H. Gers:
Aluminium Alloys for High Performance Space Frame Profiles

2012-03-26
# Martinrea Honsel: Worldwide Producer of Lightweight Components

## Key Figures

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Founded</strong></td>
<td>1908</td>
</tr>
<tr>
<td><strong>Turnover (FY 2010/11)</strong></td>
<td>~ 550 Mio. €</td>
</tr>
<tr>
<td><strong>Employees</strong></td>
<td>~ 3.200</td>
</tr>
<tr>
<td><strong>Locations</strong></td>
<td>Germany, Meschede, Nuttlaar, Soest</td>
</tr>
<tr>
<td></td>
<td>Spain, Madrid</td>
</tr>
<tr>
<td></td>
<td>Mexico, Querétaro</td>
</tr>
<tr>
<td></td>
<td>Brasil, Monte Mor</td>
</tr>
<tr>
<td><strong>Technology</strong></td>
<td>High Pressure Die Casting, Permanent Mold Casting, Sand Casting, Rolling, Extrusion, Machining, Assembly</td>
</tr>
<tr>
<td><strong>Products</strong></td>
<td>Automotive Components for Motors, Gear boxes, Suspensions, Body-in-White</td>
</tr>
<tr>
<td></td>
<td>Non-Automotive</td>
</tr>
<tr>
<td><strong>Alloys</strong></td>
<td>Aluminium and Magnesium</td>
</tr>
</tbody>
</table>
Martinrea International

Canada
14 Locations

USA
12 Locations

Mexico
9 Locations
(1 Martinrea Honsel)

Brasil
1 Location
(1 Martinrea Honsel)

Europe
5 Locations
(4 Martinrea Honsel)

Asia
2 Locations

Soest / Germany

1 Martinrea Honsel
Extrusion Plant Soest

37% Automotive Suspension
23% Automotive Body-in-White
40% Non-Automotive

Sales 2011: 83,7 Mio. Euro
Capacity: 20,000 to/year
Employees: approx. 330
Development of Alloys

Production Process
Reduction of Tolerances

Competencies
Extrusion Plant Soest

Die Design

Machining and Assembly

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Hydroforming
Heatforming
Riveting
Joining with Castings
Bending
Side Beam and Front Bumper:
Crush-critical part with special requirements:

- complex multihollow design
- decreasing ratio of wall thickness / circumscribing diameter
- increasing mechanical properties, higher ductility
Explanation of different crush behavior:

**Crush behavior:**
- no folding
- very brittle
- poor general impression

**Crush behavior:**
- uniform folding
- no cracks
- good general impression

Audi AG
Requirements regarding alloy properties for space frame application

<table>
<thead>
<tr>
<th>Alloy</th>
<th>Rp0.2 (MPa)</th>
<th>Rm (MPa)</th>
<th>A (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alloy 6106 T6</td>
<td>&gt;200</td>
<td>&gt;220</td>
<td>&gt;11</td>
</tr>
<tr>
<td>Alloy 6951 T66</td>
<td>&gt;241</td>
<td>&gt;260</td>
<td>&gt;10</td>
</tr>
<tr>
<td>Alloy 6005 T66</td>
<td>&gt;280</td>
<td>&gt;305</td>
<td>&gt;9</td>
</tr>
</tbody>
</table>

1992  | 2004  | 2009  

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Products – Body-in-White
Extrusion Billets

Die Technology

Extrusion Process

higher strength

higher crush performance
higher extrusion speed

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Zoller et. al.,
Z. Metallkunde
DC-Casting: Process Controll
Grain Size ASTM: 3,5
Avg. Diameter ~ 90 µm

Grain Size ASTM: 2,5
Avg. Diameter ~ 150 µm
Complex profile structures with high risk of die failure
FEM calculation of die deformation

extrusion direction

0.93 mm

0.77 mm
Extrusion Billets \hspace{1cm} \text{Die Technology} \hspace{1cm} \text{Extrusion Process}

FEM calculation of extrusion temperatures
globulitic precipitations: good crush performance

plate-like precipitation: poor crush performance
Result: excellent crush performance
Development: FSW

Advantages
- low heat disposal
- minimum distortion
- large wall thickness
- excellent weld quality
- good mechanical properties
- material combination possible

