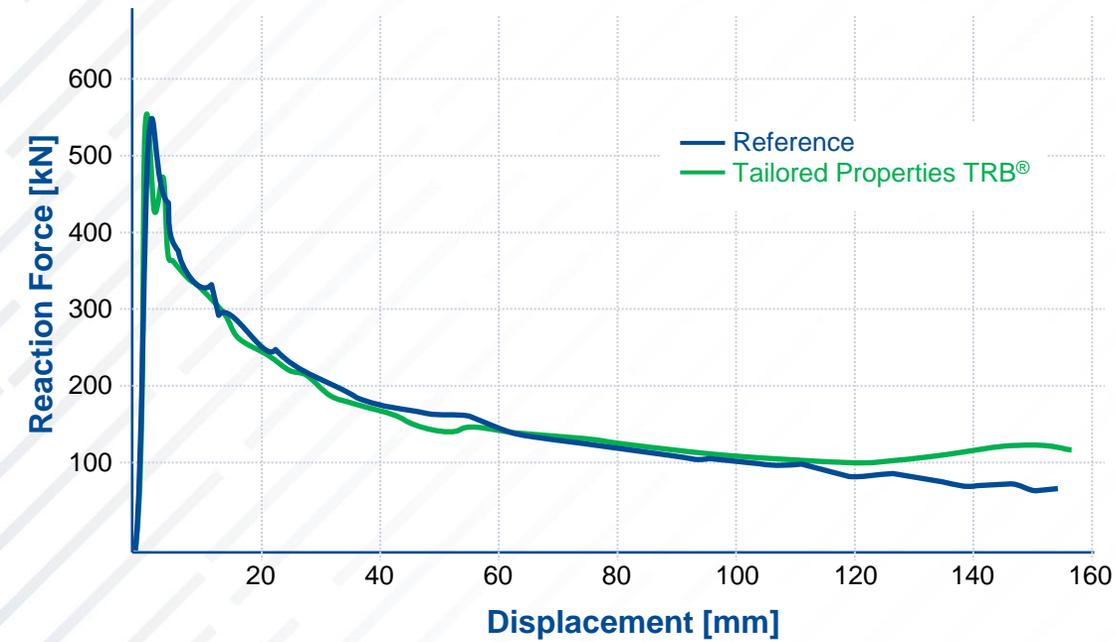


Reference monolithic Kick-Up Rail Inner

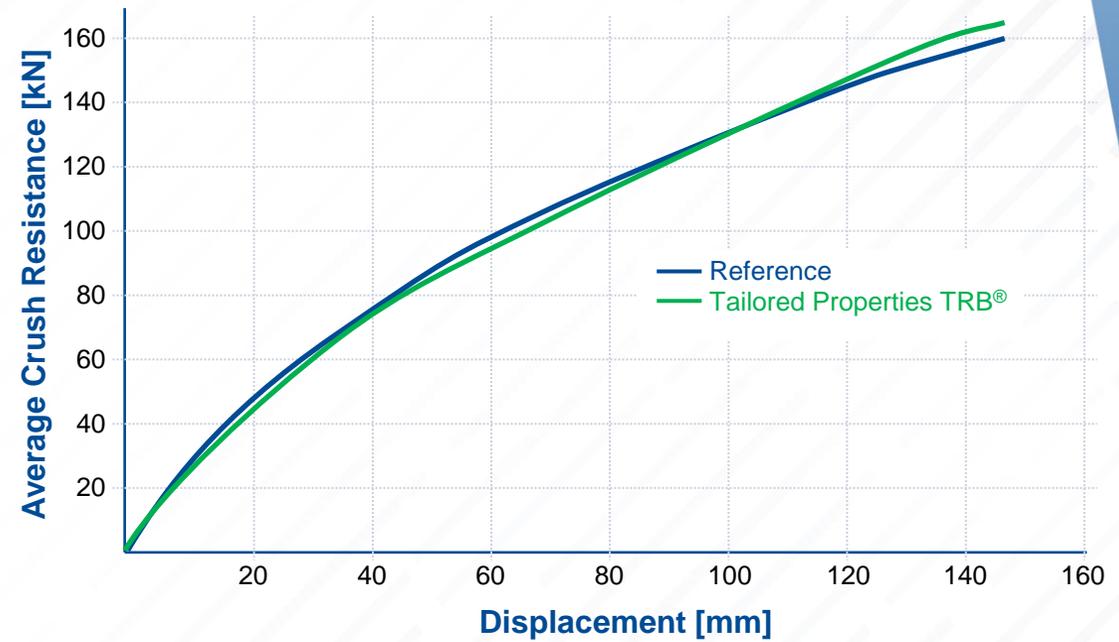
Tailored Properties TRB Kick-Up Rail Inner

- **Crash kinking areas: low yield AND low gauge desirable**
- **Crash Resistance: no kink wanted / high strength AND high thickness desirable**

