Supply Chain Resiliency: Replacing Aluminum with Steel to Avoid Manufacturing Disruptions

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GREAT DESIGNS IN STEEL™

Agenda

- Automotive Supply Disruption
- Emergency Supply of Steel
- Cliffs' Automotive Advantages
- Benefits of Steel
- Case Studies:
  - Fender & Hood Outer
    - Stamping Performance
    - Structural Performance
    - Cost
- Conclusions
- Q&A

Major Automotive Supply Disruption

Major Novelis aluminum plant in New York experiences second fire in two months

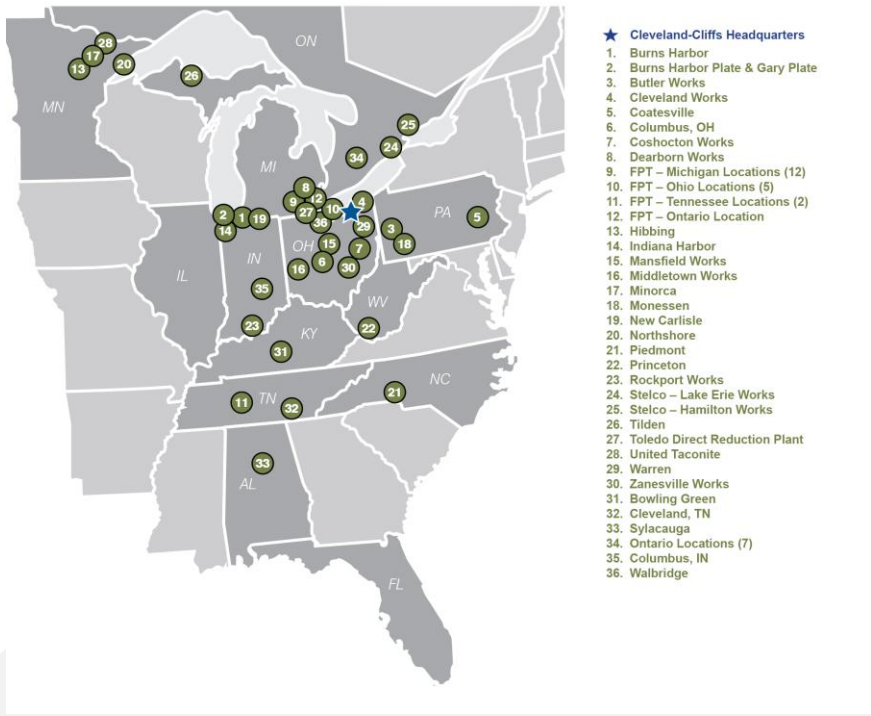
- The September shutdown of the plant sparked concerns that aluminum would lose ground to steel.
- US steel company Cleveland-Cliffs said Oct. 29 that it had begun supplying the US auto sector with steel substitutes for aluminum auto parts, exacerbating these worries.
- Aluminum analysts with S&P Global Energy had said the estimated restart of the plant by December would prevent any significant substitution trends.
- The latest incident, however, may provide more opportunities for the steel sector to advance into aluminum territory if restart plans are delayed.
- US aluminum markets have already been grappling with tight supply and record high prices, for most of 2025 due to US 50% tariffs on aluminum imports.

Source: S&P Global, November 21, 2025

Major Novelis aluminum plant in New York experiences second fire in two months

Cliff's Automotive Advantages

- The most automotive coating capacity in North America
- All steel substrate and coating lines located in the United States
- All steel substrate sourced from BF/BOF for superior surface quality and formability
- Interchangeability of our coated, surface critical products – EG, GA, GI



	Burns Harbor	Dearborn	Cleveland	Columbus	Indiana Harbor	Middletown	New Carlisle	Rockport	Spartan
Location	USA	USA	USA	USA	USA	USA	USA	USA	USA
Steel Source	USA	USA	USA	USA	USA	USA	USA	USA	USA
Exposed	X	✓	X	✓	X	✓	✓	✓	X

