Technological Innovations in Body in White Manufacturing of the BMW X6

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Content

- Body in White Requirements for Efficient Dynamics
- Body in White Materials
- Ultra High Strength Steel Grades
- Joining Technologies
- Conclusion
Body in White Requirements
Efficient Dynamics

- Power Train
- Body In White
- Axle and Kinematics
- Aerodynamics
- Weight and Axle Load Distribution

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- Torsional Stiffness of 29,000 Nm/°
- Implementation of Ultra High Strength Steel Grades
- Mixed Material Concept (Steel, Aluminum, Thermoplastic)
- Cost Efficient Engineering using existing Panels with a maximum Design Differentiation
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Body in White Materials
Yield Strength

- Deep Drawn Steel: 14%
- 180 MPa, 15%
- 200-220 MPa, 4%
- 260 MPa, 7%
- 300 MPa, 18%
- 380-420 MPa, 25%
- 550 MPa, 3%
- 680 MPa, 5%
- 950 MPa, 3%
- 6xxx Aluminum, 2%
- Others, 4%
- 550 MPa, 3%

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Body-In-White Materials
Average Minimum Yield Strength
**Body-In-White Materials**

**Average Thickness**

- BMW Group
- Start of Production
- Without Advanced High Strength Steel

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<table>
<thead>
<tr>
<th>Model</th>
<th>Average Thickness (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7' Series</td>
<td>1.0</td>
</tr>
<tr>
<td>5' Series Convertible</td>
<td>1.1</td>
</tr>
<tr>
<td>6' Series Convertible</td>
<td>1.2</td>
</tr>
<tr>
<td>Previous X5</td>
<td>1.3</td>
</tr>
<tr>
<td>Current X5</td>
<td>1.5</td>
</tr>
<tr>
<td>6' Series Wagon</td>
<td>1.7</td>
</tr>
<tr>
<td>3' Series Wagon</td>
<td>1.8</td>
</tr>
<tr>
<td>7' Series Convertible</td>
<td>1.9</td>
</tr>
<tr>
<td>5' Series Wagon</td>
<td>2.0</td>
</tr>
<tr>
<td>1' Series Convertible</td>
<td>2.1</td>
</tr>
</tbody>
</table>
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**UHSS – Hot Stamped 22MnB5**

**Side Crash**

**Thickness (t)**
- \( t = 1.2 \text{ mm} \)
- \( t = 2.2 \text{ mm} \)
- \( t = 1.4 \text{ mm} \)

**Weight Savings:** 2 kg/side (compared to a hot stamped part with a constant thickness)

**Mechanical Values:**
- Yield Strength \( R_{p0.2} \): > 950 MPa
- Tensile Strength \( R_m \): > 1300 MPa
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UHSS – CP800 Rear Crash

Weight Savings for the Longitudinal Rear Member: 4.4 kg

Mechanical Values:
- Yield Strength $R_{p0.2}$: 680 - 830 MPa
- Tensile Strength $R_m$: 800 - 980 MPa
- Elongation $A_{80}$: > 10%

(Complete Longitudinal rear member including other steel grades)
## UHSS – CP800 Rear Crash

### Tested profile

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Yield Strength</strong> $R_{p0.2}$</td>
<td>692 MPa</td>
<td>796 MPa</td>
</tr>
<tr>
<td><strong>Tensile Strength</strong> $R_m$</td>
<td>901 MPa</td>
<td>923 MPa</td>
</tr>
<tr>
<td><strong>Elong. after Fracture</strong> $A_{80}$</td>
<td>11,4</td>
<td>10,8</td>
</tr>
<tr>
<td><strong>Thickness</strong></td>
<td>0,99</td>
<td>0,99</td>
</tr>
</tbody>
</table>

Deformation Force vs. Deformation Time:

- **157,37 kN** (with Bake Hardening Response)
- **155,84 kN** (without Bake Hardening Response)

Specimen after Drop Test
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UHSS – CP800

X6 Part Application

Thickness of all Parts: 1.5 mm
Tool Change Content:

a) Optimize the release of flange form
b) Optimize the draw of the embossments
c) Increase the radii if necessary
d) Optimize the trim
Secure the part fastening assembly process in the Prototype Phase.
• Testing the Series assembly Tools with the Prototype Parts and early Optimization of the Clamping Technology.
• Higher Measurement Stability in the BIW.
Main Joining Technologies:
• Resistant Spot Welding (6643 Spot Welds)
• Adhesive Bonding (116999 mm)

Other Joining Technologies:
• Self Pierce Riveting (82)
• Clinching (53)
• Mig Welding and Brazing (8053 mm)
• Capacitance Discharge Welding
### Joining Technologies

#### Benefit of Structural Adhesives

<table>
<thead>
<tr>
<th>Benefit on Stiffness</th>
<th>Applied Adhesives</th>
<th>Benefit of Structural Adhesives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local Static Stiffness of the Upper Control Arm</td>
<td>+ 12%</td>
<td></td>
</tr>
<tr>
<td>Static Torsional Stiffness</td>
<td>+ 2%</td>
<td></td>
</tr>
<tr>
<td>Dynamic Stiffness</td>
<td>+ 0.1Hz to + 0.3Hz</td>
<td></td>
</tr>
</tbody>
</table>

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**Applied Adhesives**

**Benefit of Structural Adhesives**

**Joining Technologies**

**Local Static Transversal Stiffness of the Upper Control Arm**

**Difference of Displacements of the Spring Support with and without Adhesive Application**

**with Adhesive**

**without Adhesive**
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Joining Technologies
Aluminum Casted Front Shock Tower

Supplier
- High Pressure Vacum Casting
- Heat Treated
- Machined
- Cataphoretic Painting

Body In White
- Bonding (ca. 5.4 m)
- Self Pierce Rivets (82 times)

Paint Shop
- PVC Sealant

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Joining Technologies
Capacitance Discharge Welder

Advantages:
- More economical Process
- Less Weld Splatter
- High local connection Stiffness
- Smaller amount of Heat introduced in Parts during the welding Process
- No Process induced Material Structure Change.

Cold Forged part
Material: C15E2C

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Force vs. Distance Relationships:
1. Outer projection
2. Inner projection

Internal Weld Seam Evaluation:
- Small Fusion Zone
- Small heat induced Zone
- Continuous Material Connection
Conclusion

- Mixed Material light weight Concept for the Body in White
  - 8% Ultra High Strength Steel Grade
  - 46% Advanced High Strength Steel Grade

- Significant Weight Savings by UHSS
  - Hot Formed B- Pillar Reinforcement with tailor rolled Blank
  - CP800 for Longitudinal Rear Member

- Capacitance Discharge Welding for Bushings
  - High local stiffness
  - Extreme short Process Time
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Thank You for Your Attention