# TP TRB®: POTENTIAL APPLICATIONS



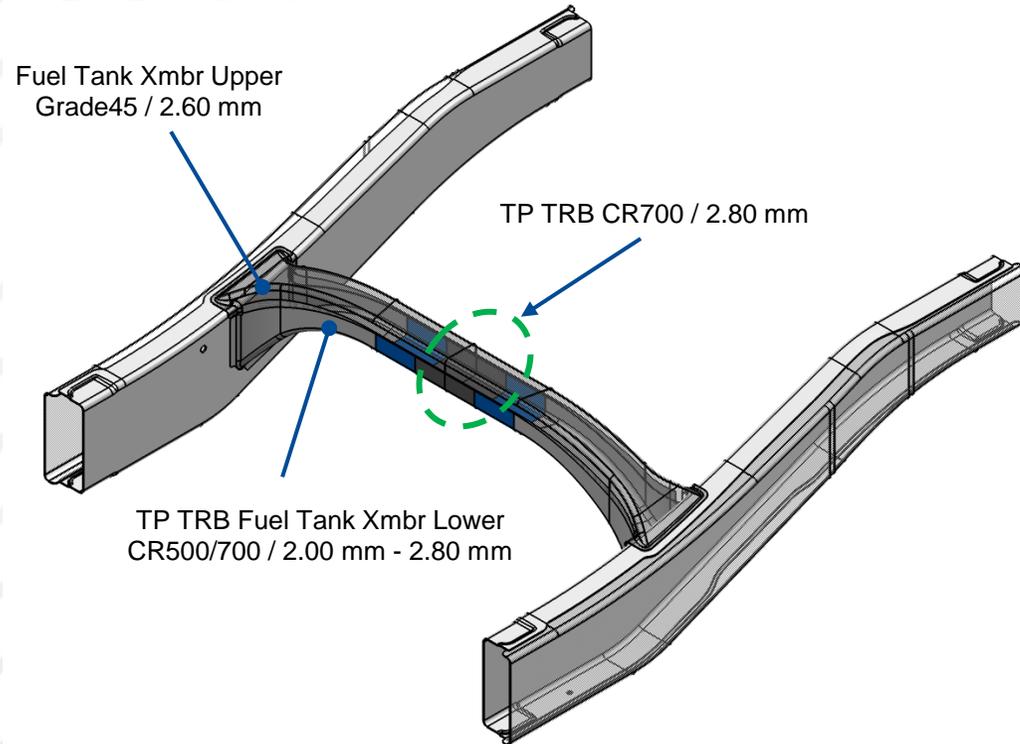
Reaction Force vs. Displacement



Average Crush Resistance vs. Displacement

Same crash performance with different deformation behavior / locations

# TP TRB®: FUEL TANK CROSS MEMBER



Tailored Properties TRB Kick-Up Rail Inner

## TP TRB® Fuel Tank Cross Member Lower

- Material change to CR500/700LA TRB
- Thickness difference min. 2.00 mm to max. 2.80 mm

### Objective

- Increase crash performance due to new side crash protocol
- Keep same crash behavior → progressive crush in center
- Keep same complex geometry on both ends

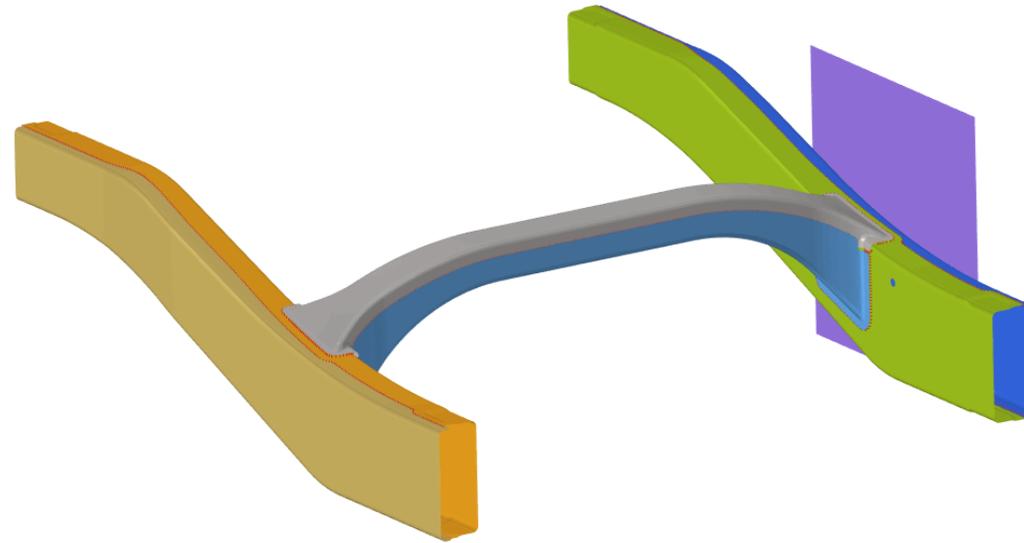
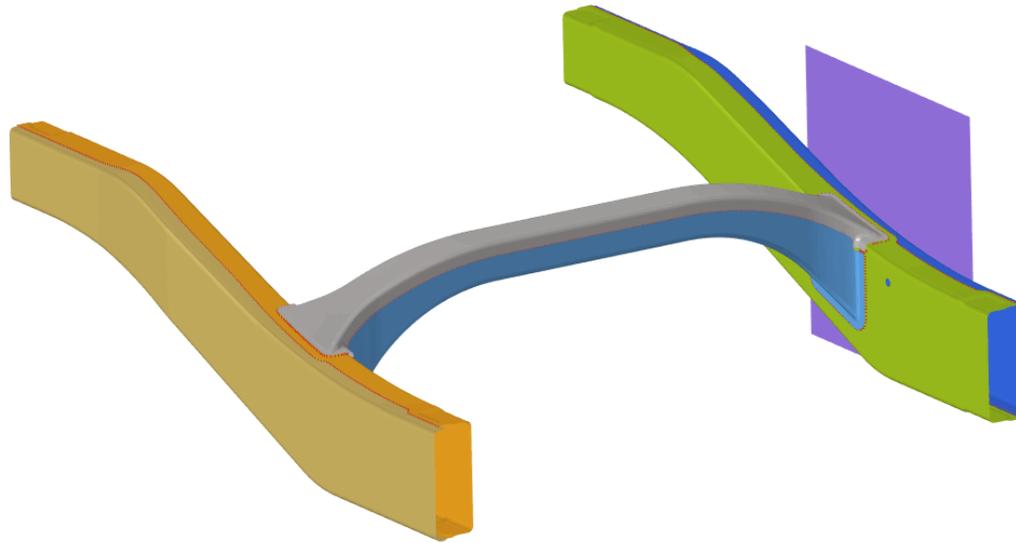
### Optimization setup

- Simple Clip-Model of Kick-Up Rails and Fuel Tank Xmbr Assy
- Load case: Side Impact with rigid plate
- Increase of reaction force and average crush resistance