Emergency Supply of Steel

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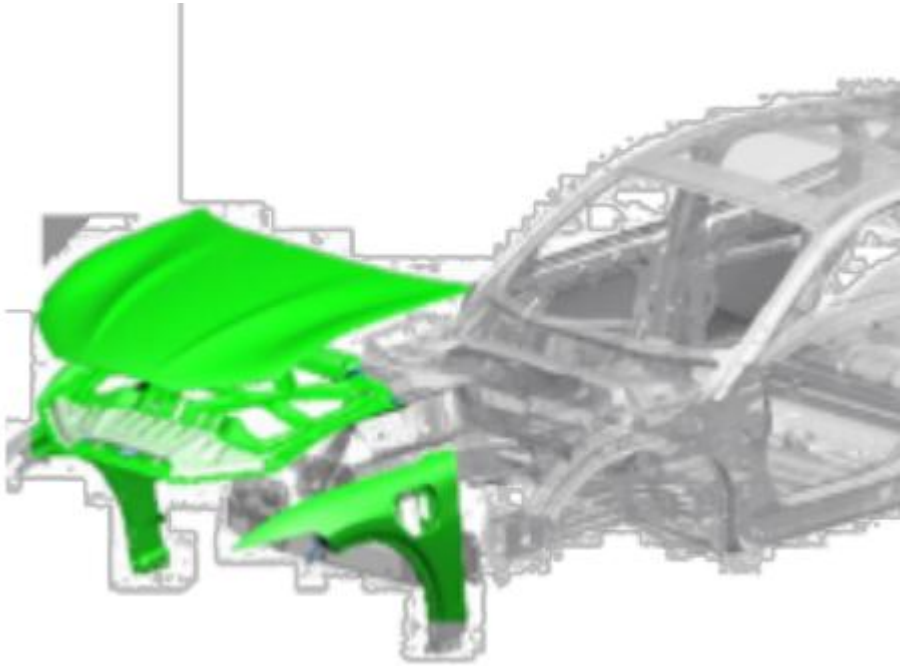
Cliffs is currently supplying steel in lieu of aluminum to several OEMs, allowing production to continue across multiple vehicle lines.

The following are the simple steps for success:

- Technical meeting and part assessment ✓
- FEA forming feasibility ✓
- Small volume trial (10-20 hits) ✓
- Dimensional & visual inspection ✓
- Run at rate ✓
- Production initiated ✓
- Consideration for permanent change ✓



For illustration purposes only

Steel Cost Advantages

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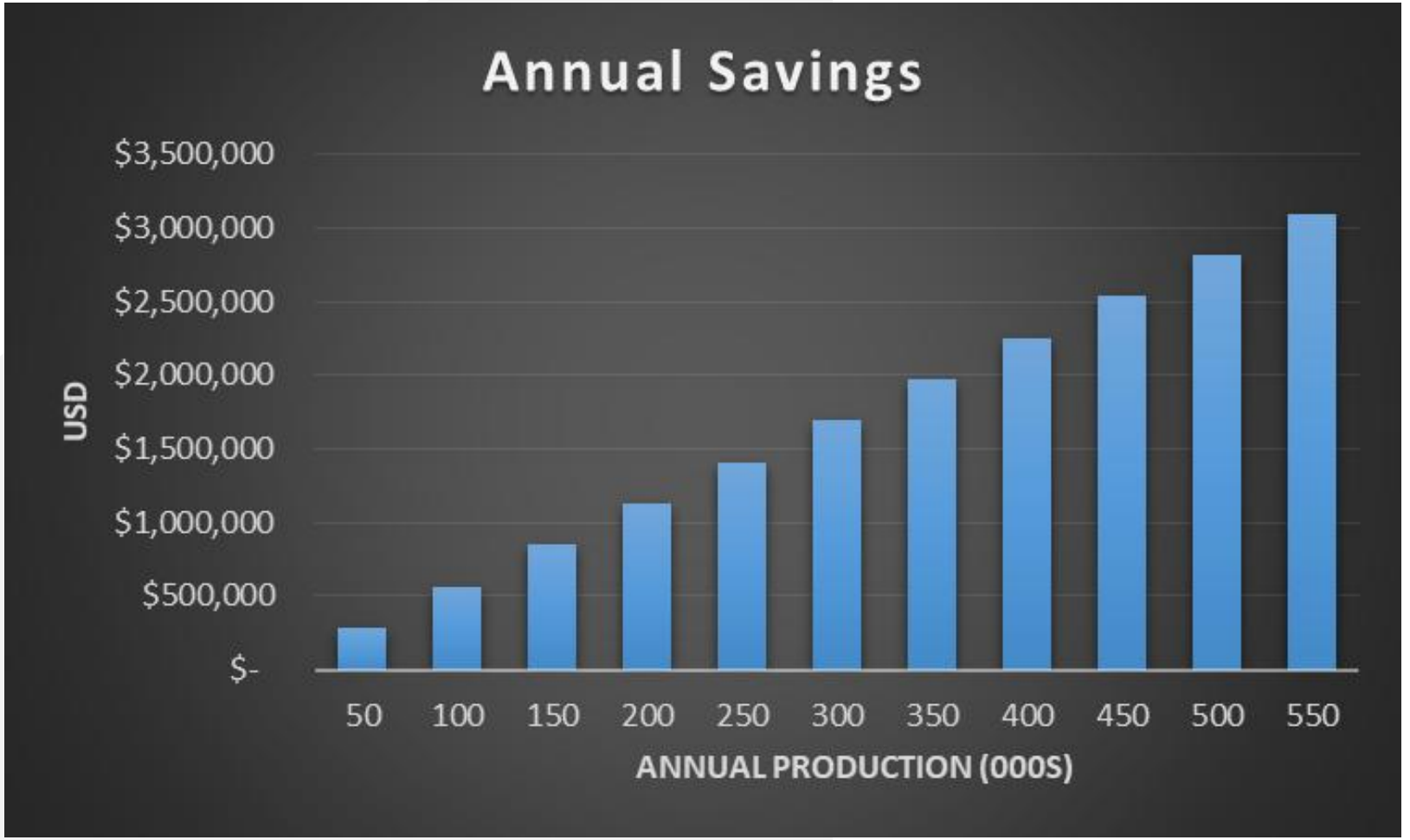
With aluminum pricing currently estimated at **3.5 times** or more than the price of steel, it is easy to see how a steel substitution can reduce overall cost

