Hot Stamped bumper design
challenges in development for meeting multi-regional (new) requirements.

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Benteler Automotive
- Structures -
Agenda

- Bumper Technology and Customer Portfolio
- The Hot Stamping Process
  - Material, Process, Performance, Design
- Challenges in the bumper development for multi regional requirements:
  - Europe (Changes, effect and conclusion)
  - North America (Changes, effect and conclusion)
1) UHSS Hot Formed Bumper
2) UHSS Cold Formed Bumper
3) Aluminium Bumper Extruded
4) TRB Bumper
5) UHSS/HSS Roll Formed Bumper
6) Magnesium Bumper
   (Customer Project)
7) Tube Bumper
8) Plastic or Hybrid Bumper
   (R&D project)
Benteler US-Bumper Examples in Production

Developed for US/Canada requirements
The Hot Stamping process

**direct process**
- coil
- blank
- furnace
- handling
- press
- cooling

**indirect process**
- coil
- blank
- press (pre-forming / trimming)
- furnace
- handling
- press
- cooling
Material Overview - Steel Grades

DB200 - hotstamped:
- Y_S: min: 950MPa
- T_S: min: 1300MPa
- Elongation: 9 +/- 3% (A5)

Tensile Strength [MPa]

Elongation [%]

DB200 hot formed
DB200 as rolled

UTS = Tensile Strength (Zugfestigkeit)

BB = complex phase
PM = partial martensitic
DP = dual phase
FB = ferritic bainitic
TRIP = transformation induced plasticity
HSLA = high strength low alloyed
P = reporphosphorized
BH = bake hardening
IFHS = interstitial free high strength
DDQ = deep drawing quality
UDDQ = ultra deep drawing quality
ETR 165 = European Benteler grade
DB 200 = US Benteler grade
Crash Performance of DB200 Hot Stamped
High Design Flexibility with Hot Stamped design

Peugeot 407 Front Bumper

BMW E63 Rear Bumper
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European low speed Test Specifications

Pendulum Tests
- ECE R42

Offset Barrier
- AZT Test
- Thatcham

Remark: High speed and towing requirements not listed

<table>
<thead>
<tr>
<th>AZT changes</th>
<th>old</th>
<th>new</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barrier angle</td>
<td>0°</td>
<td>10°</td>
</tr>
<tr>
<td>Position</td>
<td>Driver side</td>
<td>Driver + passenger side</td>
</tr>
<tr>
<td>Barrier mass</td>
<td>1000kg</td>
<td>1400kg</td>
</tr>
<tr>
<td>Position</td>
<td>Driver side</td>
<td>Driver + passenger side</td>
</tr>
</tbody>
</table>
Conclusions

A change of the barrier angle has a large effect on the bumper design

- Due to the 10° barrier angle, the barrier directly hits the crash box.
- The function of the crash box has increased, resulting in more energy taken over by the crash box.
- The function of the beam is solely to connect the left and the right side rail.
- The total dimension of the beam has decreased due to the loss of function.
- The test can be done on driver and passenger side - non symmetric design has no longer benefit
- Rear test only: The increase of mass leads to 40% more energy input

Remark: Thatcham and AZT are discussing to place a low speed test - similar to the IIHS criteria

ECR 42 Pendulum test with only 4.0km/h for center and 2.5km/h for corner testing and only one pendulum layer has no big effect on the bumper design and is even not needed to release the car in the market.
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Mismatch Example

Nissan Murano vs Micra – Cut Away

Nissan Murano vs Micra - Impact

Source: Thatcham

Result: About 5,000$ repair cost on the Micra
North American low speed Test Specifications

- Pendulum Tests
  - CMVSS 215
  - US Part 581

- Barrier 0°
  - CMVSS 215
  - US Part 581
  - IIHS

- Barrier 30°- / Pole Test
  - IIHS

**Remark:** High speed and towing requirements not listed
Conclusion (IIHS bumper test)

• Stiff bumper is needed to reduce risk of under or over run. Due to this requirement, the weight will increase.
• Shape and density of foam have a big influence on the system performance.
• Weak crash box/bumper connection can cause problems in deformation performance.
• Different results between full car models and component models possible. Movement of component cart could be more than 30mm in Z-direction.
• More than 60% coverage between bumper and barrier is necessary.
• Bumper front cover height proposal: between 110 and 130mm minimum.
• Complete car model to be taken for FE analysis or
  - add damping systems values to crash cart
  - add outer skin and foam to crash cart along with repair to the car
  - exact definition of position between bumper and barrier
  - Center of gravity, inertia tensor, axle position
  …
• to be completed as more results are available!
End of Presentation
- Thank You -