Optimization Side Crash Performance Using a Hot-Stamped B-Pillar

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Highlights

- Met all impact performance targets
- 46% weight reduction versus baseline
- No change to final assembly process
- Cost effective solution
Test Criteria

- FMVSS 214 Dynamic Side Impact
- FMVSS 214 Static Crush
- IIHS Dynamic Side Impact
  - Measures clearance between Centerline of steering wheel and B-Pillar inner
  - Heavily dependent on B-Pillar performance
  - Most difficult to meet

IIHS side impact, courtesy http://www.iihs.org
Design Solution (Baseline)

- Geometry
  - B-Pillar Reinforcement Assembly (16.0 lbs total)
    - Main Stamping
    - Bulkhead at upper hinge / beltline
    - Hinge reinforcement at lower hinge

Dual Phase 590
1.8 mm min. thk
13.0 lbs.

Dual Phase 590
2.3 mm min. thk.
3.0 lbs.
• Clip Model
  – Created a component-level model of the b-pillar assembly
  – Ran multiple iterations to optimize thickness distribution

• Full Vehicle
  – Submitted best component designs to customer for full vehicle FEA
Design Solution (baseline)

Passenger zone remains straight, protecting the occupant

Deformation zone absorbs energy safely away from occupant
Design Methodology

• Energy Management
  – Structural Deformation
    • High deformation load to limit intrusion
    • Controlled deformed shape to limit intrusion
  – Reaction Movement
    • Absorbs energy by moving vehicle
    • Even deformation load to limit deflection
    • High deformation load to increase reaction movement

IIHS side impact, courtesy http://www.iihs.org
Crash Energy Management

The area under the Force Deflection curve is the amount of energy absorbed.

Pushing the car away from the crash absorbs energy.
Design Solution (Improved)

• Geometry
  – B-Pillar Reinforcement Assembly (13.1 lbs total)
    • Main Stamping
    • Bulkhead at upper hinge / beltline
    • Hinge reinforcement at lower hinge
Design Solution (Improved)

Passenger zone remains straight, protecting the occupant

Deformation zone absorbs energy safely away from occupant
Advanced Design Options

Possibilities for strategic strengthened hot formed parts

- Conventional design:
  - upper: UHSS
  - lower: mild steel
  + joining operation

- 2-piece-design

- Local hot stamping:
  - Diff. material strengths in one hot stamped component
  - $R_m: 1450$ MPa
  - $A5: 9\%$

- Tailored rolled blanks:
  - Diff. material thicknesses in one hot stamped component
  - 1.0 mm, 1.3 mm, 1.75 mm, 1.6 mm, 1.75 mm, 1.0 mm

- Patch work blanks:
  - Two blanks formed in one hot stamped component
  - 1.0 mm, 1.0 mm + 2.0 mm, 1.0 mm
• Materials
  – Hot Stamped DB200 Stamping)
    • Yield = 950 MPa (+171%)
    • Tensile = 1300 MPa (+117%)
    • Elongation = 6% (-74%)
  – HSLA 050 (Lower Stamping)
    • Yield = 345 MPa (-1.4%)
    • Tensile = 420 MPa (-30%)
    • Elongation = 22% (-4.5%)
    • Galvaneal for corrosion resistance
Design Solution (final)

- **Materials**
  - **Thickness**
    - Upper Stamping = 1.3-1.6-1.9-1.0 mm (Tailor Rolled)
    - Lower Stamping = 1.4 mm
    - 8.7 lbs total (-46%)
Advanced High Strength Steel

Overview of Steel Grades

- CP = complex phase
- PM = partial martensitic
- DP = dual phase
- FB = ferritic bainitic
- TRIP = transformation induced plasticity
- HSLA = high strength low alloyed
- P = rephosphorized
- BH = bake hardening
- IFHS = interstitial free high strength
- DDQ = deep drawing quality
- UDDQ = ultra deep drawing quality
- BTR 165 = European Benteler grade
- DB 200 = US Benteler grade

DB200 Hot Stamped

DB200 As Rolled

UTS, MPa:
- HSS
- UHSS
- PHS

Elongation, %:
- HSLA
- P, BH, IFHS
- Multiphase steels
- Martens.

DB200 = European Benteler grade
DB 200 = US Benteler grade

BTR 165 = European Benteler grade
Benefit of Hot Stamping

- highest material strength with high ductility
- high potential of weight reduction
- best form accuracy
- no spring-back-effect
- complex geometries feasible
- excellent intrusion control in crash events
Tailor Rolling Benefits

- Allows complete tuning of deformed shape
- Allows weight reduction by removing low-stress material
- No stress risers from welded joints
- Unlimited number of thickness changes

6.6 kg
**Hot Stamping Process**

- coil
- blank
- furnace
- handling
- press
- cooling

**Tailor Rolling Process**

- Sollprofil
- gewalzte Bandkontur
- gewalztes Bandprofil

www.autosteel.org
But can I weld it?

• Design for Manufacturability
  – Stamped design
    • Requires no changes to mating parts
    • Requires no changes to assembly process
  – Weldable
    • Requires no special weld capital
    • Requires no special weld testing
• Processes
  – Spot Welding
    • No special equipment needed
    • Sufficient joint strength for crash
  – Projection Welding
    • Ultra High Strength Steel allowed hinge tapping plates to be replaced by simple weld nuts
Passenger zone remains straight, protecting the occupant.

Deformation allowed in hot stamped material to increase energy absorption.

Deformation zone absorbs energy safely away from occupant.
Highlights

– Met all impact performance targets
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Product Samples for Hot Stamping

- Doorbeam
- Roof Rail-reinforcement
- Beltline Reinforcement
- Rear Bumper
- B-Pillar-reinforcement
- Rocker Panel-reinforcement
- A-Pillar-reinforcement
- Side member-reinforcement
- Mountingplate
- Front wall
- Carrier
- Understructure
- Tunnel
- Front Bumper
- Beltline Reinforcement

Other Applications
• Questions & Answers