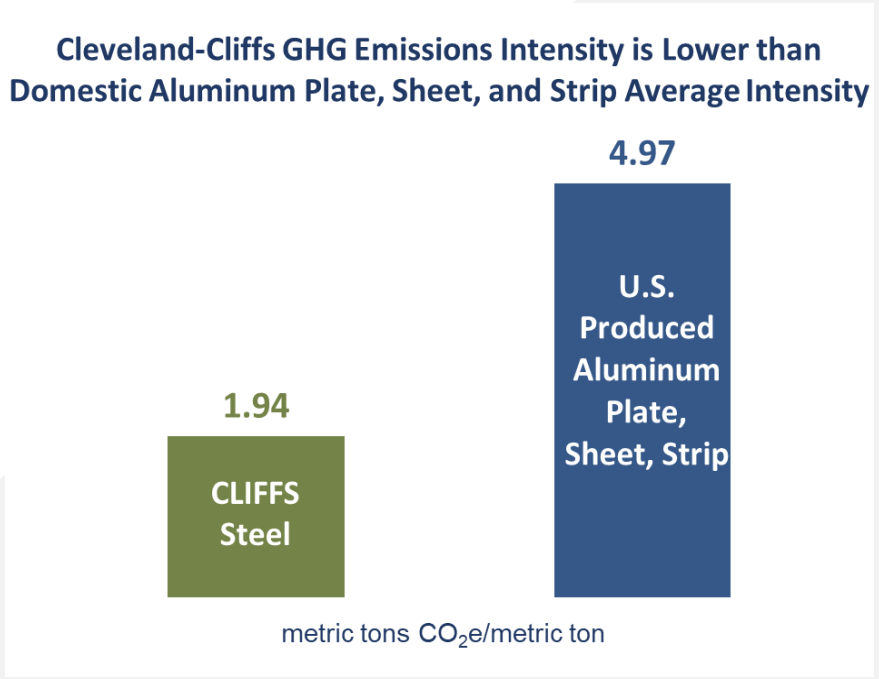


per *https://www.investing.com*
Aluminium $3450~3500/ton vs. steel $950~$1050/ton

Cliff's Steel vs. Aluminum GHG Emissions

GDIS

- The U.S. International Trade Commission collected data from domestic steel and aluminum facilities to calculate average and highest GHG emissions intensities for select U.S. produced product categories.
- U.S. produced sheet aluminum is **60%** more carbon emissions intensive than Cliffs' Consolidated Mining, Iron, Steel and Downstream GHG Emission Intensity (1.94 mt CO2e/mt crude steel), which incorporates our entire vertically-integrated operating footprint. International aluminum production is even more carbon intensive.
- Depending on part weight, switching to Cliffs' steel can reduce automotive upstream scope 3 GHG footprint versus aluminum.



