APPLICATION OF NEW COLD FORMING FLEXIBLE ROLLED AHSS

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Flexible rolling:

**Idea**
- Lightweight parts with load and function-optimized material usage and improved performance

**Implementation**
- Flexible Cold-Rolling process
- Flat material with repeated, varying thicknesses and harmonious transition zones
  - No heat affected zone
  - No notch effect
  - No stress peaks at thickness changes
- Thickness distribution change is software driven
  ➔ Thickness run optimization drives the cost efficiency

**Targets / Benefits**
- Weight reduction
- Part integration / design simplification ➔ cost reduction
- Functional improvement (crash, manufacturing,…)
COLD FORMING VS. HOT FORMING

**Cold Form Material**
- Flex Rolling
- Annealing (optional)
- 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] *

*) hot stamping lines already in serial production in Germany and China => planning to invest in hot stamping line in U.S.
TYPICAL MATERIAL PORTFOLIO

- Cost effective alternative with mild steel / Cost effective + high strength with micro alloyed and multiphase steel

- Mechanical properties are tailored to individual component during design phase

- Customer request of cost effective + high strength grades

Cost effective alternative with mild steel / Cost effective + high strength with micro alloyed and multiphase steel
Mechanical properties are tailored to individual component during design phase.

TYPICAL MATERIAL PORTFOLIO

Cost effective alternative with mild steel / Cost effective + high strength with micro alloyed and multiphase steel
MUBEA TAILORHARDENED PRINCIPLE (WORK HARDENED)

Conventional TRB process flow

Raw Material
Grade 90

Flex Rolling

Batch Annealing

Blanking / Forming

Homogeneous mechanical properties

CR420LA TRB

Mubea TailorHardened TRB → Cost Effective + High Strength

Raw Material
DD13

Flex Rolling

Batch Annealing

Blanking / Forming

Yield Strength depending on gauges
min. 420 MPa at highest gauge
min. 550 MPa at the lowest gauge

MTH420Y/550Y TRB

Cost effective due to use of lower grade raw material + omitted batch annealing process step
MUBEA TAILORHARDENED PROPERTIES

- Rolling of Single-Phase Ferritic Steels and lift it up to a higher strength level
- **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
- Enhanced TRB® cold forming portfolio beyond CR500LA TRB®

Cost effective alternative with mild steel / Cost effective + high strength with micro alloyed and multiphase steel
TAILORHARDENED POTENTIAL APPLICATION

Targeted applications are **Straight Regular Profiles** with minor deep drawing sections

- **Ladder Frame**
- **Body in White**

Ongoing investigations include successful physical testing

Potential applications driven by BEV architectures
TAILORHARDENED DEFORMATION BEHAVIOR

- Sample assemblies to conduct 3-point bending trials composed of:
  - Hat Profile geometry with MTH550Y/700Y TRB and MTH420Y/580Y TRB
  - Closing Plate with CR500LA joined by laser welding
- Initial 3-point bending trials with 2 materials...
  - have shown a folding behavior like expected
  - no cracking appeared in any of the parts

Good deformation behavior in areas with high rolling reductions (high Yield Strength / lower Elongation)
TAILORHARDENED FORMABILITY

- Formability trials of Kick-Up Rails with minor deep drawing sections
- 3 different raw materials with same final thickness profile (min. 2.00 mm – max. 3.00 mm)
  - DD13 ➔ MTH550Y/630Y TRB  min. 550 MPa at 3.00 mm / min. 630 MPa at 2.00 mm
  - Grade45 ➔ MTH560Y/690Y TRB  min. 560 MPa at 3.00 mm / min. 690 MPa at 2.00 mm
  - Grade60 ➔ MTH590Y/780Y TRB  min. 590 MPa at 3.00 mm / min. 780 MPa at 2.00 mm
- Same final thickness profile (min. 2 mm – max. 3 mm)

No major issues detected ➔ good results even before spring back compensation

Source: https://www.nhtsa.gov/crash-simulation-vehicle-models
Mechanical properties are tailored to individual component during design phase.
Mechanical properties are tailored to individual component during design phase.

Cost effective alternative of high formability demands.

PHS / 22MnB5

MTS TailorSoftened
Tailored Properties

MTH TailorHardened
Work Hardened
MUBEA TAILORSOFTENED PRINCIPLE

Conventional TRB process flow

- Raw Material Grade 90 x 3.00 mm
- Flex Rolling
- Batch Annealing
- Blanking / Forming

Homogeneous mechanical properties

**CR500LA TRB**

- Raw 3.0 mm
- Part / Blank 1.4 mm
- Rolling Reduction

Conventional TRB process flow with lower rolling reduction

- Raw Material Grade 90 x 2.20 mm
- Flex Rolling
- Batch Annealing
- Blanking / Forming

**Mubea TailorSoftened**

**MTS700Y/500Y TRB**

- Raw 2.2 mm
- Part / Blank 1.4 mm
- Rolling Reduction

- recrystallized ➔ 500MPa
- recovered ➔ 700MPa
Rolling of Single-Phase Ferritic Steels with **low** and **high** rolling reductions

- **High gauge / low rolling reduction** = high strength \(\rightarrow\) crash collapse area / definition of reaction force
- **Low gauge / high rolling reduction** = high formability \(\rightarrow\) high elongation desirable for complex geometry

- Mechanical properties increased by rolling reductions < 10%
- Mechanical properties decreased at rolling reductions > 30%

Cost effective cold forming alternative with two property zones \(\rightarrow\) high strength and high formability
- Mubea generic Door Intrusion Beam concept geometry
- U-Channel design with same center cross section and percent rolling reduction
- Surrogate U-Channel part used for material card validation
MTS INTRUSION BEAM FORMABILITY

- Hot forming simulation with 1.30 mm monolithic PHS material => safe
- Cold forming simulation with 2.00 mm monolithic CR700LA => not feasible
- Cold forming simulation with 1.20/1.40/2.00 mm MTS700Y/500Y => safe

Cost effective cold forming alternative with two property zones: high strength and high formability
MTS 3-POINT BENDING SIMULATION

- Total enforced Displacement: 3 inch to 6 inch
MTS 3-POINT-BENDING VALIDATION

Deformed part after 6" displacement

Material card for FEM simulation shows good correlation between real test and simulation.
SUMMARY

Mubea TailorHardened MTH
- Introducing cost effective steel grades for cold forming steel with variable gauges
- Cost effective TRB® cold forming portfolio with mild steel raw material
  - up to strength level of CR550LA
  - MTH200Y/400Y TRB – MTH550Y/630Y TRB under development
- Enhanced TRB® cold forming portfolio with Micro Alloyed and Multiphase steel raw material
  - Strength level ≥ CR550LA for Ultra High Strength steel application
  - MTH340Y450Y TRB – MTH700Y/850Y TRB under development

Mubea TailorSoftened MTS
- 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
- “New Steel Family” under development
  - MTS315Y/240Y ; MTS420Y/300Y ; MTS500Y/340Y
  - MTS550Y/380Y ; MTS600Y/420Y ; MTS700Y/500Y
Drive e-mobility with Mubea

THANK YOU VERY MUCH FOR YOUR ATTENTION !
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