Light Weighting with AHSS: Minimum Thickness Study & Application Guidelines, Version 5.0

Harry Singh – EDAG, Inc.
George Coates – WorldAutoSteel
Presentation Overview

1. Minimum Thickness Study –
2. What is the minimum thickness possible for body structure panels?
3. Questionnaire and Results
4. Mass saving potential of lower thickness AHSS applications to body panels
5. Application Guidelines, Version 5.0
Notable light weighting programs and AHSS applications guidelines – additional information:
http://www.worldautosteel.org/projects/
Range of EDAG and FFT Services

PRODUCT DEVELOPMENT
- Design concepts
- Vehicle development
- Function development
- Vehicle validation
- Electrics / electronics

PRODUCTION SOLUTIONS
- Project management
- Quality and documentation management
- Production engineering
- Production process planning
- IT services
- Process consulting
- Factory and logistics planning
- Tooling and vehicle body systems

PLANT CONSTRUCTION
- Turnkey systems, body in white and assembly
- System technologies and products
Wherever You Need Us - Worldwide
### Body Structure Sheet Metal Mass

<table>
<thead>
<tr>
<th>Typical Mid Size Sedan (kg)</th>
<th>BIW Structure (kg)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,500</td>
<td>436</td>
<td>29%</td>
</tr>
</tbody>
</table>

**Body Structure Sheet Metal**

Average Thickness – 1.1 mm, Range 0.65 mm to 2.5 mm
Closed sections constructed from AHSS are very mass efficient compared with materials with lower strength.
<table>
<thead>
<tr>
<th>BIW Structure (kg)</th>
<th>BIW Structure Major Panels (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>436</td>
<td>130</td>
</tr>
</tbody>
</table>

Grades of choice – BH and IF
Class A Surfaces
Dent resistance
Surface stiffness ‘oil caning’
Higher depth of draw

What is the minimum thickness possible for body structure panels?
To meet same dent resistance requirements at lower panel thickness the material ‘yield strength’ must be increased.
Body Side from Steel Mill to End User:
Manufacturing process from coil to final assembly

Manufacturing process – blank handling, forming, part handling, joining

Rolling Mill → Steel Coil → Leveler → Blanking Press

Stamping/Forming Transfer Press → Storage & Transport → Body Assembly → Paint

Final Assembly → End User
**WorldAutoSteel - Minimum Thickness Questionnaire**

Company: ____________________________
Name: _______________________________
Contact Phone: _______________________

(Company, name & contact phone optional)

**CONFIDENTIAL INFORMATION:**
All information received by EDAG Inc for the purpose of this project is considered confidential and will not be released by EDAG to any 3rd party.

Harry Singh (Program Manager)
harry.singh@edag-us.com, Phone: (248)-635-3174

### Assessment Categories

<table>
<thead>
<tr>
<th>Material Availability</th>
<th>Performance</th>
<th>Appearance</th>
<th>Manufacture</th>
<th>Assembly</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dent Resistance</td>
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<td></td>
<td>with same level of</td>
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<tr>
<td></td>
<td>insulation material</td>
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<td></td>
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<tr>
<td></td>
<td>with additional</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>insulation material</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>NVH</td>
<td>Surface Stiffness</td>
<td>Durability</td>
<td>Corrosion</td>
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<tr>
<td></td>
<td></td>
<td>'Snap Through'</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Surface Stiffness</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>'Snap Through'</td>
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<tr>
<td></td>
<td>Durability</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Class A Surface</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Paintability</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Corrosion</td>
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<tr>
<td></td>
<td>Forming</td>
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<tr>
<td></td>
<td>Part Handling</td>
<td></td>
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<tr>
<td></td>
<td>Spot Welding</td>
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<td></td>
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<tr>
<td></td>
<td>Laser Welding</td>
<td></td>
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<tr>
<td></td>
<td>Hemming</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Rating Criterion

<table>
<thead>
<tr>
<th>Highly Possible</th>
<th>Possible with suitable Material Properties</th>
<th>Possible with suitable Material Properties and R&amp;D</th>
<th>Problematic (May be Possible with New Grades and R&amp;D)</th>
<th>Highly Problematic (Not Possible)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

1st April 20XX
Total of 21 Questionnaires were filled by body structure design, performance and manufacturing experts:

