COST EFFECTIVE COLD FORMING SOLUTIONS WITH TAILOR ROLLED PRODUCTS

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Mubea Tailor Rolled Blanks
COMPANY FACTS

NORTH & SOUTH AMERICA:
• 5 locations
• 2,500 employees

EUROPE:
• 31 locations
• 9,700 employees

ASIA:
• 14 locations
• 1,800 employees

• Owner-operated family company since 1916
• Lightweight component design specialist
• Vertical integration from raw material to finished product
• Internal development of products and production processes
FLEXIBLE ROLLING PROCESS

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 led to cost reduction
- Functional improvement (crash, manufacturing, etc.)
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]
Mubea TailorSoftened: GENERAL IDEA

Mechanical properties are tailored to individual component during design phase.

Cost effective alternative of high formability demands.
MUBEA TAILORSOFTENED - PRINCIPLE

Conventional TRB process flow

Homogeneous mech. properties

CR500LA TRB

Conventional TRB process flow

Mubea TailorSoftened

MTS 700Y/500Y TRB
- Mubea generic Door Intrusion Beam concept geometry
- Hat shape design with same center cross section and percent rolling reduction
- Surrogate hat shaped 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 MTS 700Y/500Y TRB => safe

Cost effective cold forming alternative with two property zones  ➔  high strength and high formability
MTS – COST BENEFITS

MTS Cost Efficiency vs. PHS (Door Beam Application)

- Raw Material Costs
  - 22MnB5 AS150
- Process Costs
  - Blank cutting
  - Hot forming

- Process Costs
  - TRB
  - Cold forming

Raw Material Costs
- HR700 [Grade 100]

- MTS TRB offers cost reduction potential with comparable weight
- MTS TRB achieves same performance as benchmark
MTS POTENTIAL APPLICATIONS

Ladder Frame

MTS TRB Fuel Tank Cross Member
- MTS 700Y/500Y TRB
- 2.00 mm - 2.80 mm

- 700Y in 2.80 mm central region to prevent kink on side crash
- 500Y & improved formability at side areas
- 700Y in 2.80 mm central region to prevent kinking and protect fuel tank / battery

Body in White

MTS TRB Kick-Up Rail Inner
- MTS 700Y/500Y TRB
- 2.00 mm - 2.80 mm

- 700Y in 2.80 mm: thick and hard region to prevent kinking and protect fuel tank / battery
- 500Y in 2.00 mm rear area to trigger crushing behaviour

MTS TRB Door Intrusion Beams
- MTS 700Y/500Y TRB
- 1.2 mm - 2.0 mm

- 500Y and improved formability side areas for complex geometry
- 700Y and high gauge central region to meet side crash requirements

MTS TRB Hinge Pillar
- MTS 700Y/500Y TRB
- 1.00 mm - 1.85 mm

- 700Y and high gauge upper region to meet front crash and stiffness requirements
- 500Y and improved formability bottom area for complex geometry
Idea of TailorHardened TRB was driven by filling gap in material portfolio (CR500 <-> PHS).

Mechanical properties are tailored to individual component during design phase.

Customer request for cost effective high strength grades.

Tensile Strength $R_m$ [MPa]

Elongation $A_{50}$ [%]
CUSTOMER BENEFITS BEYOND WEIGHT REDUCTION

**Functional Improvement:**
- Crash optimization
- Optimal definition of deformation pattern

**Part Integration:**
- No sub-assembly
- Less investment
- Reduced supply chain cost
- Improved CO\textsubscript{2} footprint
- Weight reduction

**Cost Reduction by MTH*:**
* Mubea TailorHardened
- Cost reduction by...
  - elimination of process steps
  - lower grade raw material usage
  - Performance improvement
  - Weight reduction as side effect
MUEBA TAILORHARDENED: PROCESS

Conventional TRB process flow

- Raw Material (e.g. HR550LA)
- Flex Rolling
- Batch Annealing
- Forming
- Homogeneous mechanical properties "CR420 LA TRB"

