Advanced High Strength Steel Applications using Tailored Products

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TWB Company L.L.C.
Agenda

• Automotive Market Drivers
• Integration of Advanced High Strength Steel with TWB Blank Products
  – Engineered Blanks
  – Boron Steel Blanks and Hot Stamping
  – Patchwork Blanks
• Integration of Advanced High Strength Steel with Tailored Products
  – TWB Tailored Tubes
  – TWB Tailored Strips
North American Market Drivers

Customer Requirements

- Increase in Fuel Costs:
- Increase in Occupant Safety Requirements:
  - Roof Crush
  - Side Impact
- Customers demand continuous vehicle dynamics improvements:
  - Bending and Torsional Stiffness
  - NVH

Tailored Solutions Provide

- Weight Reduction
- Fuel Economy
- Improved Emissions
- Crash Worthiness
- Reduced Investment
- Reduced Variable Cost

www.autosteel.org
North American Applications

Top 3 represent 63% of total applications

Number of Applications

<table>
<thead>
<tr>
<th>Component</th>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>Front Door</td>
<td>78</td>
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<tr>
<td>Rear Door</td>
<td>54</td>
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<tr>
<td>Bodyside Inner</td>
<td>40</td>
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<tr>
<td>Front Rail - Orr.</td>
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<tr>
<td>Rear Rail - Mbr.</td>
<td>10</td>
</tr>
<tr>
<td>Liftgate</td>
<td>10</td>
</tr>
<tr>
<td>Wheelhouse - Front</td>
<td>8</td>
</tr>
<tr>
<td>B' Pillar Reinf.</td>
<td>8</td>
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<tr>
<td>Front side window Frame</td>
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<td>A Pillar/Cowl Reinf.</td>
<td>4</td>
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<tr>
<td>Other 2-</td>
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</table>
European and Asian Applications

Top 8 represent 69% of total applications

- Front Door - 78
- Rear Door - 70
- Front Rail - Out - 48
- Bodyside Inn - 40
- Rear Rail - In - 30
- Front Rail - In - 30
- Wheelhouse - Rear - 28
- Rear Rail - Membrane - 18
- C Pillar - Rear - 17
- Wheelhouse - Front - 14
- Floor Pan - Crossmember - 12
- Rear Rail - Cover Plate - 12
- Shotgun - Out - 11
- Front Pnl Ext/Tunnel Reinforce - 11
- Shotgun - In - 8
- Rear Rail - Cover Plate - 8
- Shotgun - In - 8
- Door Ring - 8
- Dash Panel - 6
- Tunnel - Reinforcement - 2
- Shotgun - Out - 2
- Rocker Reinforcement - 2
- Rail - Reinforcement - 2
- Dash Panel - 2
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Manufacturing Process

1. Coils
   - High precision cutting on a press or laser

2. Blanks
   - High speed laser welding with 8kW-laser

3. Tailored Blanks
   - High quality Door inner panel
Advanced High Strength Steel
### Welded Blank Material Combinations

<table>
<thead>
<tr>
<th>Material</th>
<th>IF</th>
<th>HSLA</th>
<th>DP</th>
<th>TRIP</th>
<th>CP</th>
<th>Boron</th>
<th>Martensite</th>
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</tbody>
</table>

- **Current Production**: Turquoise
- **Trials Underway**: Green
Rear Rail using AHSS

Tailored Blank rail design

- Dual Phase welded to HSLA to Optimize Performance

Conventional multi-part design

- Original multi part assembly includes overlap connections, etc.
## Chassis with Tailored Blanks

<table>
<thead>
<tr>
<th>Number</th>
<th>Description</th>
<th>Material</th>
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<tbody>
<tr>
<td>1</td>
<td>Rear rail Tailored Blank</td>
<td>DP600 / DP600</td>
</tr>
<tr>
<td>2</td>
<td>Outer front rail Tailored Blank</td>
<td>DP600 / HSLA 350</td>
</tr>
<tr>
<td>3</td>
<td>Inner front rail Tailored Blank</td>
<td>DP600 / HSLA 350</td>
</tr>
</tbody>
</table>