# TP TRB®: POTENTIAL APPLICATIONS

Baseline

TP



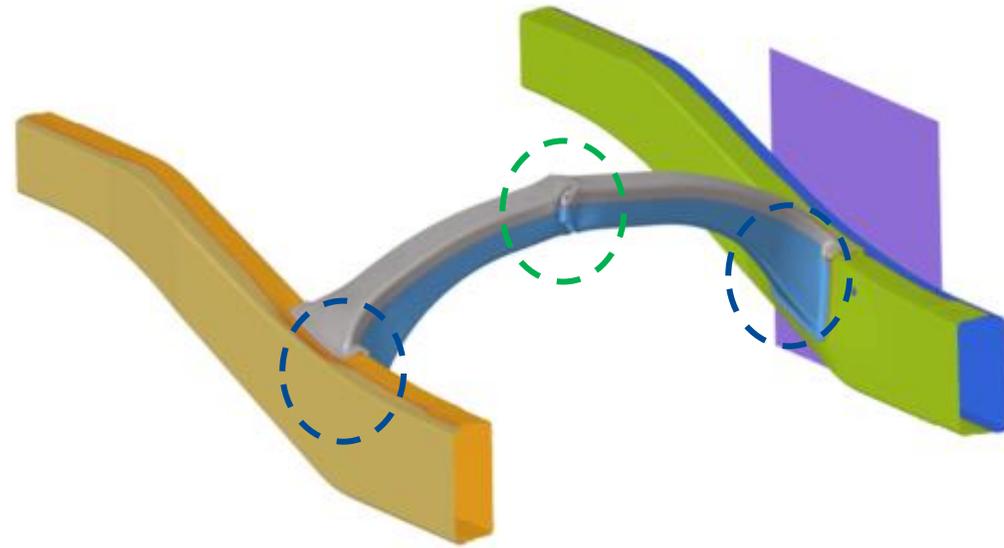
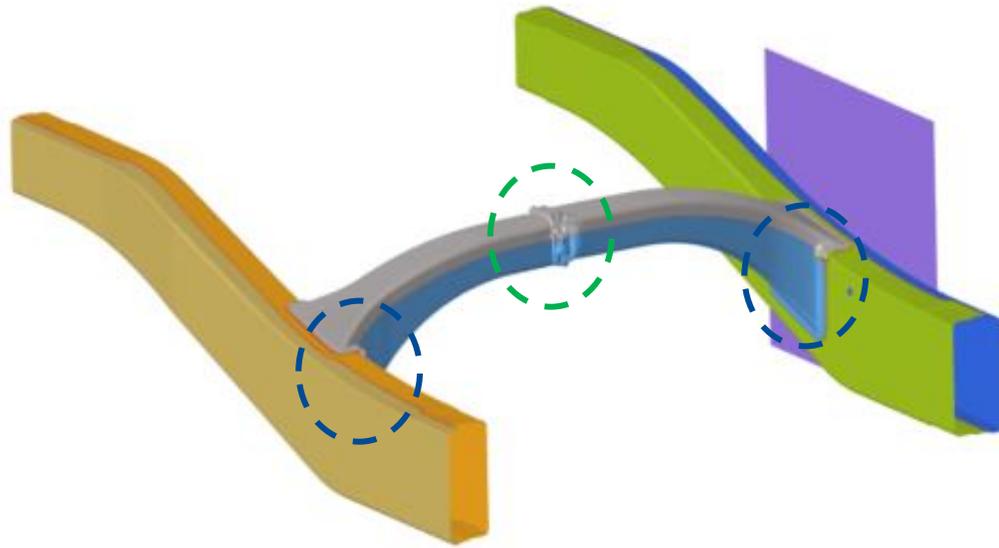
Reference monolithic Fuel Tank X-mbr