- 12 from OEM’s
- 2 from stamping manufacturers
- 7 from specialists (body design (2), assembly equipment design, laser welding, CAE - NVH, materials expert, CAE manager)
### Results of Questionnaire – Body Side

<table>
<thead>
<tr>
<th>Body Structure Body Side</th>
<th><strong>Material</strong></th>
<th><strong>Thickness (mm)</strong></th>
<th><strong>Performance</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>Material Availability</strong></td>
<td><strong>Dent Resistance</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>with same level of insulation material</strong></td>
<td><strong>with additional insulation material</strong></td>
</tr>
<tr>
<td>Steel</td>
<td>0.80</td>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td></td>
<td>0.75</td>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td></td>
<td>0.70</td>
<td>4.8</td>
<td>4.6</td>
</tr>
<tr>
<td></td>
<td>0.65</td>
<td>4.6</td>
<td>4.1</td>
</tr>
<tr>
<td></td>
<td>0.60</td>
<td>4.1</td>
<td>3.5</td>
</tr>
<tr>
<td></td>
<td>0.55</td>
<td>3.9</td>
<td><strong>2.8</strong></td>
</tr>
<tr>
<td></td>
<td>0.50</td>
<td>3.1</td>
<td><strong>2.4</strong></td>
</tr>
<tr>
<td></td>
<td>0.45</td>
<td>2.5</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
<td>0.40</td>
<td>1.9</td>
<td>1.7</td>
</tr>
<tr>
<td></td>
<td>0.35</td>
<td>1.8</td>
<td>1.5</td>
</tr>
</tbody>
</table>

- Average of 21 responses
- Rating of 3: “possible with suitable material properties and R&D”
- Major issues: Dent resistance and Snap through
## Results of Questionnaire – Body Side

<table>
<thead>
<tr>
<th>Material</th>
<th>Thickness (mm)</th>
<th>Appearance</th>
<th>Manufacture</th>
<th>Assembly</th>
<th>Average of all criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel</td>
<td>0.80</td>
<td>5.0</td>
<td>5.0</td>
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<td>4.8</td>
<td>4.7</td>
<td>4.7</td>
<td>4.9</td>
</tr>
<tr>
<td></td>
<td>0.65</td>
<td>4.6</td>
<td>4.5</td>
<td>4.2</td>
<td>4.8</td>
</tr>
<tr>
<td></td>
<td>0.60</td>
<td>4.1</td>
<td>4.1</td>
<td>3.7</td>
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<td>2.7</td>
<td>3.2</td>
</tr>
<tr>
<td></td>
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<td>2.7</td>
<td>2.3</td>
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<td>2.1</td>
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<td>1.4</td>
<td>1.6</td>
</tr>
</tbody>
</table>

**Class A Surface Paintability**

**Corrosion**

**Forming**

**Part Handling**

**Spot Welding**

**Laser Welding**

**Hemming**

**Major issues:** Forming and Part handling
33% mass saving potential. Total mass of two body side panels reduced from 32 kg to 22 kg.
Expert opinion within the OEMs and manufacturing companies:

“possible with suitable material properties and R&D”

<table>
<thead>
<tr>
<th>BIW Structure Major Panels at 0.75 mm (kg)</th>
<th>BIW Structure Major Panels at 0.55 mm (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>130</td>
<td>95</td>
</tr>
</tbody>
</table>

-27%

WorldAutoSteel member companies are pursuing suitable grades of steel that can achieve such mass saving in the very near future.
1. Blank stability when loading into press: Suction cup placement and numbers

2. Detailed Forming Simulations

3. Part ejection and stability during transfer from die to die: Simulate part ejection from the draw-die and carrier mechanism

4. Part stability when unloading from press to storage rack: Simulate carrier mechanism & storage rack design

5. Part stability when unloading from storage rack to assembly fixture: Simulate carrier mechanism

6. Panel surface dent resistance and snap through (oil canning) performance simulation
Lightweighting with AHSS:
AHSS Application Guidelines, Version 5.0

George Coates
WorldAutoSteel
Lightweighting with AHSS

Can Steel Continue to Provide Competitive Materials Solutions for the Automotive Industry?

