Roll Forming of Advanced High-Strength Steels

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Topics.

1. Company profile
2. Drivers and constraints for use of AHSS
3. Critical parameters
4. Applications
5. New process concepts
Company Profile.

- Location: Schopfheim / Germany
  Telford (PA) / USA
- Output: 50 lines per year
- Core Competencies:
  - Roll forming
  - Welding
  - Cutting
  - Punching
Next topic.

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Drivers & Constraints Using AHSS.

### Vehicle Requirements

<table>
<thead>
<tr>
<th>Driving Performance</th>
<th>Fuel Consumption</th>
<th>Safety</th>
<th>Design</th>
<th>Cost</th>
</tr>
</thead>
</table>

### Car Body Requirements

<table>
<thead>
<tr>
<th>Stiffness</th>
<th>Crash Performance</th>
<th>Manufacturing Processes</th>
<th>Weight</th>
<th>Cost</th>
</tr>
</thead>
</table>

### Material Characteristics

<table>
<thead>
<tr>
<th>Elongation</th>
<th>Yield Point</th>
<th>Spring Back</th>
<th>Minimal Radii</th>
<th>Variation</th>
</tr>
</thead>
</table>

### Investment Cost Processes Design & Parameters

www.autosteel.org
Process Characteristics.

- Continuous forming process at room temperature
- Plastic deformation of metal strip by paired roll sets
- Integration of pre and post operations (Cutting, punching, notching, welding and bending) results in reduction of total process costs
Characteristics of roll formed parts.

- Complex open and closed sections
- Variable lengths with no additional tooling costs
- Short lead times
- Lower part costs (compared with pressings)
- Limited 3D forming
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Some critical parameters.

Part design:
- Bending radius, sheet metal thickness, ...

Machine:
- Spring back compensation, number of stand, machine cost, tool cost, ...
Bending Radius.

- Steel suppliers recommend min. inner Radius $R_i = 6 - 9 \times t$ (sheet metal thickness) for AHSS.
- Up to $R_i = 1 \times t$ is achievable provided sufficient residual formability.
Strip metal thickness.

- Tensile strength 1100 MPa
- Elongation 2%
- $R_i = 6 \times t$
- $t = 1.9$ mm cracking at $60^\circ$
- $t = 2.2$ mm cracking at $30^\circ$. 
Compensating excessive spring back.

- AHSS requires much higher over bending.
- Varying material characteristics may require adjusting over bending rates.
- Roll forming allows easy adjustments.
Forming Stand Count.

- Reduction of forming stand count in theory.
- Only slight reduction recommended in order to minimize machine size, crack risk and tool wear.
Tolerances.

- Minimal stretch during roll forming results in a more accurate pre-punch pattern.
- Improved profile straightness
- Easy compensation of varying material characteristics (e.g. spring back)
Machine costs.

- Yield strength
- Forming forces
- Machine size
- Investment costs

Yield Strength [MPa] vs. Relative Machine Cost

- t = 3.0 mm
- t = 2.0 mm
- t = 1.0 mm
Tool costs.

- t = 3.0 mm
- t = 2.0 mm
- t = 1.0 mm

Graph showing relative tooling cost vs. yield strength [MPa].
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Application example “Rocker”

Open section
Length 1000 mm
Weight 3.5 kg

<table>
<thead>
<tr>
<th></th>
<th>Roll formed</th>
<th>Pressed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tool cost</td>
<td>130.000 $</td>
<td>800.000 $</td>
</tr>
<tr>
<td>Material utilization</td>
<td>95 %</td>
<td>70 %</td>
</tr>
<tr>
<td>Performance</td>
<td>30 parts / minute</td>
<td>12 parts / minute</td>
</tr>
<tr>
<td>Lead time</td>
<td>3 months</td>
<td>12 months</td>
</tr>
</tbody>
</table>

Source: Volkswagen, Germany
Application example “Rail Side Roof Member”

Closed Section
Length 3500 mm
Weight 4.3 kg

<table>
<thead>
<tr>
<th></th>
<th>Roll formed</th>
<th>Pressed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tool cost</td>
<td>200,000 $</td>
<td>2 x 1,300,000 $</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2 parts)</td>
</tr>
<tr>
<td>Material utilization</td>
<td>95 %</td>
<td>70 %</td>
</tr>
<tr>
<td>Performance</td>
<td>7 parts / minute</td>
<td>7 parts / minute</td>
</tr>
<tr>
<td>Lead time</td>
<td>3 months</td>
<td>12 months</td>
</tr>
</tbody>
</table>

Source: Volkswagen, Germany
Manufacturing process.

1 Strip feeding
2 Straightening
3 Pre punching
4 Seam preparation
5 Roll forming
6 Laser Welding
7 Seam monitoring
8 Post punching / cutting
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Composite profile concept.

- Two components being formed and welded in-line.
- Differing thickness
- Differing materials
- Complex sections become practical
Composite profile process.

- Simultaneous forming of two metal strips
- Simultaneous Laser welding of two seams with one laser
Variable cross sections.

- Expanding the degree of freedom for profile designers.
- New technology based on proven components
- Simple concept using tailored strips.
AHSS for roll form intensive structures.

- Reliable process for precise AHSS parts
- Almost 100 % material utilization
- Variable lengths with no additional tooling costs
- Superior welding speed and quality
- Low capital investment and tooling cost
Thank you.

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