Developing a Deep Drawn Hot Stamped Fuel Tank Guard

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Program Manager’s Slide

Highlights

– Met continuously increasing performance targets
– 7% lighter than baseline
– 40% fewer parts than baseline
– 89% less welding than baseline
– Cost effective solution
Development Cycle

Performance Targets

Design and Execution

Design of Record

Theory and Analysis
Test Criteria

- Honda proprietary test series
  - Multiple test conditions
  - Conditions evolved and increased throughout design cycle
  - Final design requirements substantially exceed original baseline design requirements
• Component Models
  – Created a component-level model for each test condition
  – Ran multiple iterations to optimize geometry and thickness

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

- **Geometry**
  - Pan - 2.0 mm Galvaneal 180 MPa
  - Tubes - 25.4 dia. x 1.6 mm wall  HSLA 345 MPa
  - Bracket - 2.0 mm Galvaneal 180 MPa

Summary:
4.41 kg
5 pieces
545 mm Weld
Multiple Test Conditions
Design Solution (baseline)

Target is same or greater peak load

Honda Baseline (mid position impact)
Benteler Proposal
Design Methodology

• Sheet Metal Design
  – Overall Strength
    • Deep drawn, partially closed section
    • Change to Ultra-High strength steel
  – Local Strength
    • Use beads to locally increase stiffness
    • Necessary to prevent premature buckling
    • Replace tubes where possible
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**
- **As Rolled**

**UTS, MPa**
- **HSS**
- **UHSS**
- **PHS**

**Elongation, %**
- **P, BH, IFHS**
- **HSLA**
- **DP**
- **TRIP**
- **CP**

**BTR 165**
- **hot formed**
- **as rolled**

**DB200**
- **Multiphase steels**

**w w w. a u t o s t e e l. o r g**
Hot forming (Press hardening)

**Direct Process**
- Coil
- Blank
- Furnace
- Handling
- Press cooling

**Indirect Process**
- Coil
- Blank
- Press (pre-forming / trimming)
- Furnace
- Handling
- Press cooling
General hot stamping process Precoated PHS

before heat treatment
- aluminized coating (Al-Si)
- substrate: PHS

25-35 µm

temperature, time

after heat treatment
- alloyed Al/Fe/Si-layer

35-45 µm

Fe, Al
Design Solution (Improved)

- **Geometry**
  - Pan - 2.0 mm Aluminized Hot Stamped 950 MPa
    - Direct Hot Stamped, Laser Trimmed
  - Tube - 25.4 dia. x 1.6 mm wall  HSLA 345 MPa
  - Bracket - 2.0 mm Galvaneal 180 MPa

Summary:
- 4.28 kg (-3%)
- 3 pieces (-40%)
- 120 mm Weld (-78%)
Design Solution (improved)

Equal peak load at 25 mm less intrusion

CONTACT FORCES (Kgf)

Honda Baseline (mid position impact)
Benteler Proposal
Design Solution (Final)

- **Geometry**
  - Pan - 1.6 mm Aluminized Hot Stamped 950 MPa
    - Direct Hot Stamped, 133 mm Draw, Laser Trimmed
  - Outer Bracket - 2.0 mm Galvaneal 180 MPa
  - Inner Bracket - 2.0 mm Galvaneal 180 MPa

Summary:
4.10 kg (-7%)
3 pieces (-40%)
60 mm Weld (-89%)
• 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
• Process
  – Use indirect hot stamp process to eliminate laser cutting
  – Re-design to allow die cutting after hot stamp
  – Replace aluminized pre-coating with zinc-flake post-coating

Spray painting robot
Product Samples for Hot Stamping

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

Other Applications
• Questions & Answers