Tailored Properties TRB Fuel Tank X-mbr Lower

# TP TRB®: POTENTIAL APPLICATIONS

Baseline

TP

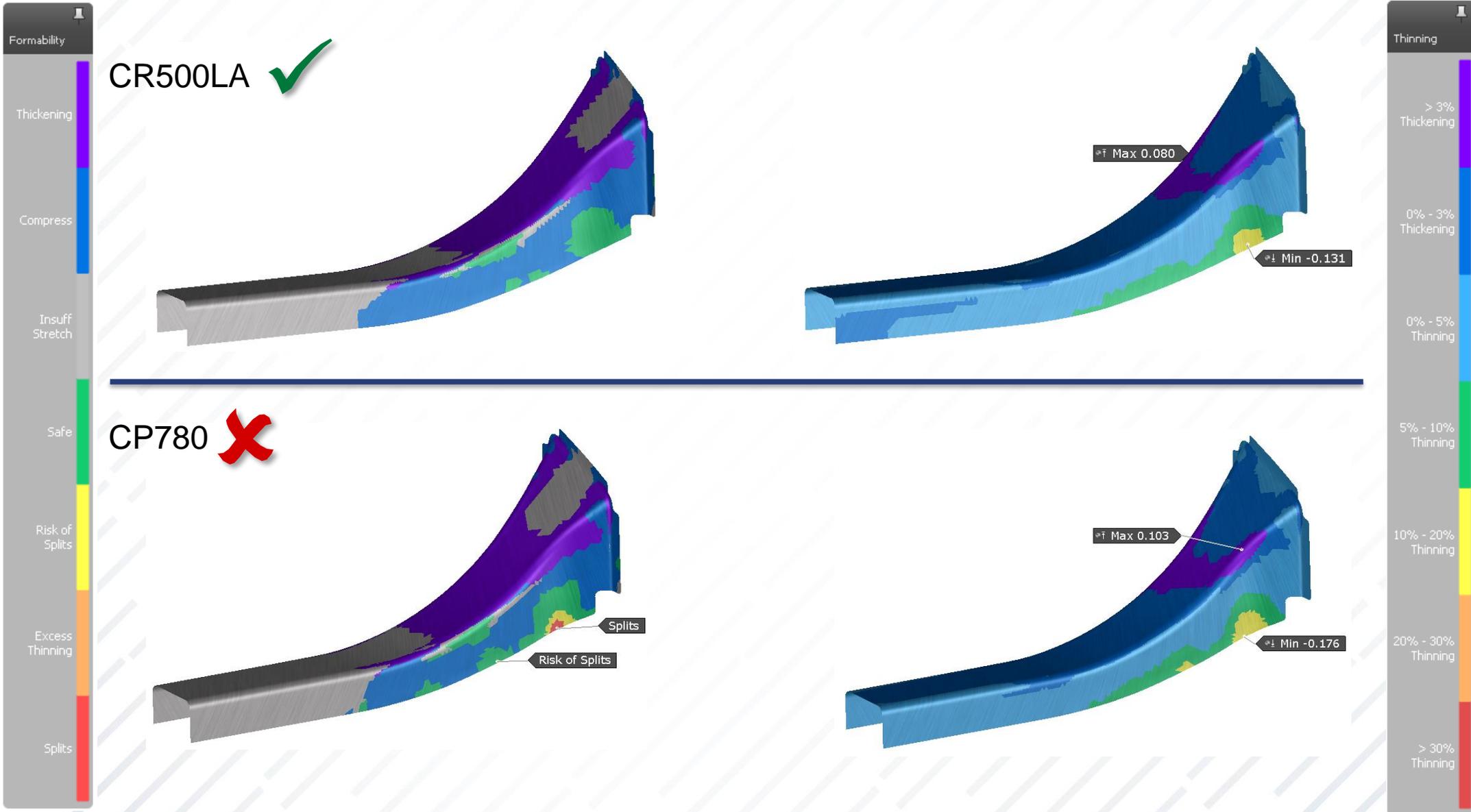


Reference monolithic Fuel Tank X-mbr

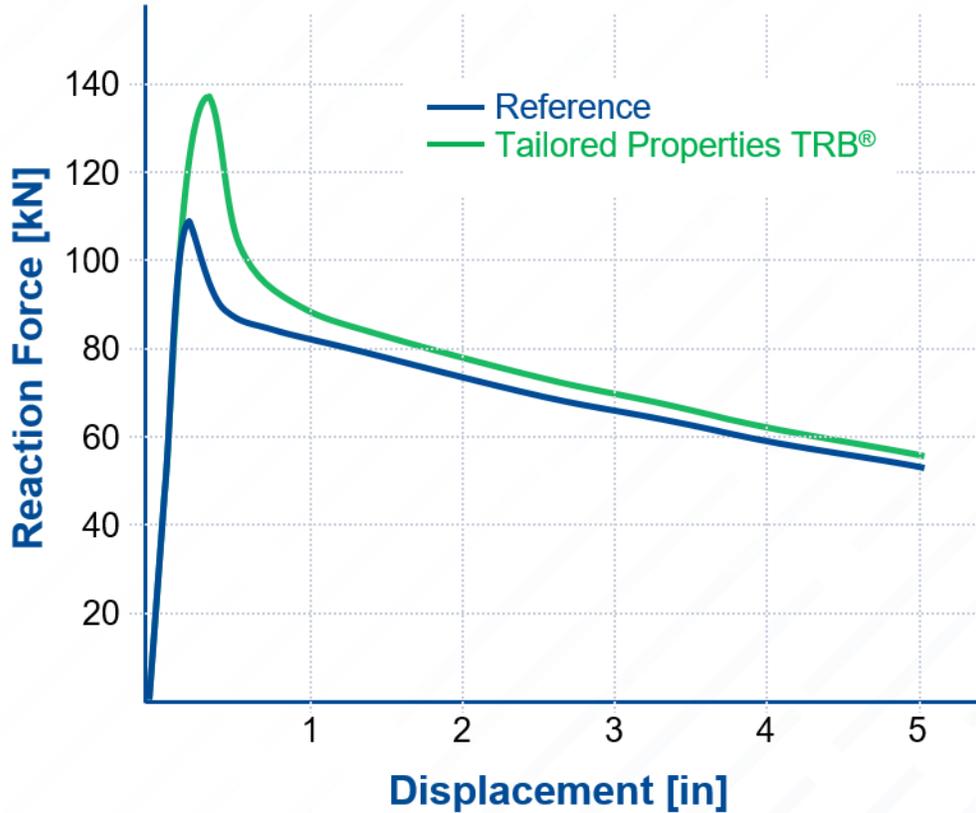
Tailored Properties TRB Fuel Tank X-mbr Lower

- **Formability demanding area: high Elongation desirable for complex geometry**
- **Crash collapse area / defining the reaction force: high strength AND high gauge desirable**

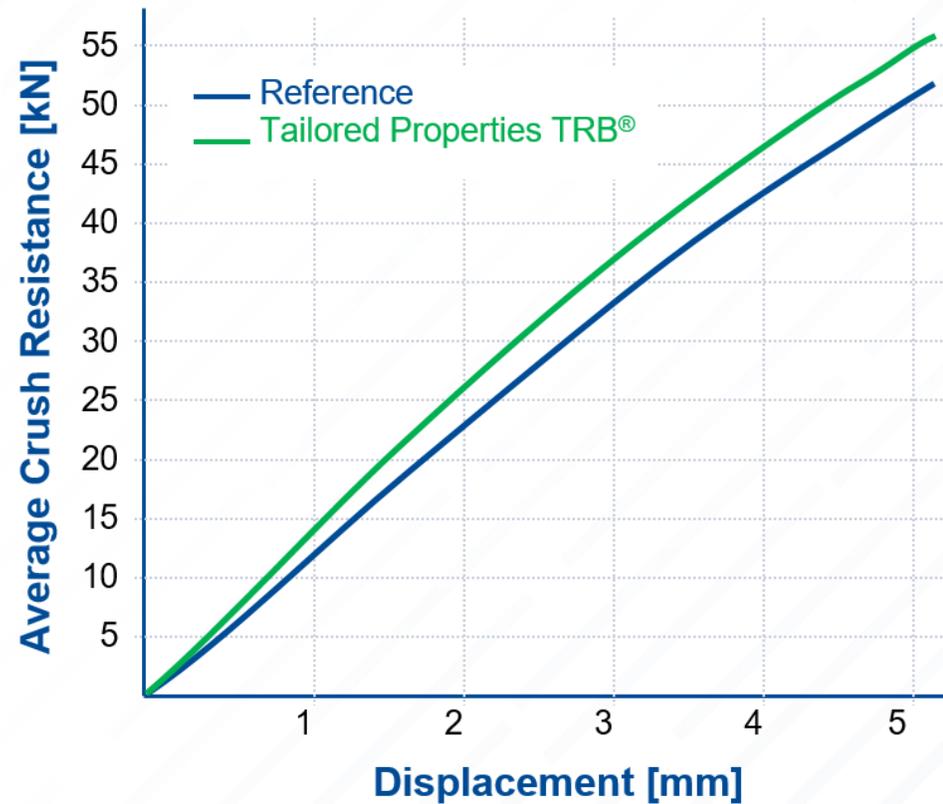
# TP TRB®: FEASIBILITY COMPARISON



# TP TRB®: POTENTIAL APPLICATIONS



Reaction Force vs. Displacement



Average Crush Resistance vs. Displacement

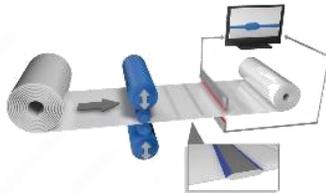
Higher reaction force / crush performance with good formability of complex geometries