**Applications**

- Porsche Cayenne
- VW Touareg

**Applications**

- Porsche Cayenne
- VW Touareg
• Materials Evaluated
  – DP600, DP800, DP1000,
  – Trip, CP, Boron
• Samples produced via 8kW CO₂ Laser
• All Welds Autogenous
• Ball Punch Test used to evaluate formability
Cup Height Analysis

Materials through DP1000 are laser weldable. However, as yield strength increases, weld line location during the forming process becomes more critical.
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Boron Steel welded to HSLA

B pillar Reinforcement

Tailored Blank

HSLA 350 t=1.0 mm

Boron t=1.5 mm

HSLA 350 t=1.0 mm
Boron Steel welded to HSLA

- Tailor Welded Blanks enable the use of Boron Steel
- TWB plus hot-stamping create formable microstructures
- TWB with Boron Steel welded to HSLA optimizes crash while reducing weight
Hardness of Hot Formed Boron Steel Tailored Blank

Pre Hot-forming

Hot-formed

Hardness of Hot Formed Boron Steel

Tailored Blank
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Patchwork Application

Liftgate Latch Reinforcement

Process Advantages

Part Integration
- Investment Reduction
  - Tooling
  - Fixtures
  - Containers/Racks
- Piece Price Reduction
  - Stamping
  - Logistics
- Mass Reduction
- Reduced Dimensional Variation
- Fit and Finish Improvements

Spot Weld

Laser Weld
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Shell to Space Frame Architecture

Classical shell structure

Profile intensive structure

Space frame structure

Expected tendency: The market for hollow sections (Tailored Tubes) will expand rapidly over the next few years
3 Generations of Tailored Tubes

1. **1st generation**
   - No variation in longitudinal cross section

2. **2nd generation**
   - Linear variation in longitudinal cross section

3. **3rd generation**
   - Variable longitudinal cross section
3rd Generation Properties, Examples

**Properties**
- Nearly finished parts prior to hydroforming
- Ancillary shape elements
- Less global strains

**Examples**
- A-pillar (3 parts, middle part monolithic)
  - Monolithic demonstrator
  - Longitudinal beam (NSB®)

Longitudinal beam
(RAKØ115 /Ø6 x 1035 x 1,5)
Closed profiles in car body structures have an excellent future if cost effective manufacturing, joining and assembling methods are available!

Appropriate actions could be:

- Shorten the process chains by joining and combining process steps
- Application of new forming and joining technologies
- Fitting the tubes with new features,
- Achieve reasonable costs for development, try-out, tool, retooling and transport
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Continuous Laser Welding of Tailored Strips

Process Characteristics:

• Continuous Coil Processing
• Edge preparation before welding
• Zero-gap at welding-point
• Max width 750mm
Tailor Strip Forms of Delivery

- Coil to Blanks
- Coil to Coil
- Coil to Roll Form
- Coil to Progressive Die
Automotive Strip Applications

Roll Form Rocker Reinforcement

Steel Wheels

Seat Supports

Dimension:
- thickness => 1.5 mm / 2.0 mm / 1.5 mm
- width => 44 mm / 61 mm / 140 mm

7J x 16 H2:
- St-W 24 (t=2.4 mm) => 5.45 kg
- DP 600 (t=2.0 mm) => 4.55 kg
- DP 600 (1.5/2.0/1.5) => 3.69 kg
- 32%

1.0 mm
1.4 mm
1.2 mm
1.2 mm
1.6 mm
1.2 mm

128 83 189 [mm]
Tailored products using AHSS provide engineered solutions:

- Crash energy management
- Improved passenger safety
- Weight reduction
- Improved fuel economy
- Cost reduction