TailorHardened cost effective process flow

- Raw Material (e.g. HR315LA)
- Flex Rolling
- Batch Annealing
- Forming
- TailorHardened mechanical properties e.g. "MTH 420Y/550Y TRB"

- Cost efficiency of Mubea TailorHardened material is realized by:
  - usage of inexpensive grade raw material
  - elimination of process step (annealing)
MUBEA TAILOR HARDENED: EFFICIENCY

TailorHardened cost effective process flow

- Raw Material (e.g. HR315LA)
- Flex Rolling
- Batch Annealing
- Forming
- TailorHardened mechanical properties e.g. “MTH 420Y/550Y TRB”

MTH Cost Efficiency

- Process Costs - Forming
- Process Costs - Forming
- Material Costs CR-CPxxx
- TRB Cold Rolling
- Raw Material Costs HRxxx
- Benchmark CP
- MTH TRB

• MTH achieves same performance as benchmark by lifting properties of inexpensive raw material
• MTH TRB offers additional weight advantage up to ~15% → max. customer benefit in weight & cost
MUBEA TAILOR HARDENED: FORMING TRIALS

- Performed multiple forming trials in existing series tooling & built prototype dyes
- Great results during forming trials with formability & dimensional stability
  - up to 3-point bending trials without any crack indications
  - results beyond expectations if only considering elongation properties $A_{50}^5$
- $S550MC / 35\% \text{ rolling red}$
- $910Y / 960T / 5.0\% \text{ A}_{50}^5$
MUBEA TAILOR HARDENED: VALIDATION

1. Development of MTH Material Cards

- Based on DD13, S420, S700, CP800 further base materials in progress
- Characterization of material quasi static & dynamic
- Forming limit curves
- Fracture limit curves
MUBEA TAILOR HARDENED: VALIDATION

1. Development of MTH Material Cards

2. CAE Simulations including failure
   (CrachFem/Gissmo)
MUBEA TAILOR HARDENED: VALIDATION

1. Development of MTH Material Cards

2. CAE Simulations including failure (CrachFem/Gissmo)

3. Physical Static 3-point bending testing

- Performed trials on hat profiles with different:
  - materials (DD13, S700)
  - rolling degrees (5% - 50%)
- No cracking of the material
  - great correlation to static simulation
MUBEATAILOR HARDENED: VALIDATION

1. Development of MTH Material Cards

2. CAE Simulations including failure (CrachFem/Gissmo)

3. Physical Dynamic 3-point bending testing

- Performed drop tower testing on hat profiles with different:
  - materials (DD13, S700)
  - rolling degrees (5% - 50%)
  - energies (4 -8kJ)

- Target to initiate cracking on higher energy levels for optimized correlation analysis
MUBEA TAILOR HARDENED: VALIDATION

1. Development of MTH Material Cards

2. CAE Simulations including failure (CrachFem/Gissmo)

3. Physical Dynamic 3-point bending testing

4. Correlation Simulation vs. Physical Testing
   • Successful correlation could be stated on:
     • detailed element tracking
     • crack initiation (time & location)
MTH APPLICATIONS IN UNIBODY & BOF

- Multiple potential applications for MTH have been identified and are currently in development
- BEV architectures in Unibody & BoF have geometry and performance requirements to enhance MTH advantages

Alternative design solution in development: MTH closed profile with horizontal layers for Bumper and Frame Rail applications
MTH: RESUME & OUTLOOK

- Idea TailorHardened TRB driven by filling gap in current material portfolio
- Simple ferritic hot rolled raw material properties are being “lifted up” by cold rolling
- Cost reduction by ...
  - usage lower grade material (lifting properties)
  - elimination of process step (annealing)
- Multiple successful forming trials in ...
  - existing series tooling
  - specifically built prototype dies
- Creation of material cards for forming and crash (Partner: MatFem)
  - first material cards available (DD13 / S700) since Dec 2022
  - S420 & CP800 will be available in Q2/2023
  - S315 & S500 planned for Q4/2023

Design and validation of MTH ideas with the OEM begins NOW!
FOR MORE INFORMATION

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