# TRB® WORK HARDENED PRINCIPLE

## Conventional TRB process flow



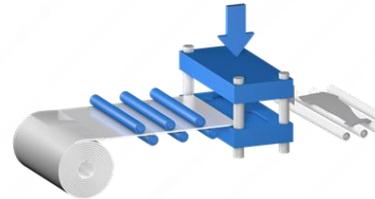
Raw Material  
Grade 90



Flex Rolling



Batch Annealing



Blanking / Forming

## CR420LA TRB

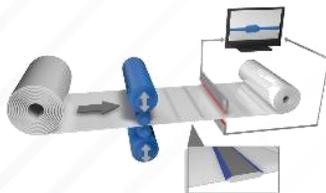


Homogeneous  
mechanical properties

## Work Hardened TRB → Cost Effective + High Strength



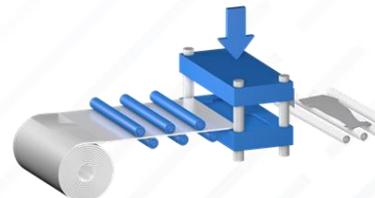
Raw Material  
DD13



Flex Rolling



Batch Annealing



Blanking / Forming

## CR420LA WH TRB



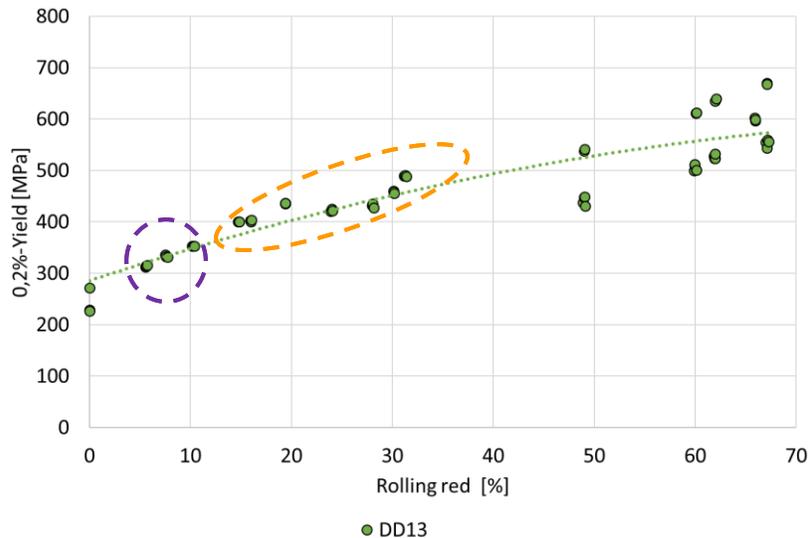
mech. properties depending  
on gauges / min. 420 MPa

# TRB<sup>®</sup> WH COST EFFECTIVE SPECIFICATION

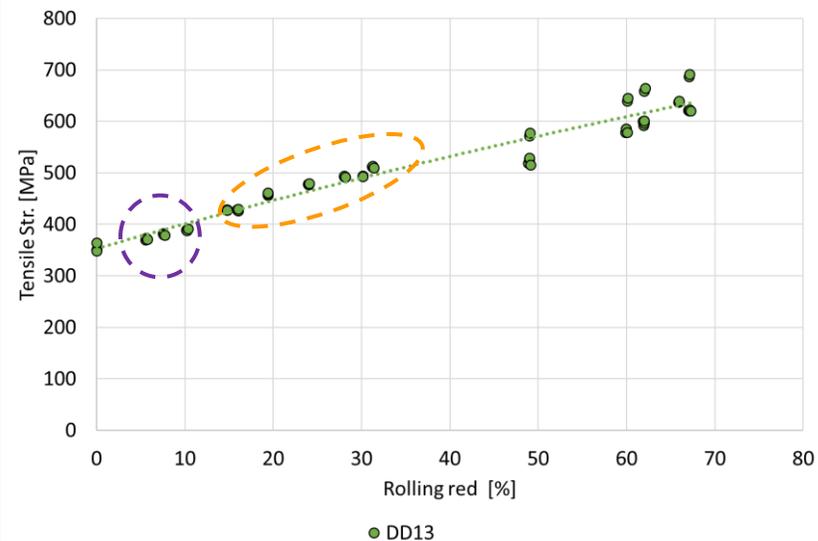
## Work Hardened for current TRB<sup>®</sup> cold forming portfolio up to CR420LA

- Use of mild steel raw material with high elongation
- **High gauge** mechanical properties slightly elevated due to minor rolling reduction → **high elongation**
- **Low gauge** mechanical properties increased due to major rolling reduction → **high strength**
- Cost effective alternative to current TRB<sup>®</sup> cold forming portfolio

