Hydroform Intensive Body Structure with Advanced High Strength Steels

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Vari-Form
Agenda

1) Study Introduction – Assumptions
2) Front End Structure
3) Body Side Structure
4) Global NVH Performance
5) Summary
6) Next Steps
Contracted EDAG to do the Engineering study utilizing a modified FSV (Future Steel Vehicle) structure.

FSV is a 2025 m.y. “what if” vehicle utilizing extensive use of laser welded blanks and laser welded body.

Baseline stamped vehicle wanted to be more like today’s BIW (conventional stampings and spot welded).

Baseline stamped vehicle was also stretched (overhang and wheelbase), placing it size wise in the middle of C-segment vehicles.

Baseline stamped vehicle materials are primarily AHSS (DP 800/1000).
Hydroform Study - Applications

- Roof Rail Reinforcement
- Rear Rail
- B-Pillar Reinforcement
- Shot Gun
- Front Rail Assembly
Material Utilization

Stamped
(264.78 Kg)

- 45% < 500 MPa (UTS)
- 46% 500 - 1000 MPa
- 9% > 1000 MPa

Hydroformed
(250.15 Kg)

- 48% < 500 MPa (UTS)
- 46% 500 - 1000 MPa
- 6% > 1000 MPa
Material Utilization Comparison

Stamped Baseline

Materials and Weights - Overview

75% < 500 MPa (UTS)
19% 500 - 1000 MPa
4% > 1000 MPa

Zafira B

Zafira Tourer

77% < 500 MPa (UTS)
17% 500 - 1000 MPa
4% > 1000 MPa

www.autosteel.org
Front End Structure

Stamped
(50 Kg)

- 21% < 500 MPa (UTS)
- 79% 500 - 1000 MPa
- 0% > 1000 MPa

Hydroformed
(44.6 Kg)

- 19% < 500 MPa (UTS)
- 74% 500 - 1000 MPa
- 7% > 1000 MPa
Front End Structure

500 – 1000 MPa
Front End Structure

Hydroformed Components

4.00 in. dia. x .051 in.
DP 980 (x2/veh.)

2.50 in. dia. x .051 in.
DP 980 (x6/veh.)

500 - 1000 MPa

View A-A
Euro NCAP – Off-Set Barrier

Stamped

Hydroformed
Euro NCAP – Off-Set Barrier Intrusion

Stamped

Hydroformed
## Front End Performance Comparison

<table>
<thead>
<tr>
<th>Performance</th>
<th>Stamped</th>
<th>Hydroformed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Euro NCAP - Off Set Barrier</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>US NCAP - Flat Frontal (&lt;40g)</td>
<td>39</td>
<td>39</td>
</tr>
<tr>
<td>Weight (Kg)</td>
<td>49.95</td>
<td>44.63</td>
</tr>
<tr>
<td>Delta (Kg) [%]</td>
<td>-5.32 [10.7%]</td>
<td></td>
</tr>
</tbody>
</table>
EDAG Cost Model Used

**Cost**

- **Piece Cost**: 12% savings over stamped
- **Tooling**: 31% savings over stamped

* (includes component, sub-assy, and body shop assy. costs)
Body Side Structure

**Stamped**
(94.42 Kg)

- 39% < 500 MPa (UTS)
- 39% 500 - 1000 MPa
- 22% > 1000 MPa

**Hydroformed**
(89.32 Kg)

- 39% < 500 MPa (UTS)
- 50% 500 - 1000 MPa
- 11% > 1000 MPa
Body Side Structure

**Stamped**

**Hydroformed**

- **< 500 MPa (UTS)**
- **500 – 1000 MPa**
- **> 1000 MPa**
Body Side Structure

Hydroformed Components

2.75 in. dia. x 0.051 in. DP 780 (x2/veh.)

2.25 in. dia. x 0.047 in. DP 980 (x4/veh.)

Section B-B

500 – 1000 MPa
FMVSS 216A Roof Crush Performance

**Stamped**

**Hydroformed**

**Driver**

**Passenger**
IIHS Side Impact

Stamped

Hydroformed
IIHS Side Impact

Stamped

Hydroformed
## Body Side Performance

<table>
<thead>
<tr>
<th>Performance</th>
<th>Stamped</th>
<th>Hydroformed</th>
</tr>
</thead>
<tbody>
<tr>
<td>FMVSS 216 A Roof Crush</td>
<td>69D/68P</td>
<td>70D/73P</td>
</tr>
<tr>
<td>(&gt;36.5 Kn both D&amp;P)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IIHS Side Impact (&gt;125 mm)</td>
<td>127</td>
<td>126</td>
</tr>
<tr>
<td>FMVSS 214 Pole Impact</td>
<td>133</td>
<td>142</td>
</tr>
<tr>
<td>(&gt;125 mm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight (Kg)</td>
<td>94.42</td>
<td>89.32</td>
</tr>
<tr>
<td>Delta (Kg) (%)</td>
<td>- 4.90(6.0%)</td>
<td></td>
</tr>
</tbody>
</table>
EDAG Cost Model Used

Cost

Piece Cost*  9% savings over stamped

Tooling*  7% savings over stamped

*[includes component, sub-assy, and body shop assy. costs]
Global NVH

Performance

Bending (>40 Hz)  50.33  46.44
Torsion (>40 Hz)  44.20  43.62

- target 3Hz separation between modes
Body Shop

Body Shop Floor Space
Hydroform saved 13859sq. ft.
### Summary of Study

**Performance**

Matched/Exceeded Stamped – Impact/NVH

**Cost**  
($Cdn Savings)

Piece Cost - $64.8 (-11%)

Tooling Cost - $11.2 mil. (-14%)

**Weight**  
(3 sub-systems)

- 14.7 Kg (-7.3%)

**Assy. Plant Footprint**

- 13,859 sq. ft. (-7.5%)

**CO2**

- 487 Kg (life of vehicle) [-1%]
Next Steps

1) Investigate Alternative Materials
   - Boron
   - Aluminum
   - Stainless Steel

2) Investigate Tailored Thickness Tubes
   - tailor rolled tube
   - tailor welded tube (longitudinal/radial)

3) Investigate Other Applications

4) Determine Assy Plant Process Limitations on Weight (initiated)
Thank you for your attention