Disadvantages
- 3D structures difficult to weld
### Mechanical Properties

<table>
<thead>
<tr>
<th></th>
<th>Base Material longitudinal</th>
<th>Welding Seam longitudinal</th>
<th>Base Material transvers</th>
<th>Welding Seam transvers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tensile (MPa)</strong></td>
<td>224</td>
<td>170</td>
<td>-25%</td>
<td>223</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>172</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-23%</td>
</tr>
<tr>
<td><strong>Yield (MPa)</strong></td>
<td>185</td>
<td>128</td>
<td>-31%</td>
<td>183</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>125</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-32%</td>
</tr>
<tr>
<td><strong>Elong. (%)</strong></td>
<td>14</td>
<td>18</td>
<td>15</td>
<td>10</td>
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</table>
Crushtest on FSW-parts
## Technical Data of Extrusion Presses

<table>
<thead>
<tr>
<th></th>
<th>P22</th>
<th>P44</th>
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</thead>
<tbody>
<tr>
<td>Extrusion Force (MN)</td>
<td>22</td>
<td>44</td>
</tr>
<tr>
<td>Circumscribing Diameter (mm)</td>
<td>220</td>
<td>420</td>
</tr>
<tr>
<td>Extrusion Length (m)</td>
<td>51</td>
<td>51,5</td>
</tr>
<tr>
<td>max. Weigth (kg/m)</td>
<td>5</td>
<td>30</td>
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# Overview Alloys

<table>
<thead>
<tr>
<th>Alloy</th>
<th>Typical Mechanical Properties</th>
<th>Properties</th>
<th>Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tensile (MPa)</td>
<td>Yield (MPa)</td>
<td>Elong. (%)</td>
</tr>
<tr>
<td>EN AW 1200</td>
<td>100</td>
<td>50</td>
<td>20</td>
</tr>
<tr>
<td>EN AW 2618</td>
<td>450</td>
<td>360</td>
<td>8</td>
</tr>
<tr>
<td>EN AW 3103</td>
<td>120</td>
<td>50</td>
<td>28</td>
</tr>
<tr>
<td>EN AW 6060</td>
<td>220</td>
<td>180</td>
<td>12</td>
</tr>
<tr>
<td>EN AW 6063</td>
<td>270</td>
<td>220</td>
<td>10</td>
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<tr>
<td>EN AW 6082</td>
<td>350</td>
<td>300</td>
<td>8</td>
</tr>
<tr>
<td>EN AW 7020</td>
<td>380</td>
<td>320</td>
<td>10</td>
</tr>
<tr>
<td>EN AW 6026</td>
<td>350</td>
<td>300</td>
<td>10</td>
</tr>
<tr>
<td>EN AW 6106</td>
<td>260</td>
<td>220</td>
<td>10</td>
</tr>
<tr>
<td>EN AW 6951</td>
<td>280</td>
<td>260</td>
<td>10</td>
</tr>
<tr>
<td>EN AW 6005</td>
<td>310</td>
<td>300</td>
<td>8</td>
</tr>
</tbody>
</table>
Products

**Tubes for Heat Exchanger**
- Alloy: EN AW-3103 (AlMn1)

**Bearing Cap for Engines**
- Alloy: EN AW-2618A (AlCu2Mg1,5Ni)
Products

Primary Material for Forgings
Alloy: EN AW-6110
(AlMg1SiCu)

Steering Shaft
Alloy: EN AW-6082
(AlSi1MgMn)
## Products

<table>
<thead>
<tr>
<th>Product</th>
<th>Quantity</th>
<th>Material</th>
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</thead>
<tbody>
<tr>
<td>Bearing Housing</td>
<td>18,000 parts/day</td>
<td>EN AW 6082</td>
</tr>
<tr>
<td>Tension Strut Mounting Bracket</td>
<td>6,000 parts/day</td>
<td>EN AW 6060</td>
</tr>
<tr>
<td>Retaining Clamp for Cockpit</td>
<td>8,500 parts/day</td>
<td>EN AW 6060</td>
</tr>
</tbody>
</table>

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Products

Rollover Bar for Cabriolet
Alloy: EN AW-7108
(AlZn5Mg1Zr)

Hydraulic Cylinder for Cabriolet Roof Drives
Alloy: EN AW-6060
(AlMgSi)
Thank you for your attention!