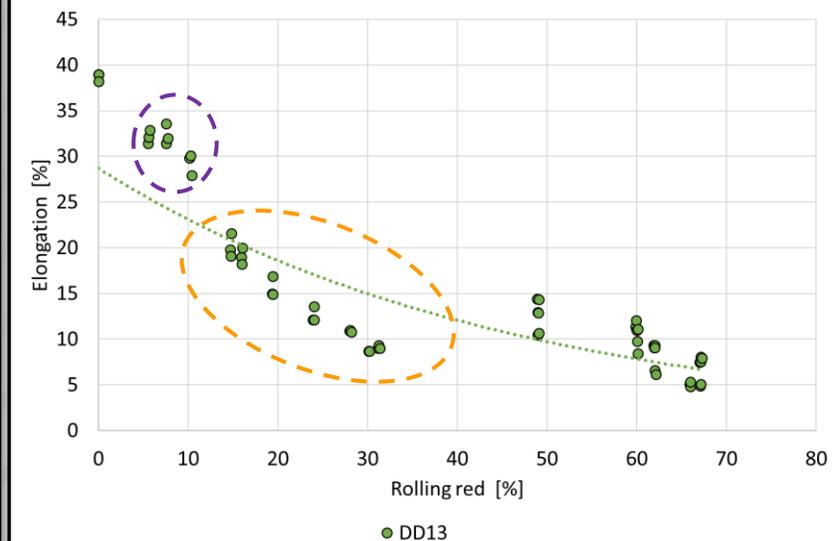
Yield Strength,  $R_{p0.2}$



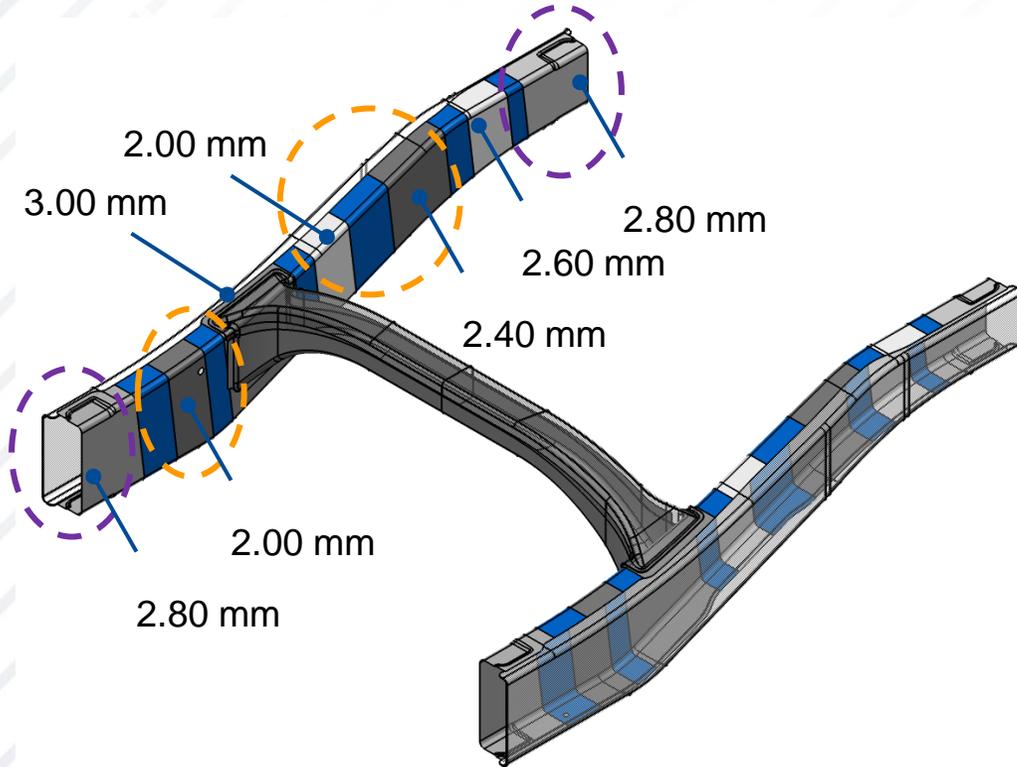
Tensile Strength,  $R_m$



Elongation,  $A_{50}$



# TRB® WH HIGH STRENGTH APPLICATION



## WH TRB® Kick-Up Rail Inner

- Reference material: Grade 60 in 2.80 mm
- Use of DD13 raw material in 3.50 mm
- Final gauges in the part min. 2.00 mm to max. 3.00 mm