- FutureSteelVehicle (FSV)
- A2mac1 benchmarking
- Cadillac ATS, VW Golf
Lightweighting with AHSS

Advanced High-Strength Steels: the Newest Materials for Automotive Applications

Key Enablers:
1) Development of new grades of AHSS that meet today’s functional performance and lightweighting needs
2) Information that allows our stakeholders to successfully apply these highly sophisticated materials

- Docol 1000 DP
- Docol 1200 M
- Docol 1400 M
- MS 1150/1400
- MS 950/1200
- DP 700/1000
Lightweighting with AHSS

Key Elements of Version 5.0

1. New Materials
   - Building on FSV, our materials portfolio now includes 50 steel grades, compared with 28 in Version 4.0. And still growing...
   - Exposed surface quality success achieved with DP steels up to 600 Mpa
   - Greater ductility in DP, CP and TPN grades for lighter gage forming
   - Higher strengths – more gigapascal steels

Available today at www.worldautosteel.org
## Lightweighting with AHSS

### Advanced High-Strength Steels Application Guidelines 5.0

#### Materials Portfolio

<table>
<thead>
<tr>
<th>DP 210/440</th>
<th>IF 260/410</th>
<th>BH 280/400</th>
<th>IF 300/420</th>
<th>DP 300/500</th>
<th>FB 330/450</th>
<th>DP 350/600</th>
<th>TRIP 350/600</th>
<th>TRIP 400/700</th>
<th>HSLA 420/500</th>
<th>FB 450/600</th>
<th>TRIP 450/800</th>
<th>TWIP 480/900</th>
</tr>
</thead>
<tbody>
<tr>
<td>DP 700/1000</td>
<td>CP 750/900</td>
<td>TPN 750/900</td>
<td>DP 750/980</td>
<td>TRIP 750/980</td>
<td>TP 750/1000</td>
<td>CP 800/1000</td>
<td>CP 850/1180</td>
<td>MS 950/1200</td>
<td>Q&amp;P 650/980</td>
<td>TWIP 950/1200</td>
<td>TP 1000/1200</td>
<td></td>
</tr>
<tr>
<td>CP 1050/1470</td>
<td>HF 1050/1500</td>
<td>DP 1150/1270</td>
<td>CP 1000/1200</td>
<td>MS 1150/1400</td>
<td>HF 1200/1900</td>
<td>MS 1250/1500</td>
<td>MS 1050/1470</td>
<td>HF 1200/1900</td>
<td>CP 1050/1470</td>
<td>HF 1200/1900</td>
<td>MS 1250/1500</td>
<td></td>
</tr>
</tbody>
</table>

**UALSAB AVC Grades**

- FutureSteelVehicle
- V5.0 New Grades

Available today at www.worldautosteel.org
Lightweighting with AHSS

Advanced High-Strength Steels Application Guidelines 5.0

Key Elements of Version 5.0

2. Updated Fabrication Technologies

• Servo presses for programmable forming
• Press-hardened steels (hot forming)
• Tool & die maintenance practices
• Laser welded blanking and forming

Available today at www.worldautosteel.org
Lightweighting with AHSS

Advanced High-Strength Steels Application Guidelines 5.0

Key Elements of Version 5.0

3. **Significant Joining Revision**
   - From 30 pages to 110 pages
   - Partnership with automotive OEMs, technical organizations
   - New joining processes with unique qualities applicable to AHSS grades – laser welding, hybrid welding, mechanical joining and adhesive bonding

Available today at www.worldautosteel.org
4. Process Comparisons

- How to account for localized formability conditions and select the correct material (Metallurgy, Section 2).

- When does a servo press make sense? (Forming, Section 3).

- How to adjust welding amperage and dwell times for TRIP 420/800 at \( t = 1.25 \text{mm} \) (Joining, Section 4).

Available today at www.worldautosteel.org
5. Case Studies (lessons learned)

- Process recipe discipline
  - Part gaging critical
- Case hardened or higher strength tool, flange and work pieces
- Length of line management
- Open-ended designs
- Restrike should be used to sharpen features or radii; achieve final form in first operation.

Available today at www.worldautosteel.org
Lightweighting with AHSS

Advanced High-Strength Steels Application Guidelines 5.0
Phase 2

Common Concerns When Lightweighting
• Manufacturability and Productivity

How We’re Addressing These
• Global, comprehensive training for OEM’s, Tier suppliers to ensure robust process performance
• Timing – 2015
Advanced High-Strength Steels Application Guidelines 5.0

Combines metallurgy, forming and joining experiences from around the world