NEW SOLUTIONS FOR LIGHT DUTY FRAME, BATTERY ELECTRIC VEHICLES, AND WELDING AHSS

Isaac P. Luther
TWB Company
30 YEARS OF WELDING

The right material in the right place for:

- Lightweighting
- Material Utilization
- Crash Energy Management
- Cost Management
Welded Blanks By Vehicle Type

- SUV: 15 parts
- Sedan/Wagon: 60 parts
- Pickup: 75 parts
- MPV/Van: 90 parts
- Hatchback: 105 parts (Coupe/Convertible)
APPLICATION TRENDS

Welded Blanks By Vehicle Type

Parts On Platforms

- Hatchback
- MPV/Van
- Pickup
- Sedan/Wagon
- SUV

2009
2022

2022
Coupe/Convertible

APPLICATION TRENDS
APPLICATION TRENDS

Welded Blanks By Vehicle Type

- Coupe/Convertible
- Hatchback
- MPV/Van
- Pickup
- Sedan/Wagon
- SUV

Driving Consolidation

- 2 components
- ≥ 4 components
- 3 components

Parts On Platforms

2009 2022
APPLICATION TRENDS

Welded Blanks On Trucks and SUVs

- Body Side
- Closure
- Crossmember
- Dash Panel
- Floor
- Pillar
- Rail
- Side Member
- Sunroof

Parts On Platforms

2009

0 5 10 15 20 25 30 35 40

2009 Applications Trends for Welded Blanks On Trucks and SUVs.
APPLICATION TRENDS

Welded Blanks On Trucks and SUVs

- Battery Cover
- Closure
- Crossmember
- Floor
- Rail
- Sunroof
- Body Side
- Cradle
- Dash Panel
- Pillar
- Side Member

Parts On Platforms

2009 vs 2022
MATERIAL USAGE

Overview

<table>
<thead>
<tr>
<th>Thickness [mm]</th>
<th>Strength [MPa]</th>
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- **MS** (Mild Steel)
- **HSLA** (High-Strength Low-Alloy)
- **DP** (Dual-Phase)
- **TRIP** (Transformation Induced Plasticity)
- **SS** (Solution Strengthened)
- **PQS** (Press Quenched Steel)
- **PHS** (Press Hardened Steel)
- **MP** (Multi-Phase)
- **FB** (Ferrite Bainite)
- **BH** (Bake Hardenable)
MATERIAL USAGE

Cold Stamped Body in White + Closures

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MATERIAL USAGE
Hot Stamped Body in White

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Symbols:
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MATERIAL USAGE

Battery Cover

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# MATERIAL USAGE

## Frame

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INNOVATIONS IN BIW + CLOSURES

- Grade Optimization
- Thickness Optimization
- Material Savings
FRAME APPLICATIONS

- Reduce vehicle weight
- Improve material utilization
- Consolidate components
- Optimize crash energy management

- Mild Steel
- HSLA
- Multi-Phase
- Ferrite Bainite
FRAME APPLICATIONS

Benchmarking

2016:
- Front rails
  - 4 TWBs
  - HSLA grades

2018:
- Rear rail inners
  - 2 TWBs
  - Mild grades
- Front/rear rails + crossmembers
  - 12 TWBs
  - AHSS grades

2019:
- Rear rails
  - 4 TWBs
  - AHSS grades
- Front/rear rails + crossmembers
  - 12 TWBs
  - HSLA grades

2021:
- Front/rear rails + crossmembers
  - 12 TWBs
  - HSLA grades

2022:
- Front/rear rails + crossmembers
  - 10 TWBs
  - AHSS grades
FRAME APPLICATIONS

Front Rails

Monolithic

Welded Blank

• Two-piece inner/outer design
• 4mm thick 410MPa HSLA

• 4mm thick 410MPa HSLA front + rear sections – 2.6mm/2.8mm 310MPa mild steel center
• Improved reaction force and crush resistance
• Optimized crumple zone in front rail structure

Crush Resistance

Reaction Force

Gross Weight

37 kg

Vehicle Weight

4.5 kg
FRAME APPLICATIONS

Rear Inner Rails
Thickness optimization – weight and cost savings

Monolithic

Gross Weight: 21.9kg
Net Weight: 14.5kg

Material Utilization: 66%

Welded Blank

Gross Weight: 14.6kg
Net Weight: 11.9kg

Material Utilization: 82%

Gross Weight: 14.6kg
Net Weight: 11.9kg

Material Utilization: 82%

Vehicle Weight: 4.8 kg

3.7mm
2.7mm
BEV APPLICATIONS

Structural Top Covers

- Consolidated battery top cover and vehicle floor
- Seats are mounted onto the battery and installed into the vehicle

Images courtesy of @WholeMarsBlog and @ajtourville
JOINING – 3\textsuperscript{RD} GEN STEELS

3\textsuperscript{rd} Gen 980 GI / 3\textsuperscript{rd} Gen 980 GI

- No HAZ softening observed
- Tensile fractures occurred in parent metal
- Olsen cup fractures occurred perpendicular to the weld
JOINING – 3\textsuperscript{RD} GEN STEELS

B-Pillar Stamping Trial

1.5mm 3\textsuperscript{rd} Gen 980 GI / 1.5mm 3\textsuperscript{rd} Gen 980 GI
1.5mm 3\textsuperscript{rd} Gen 980 GI / 1.5mm DP600 GI

3\textsuperscript{rd} Gen welded blanks formed successfully with good weld seam ductility
PHS WELDING SOLUTIONS

PHS + PQS Without Ablation – Hotwire+

- Ablation alternative for welding AlSi coated PHS
- Filler metal + proprietary process solution
PHS WELDING SOLUTIONS
Door Ring Welds

A: 1500 MPa 1.2mm
B: 1500 MPa 1.5mm
C: 1500 MPa 1.6mm
D: 500 MPa 1.4mm
E: 500 MPa 0.95mm

1500 MPa
1.2mm

1500 MPa
1.5mm

1500 MPa
1.6mm

500 MPa
1.4mm

500 MPa
0.95mm
PHS WELDING SOLUTIONS

Prior to welding

- Ferrite formation is suppressed during laser welding
- Aluminum remains distributed in weld metal

Following welding

CFD simulation showing distribution of AlSi coating into weld
Tensile fractures of differential thickness welds occur in the parent metal.

Weld performance is comparable to ablation.

**Axial Crash**

![Axial Crash graph](chart)

**3-Point Bending**

![3-Point Bending graph](chart)
FUTURE OF WELDED BLANKS

Enabling optimized steel designs – the right material in the right place

• Advanced steel applications
  • 0.5mm – 4mm thicknesses in production
  • PHS + PQS in production without ablation
  • Cold stamped grades up to DP1180 in production
  • 3rd Gen steel production ready

• All automotive grades have a validated weld process
• Engaged with steel producers for weld development of new grades

Vehicle weight reduction
Component consolidation
Optimized for crash energy management
Material utilization improvement
Cost savings
FOR MORE INFORMATION

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