## Objective

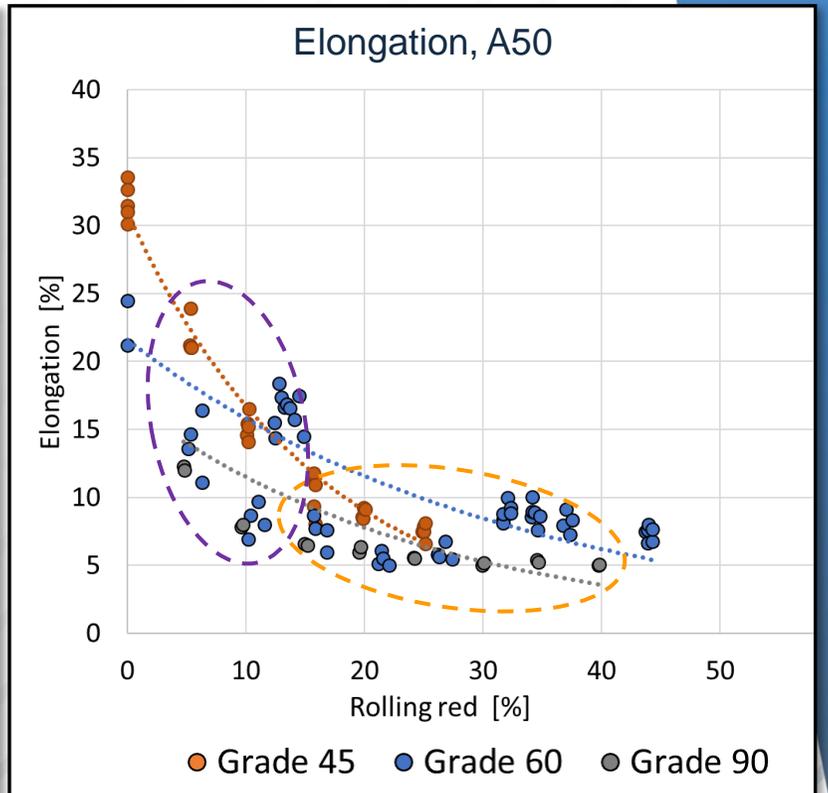
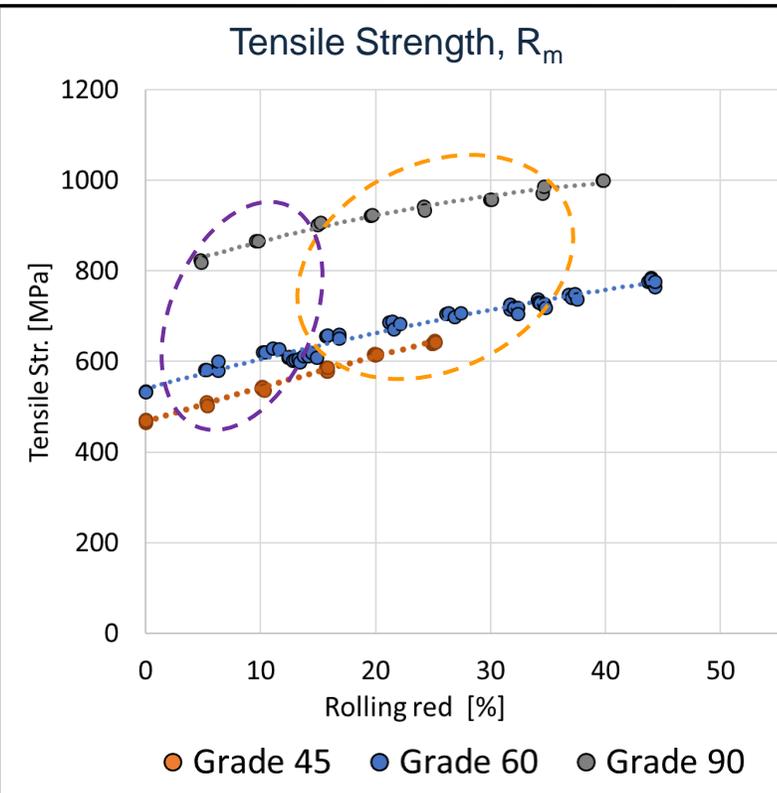
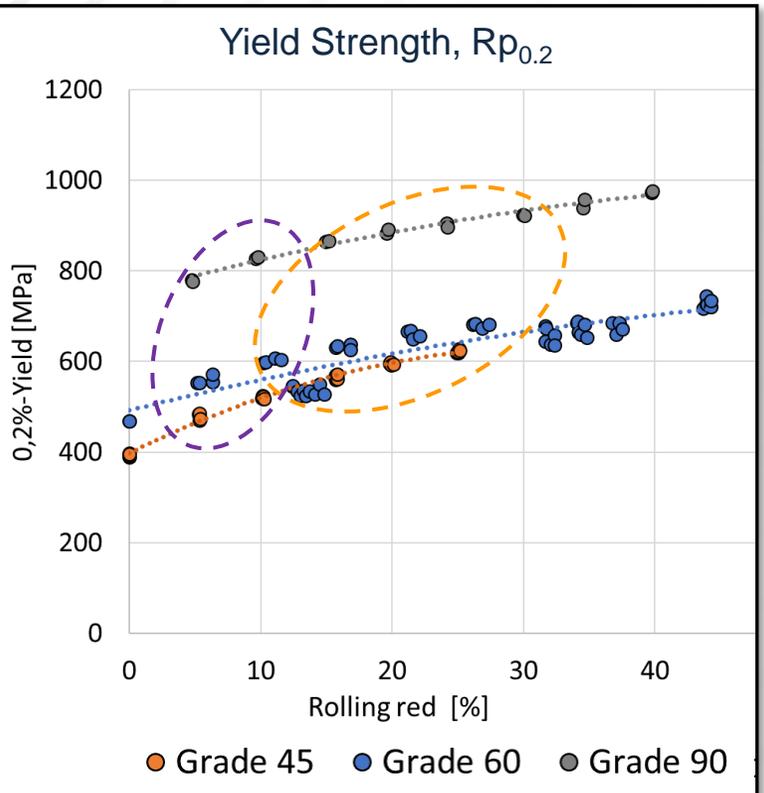
- Maximum weight reduction with work hardened TRB®
- Keep attachment areas thick → stiffness requirements
- Thinner areas compensate decreased crash performance with higher strength

- High Elongation
- High Strength

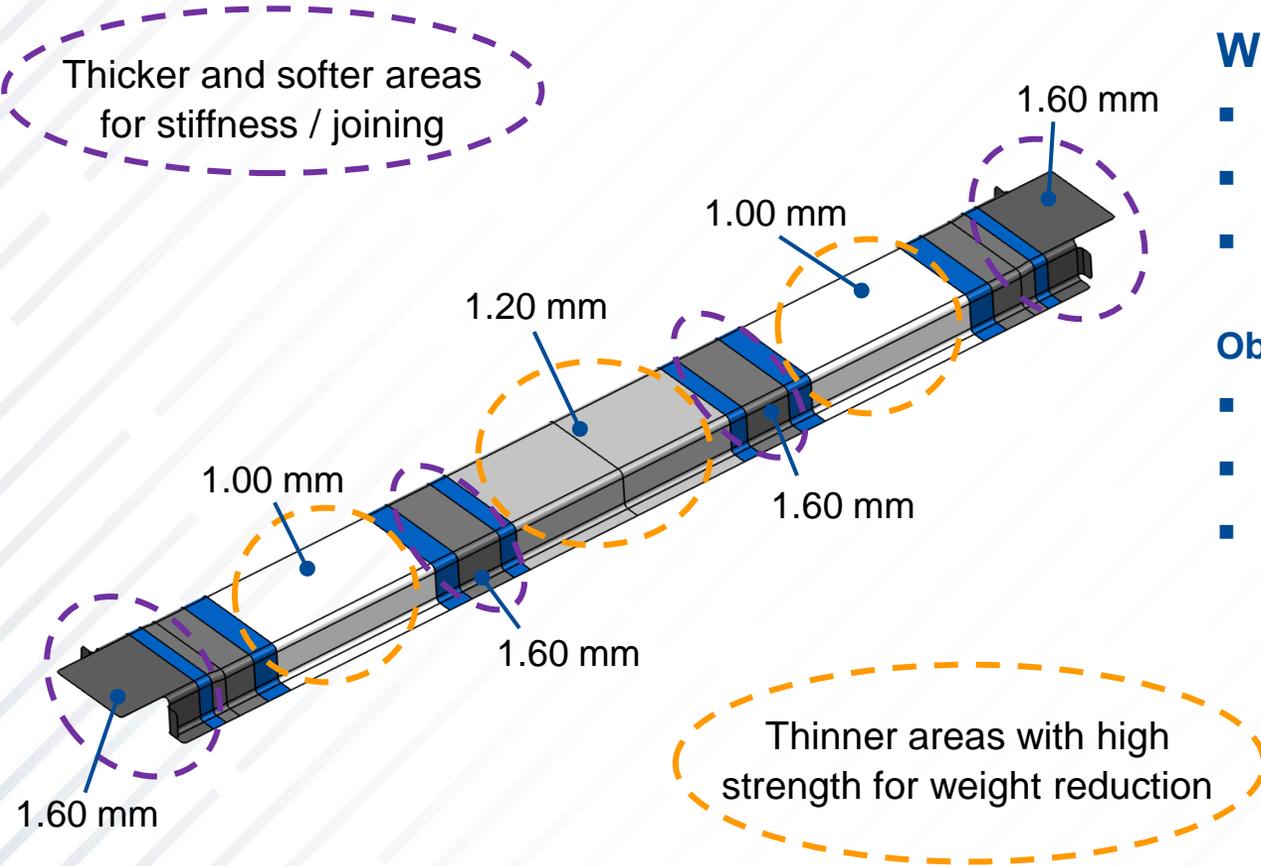
# TRB<sup>®</sup> WH HIGH STRENGTH SPECIFICATION

