GREAT DESIGNS IN STEEL

NEW ADVANCEMENTS OF COLD FORMING TRB® AHSS

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TRB® PRINCIPLE

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

- Flex Rolling
- Annealing
- Coating (optional)
- Blanking or Forming

Product portfolio:
- Rectangular Blanks [TRB]
- Tailor Shaped Blanks [TRS]
- Cold Stampings & Assemblies [TRP-C]

Hot Form Material

- Flex Rolling
- Blanking
- Heating + Forming

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

Tailored properties
CR500/700LA TRB

- Raw Material
- Grade 90 x 2.2 mm
- Flex Rolling
- Batch Annealing
- Blanking / Forming

- 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

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**Yield Strength, Rp_{0.2}**

**Tensile Strength, R_m**

**Elongation, A50**
TP TRB®: POTENTIAL APPLICATIONS

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

Reference monolithic Kick-Up Rail Inner

Fuel Tank Xmbr Upper
Grade45 / 2.60 mm

Fuel Tank Xmbr Lower
Grade45 / 2.80 mm

Kick-Up Rail Inner
Grade80 / 2.80 mm

Kick-Up Rail Outer
Grade80 / 2.80 mm
TP 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

Reference monolithic Kick-Up Rail Inner

Tailored Properties TRB Kick-Up Rail Inner
TP TRB®: 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

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 crash 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

Reference monolithic Fuel Tank Xmbr

Tailored Properties TRB Fuel Tank Xmbr Lower
TP TRB®: POTENTIAL APPLICATIONS

- - - 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

CR500LA ✔

CP780 ✗
**TP TRB®: POTENTIAL APPLICATIONS**

**Reaction Force vs. Displacement**

- **Reference**
- **Tailored Properties TRB®**

**Average Crush Resistance vs. Displacement**

- **Reference**
- **Tailored Properties TRB®**

Higher reaction force / crash 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

Work Hardened TRB → Cost Effective + High Strength

- Raw Material
  - DD13
- Flex Rolling
- Batch Annealing
- Blanking / Forming

CR420LA TRB
- Homogeneous mechanical properties

CR420LA WH TRB
- mech. properties depending on gauges / min. 420 MPa

Raw Material
- Grade 90
- DD13

Cost
- Effective + High Strength

CR420LA TRB
- Homogeneous mechanical properties

CR420LA WH TRB
- mech. properties depending on gauges / min. 420 MPa
TRB® WH COST EFFECTIVE SPECIFICATION

Work Hardened for current TRB® 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® cold forming portfolio
**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

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**High Elongation**

**High Strength**
TRB® 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® cold forming portfolio beyond CR500LA
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

Thicker and softer areas for stiffness / joining

Thinner areas with high strength for weight reduction

--- 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!
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