## Work Hardened for higher strength

- Use of micro alloyed steel raw material Grade 45 up to Grade 90
- **High gauge** mechanical properties slightly elevated due to minor rolling reduction → **high elongation**
- **Low gauge** mechanical properties increased due to major rolling reduction → **high strength**
- Enhanced TRB<sup>®</sup> cold forming portfolio beyond CR500LA



# TRB® WH COST EFFECTIVE APPLICATION



## WH TRB® Floor Cross Member

- Reference material: DP980 in 1.60 mm
- Use of Grade 90 raw material in 1.80 mm
- Final gauges in the part min. 1.00 mm to max. 1.60 mm

## Objective

- Maximum weight reduction with work hardened TRB
- Increase strength level > DP980 at thinner gauges
- Thinner areas compensate decreased crash performance with higher strength

- High Elongation
- High Strength

# NEW ADVANCEMENTS OF COLD FORMING TRB® AHSS

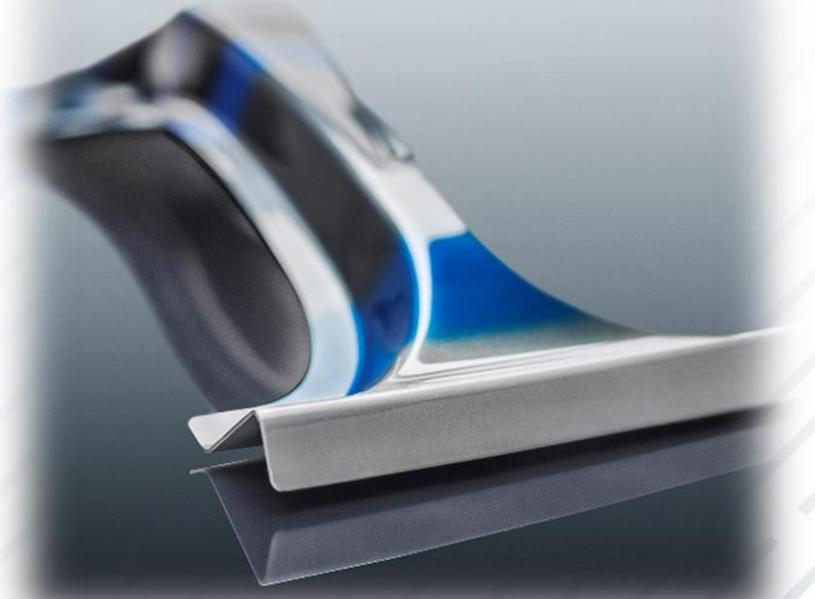
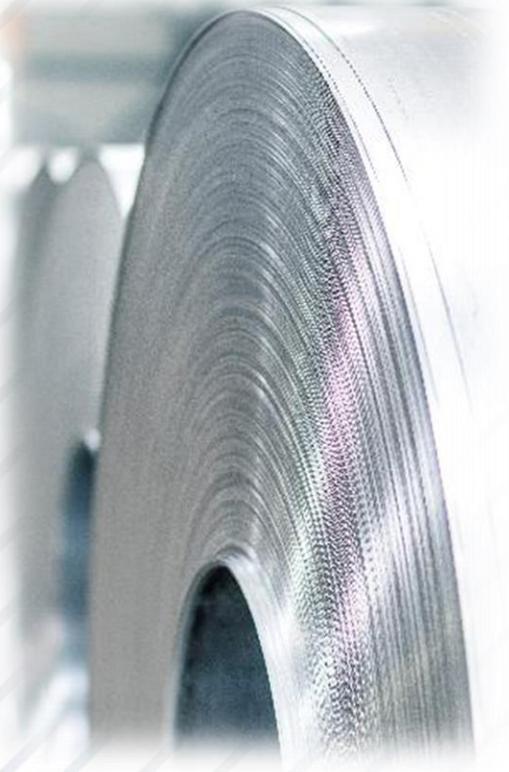
## Tailored Properties

- Introducing (2) different strength levels in one part with flexible gauges
- Crash Resistance
  - High Gauge ➡ Skim passed, properties similar to hot rolled raw material
- Energy Absorption / High Formability
  - Low Gauge ➡ Standard rolling reductions, properties similar to typical TRB® grades

## Work Hardened

- Introducing cost effective steel grades for cold forming steel with variable gauges
- Current TRB® cold forming portfolio
  - up to strength level of CR420LA
- Work Hardened for Higher Strength
  - Enhanced TRB® cold forming portfolio beyond CR500LA

***Thank you very much  
for your attention!***



# FOR MORE INFORMATION

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