Source: Cleveland-Cliffs and U.S. International Trade Commission, Greenhouse Gas Emissions Intensities of the U.S. Steel and Aluminum Industries at the Product Level, Publication Number: 5584

Closure Panels Bolted on to BIW

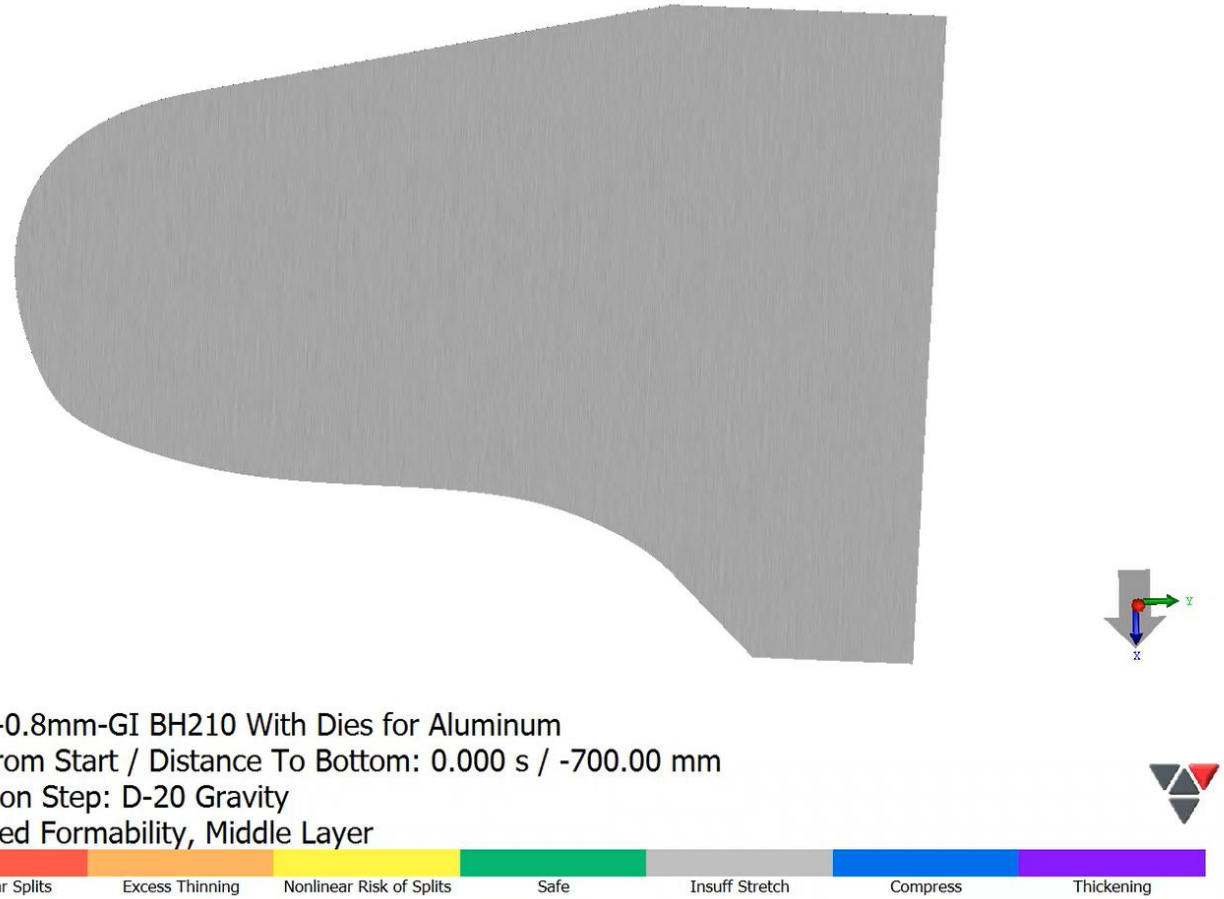
- Fender: bolted on Shotgun & A-pillar bracket, push pinned on front facia, fender liner & fender lip.
- Hood assembly: bolted on hood latch, hinges and lifter struts.
- Others: door outers, deck lid, lift gate, roof panel …

Source: https://www.ebay.com

Source: www.motorbiscuit.com

Stamping with Production Lines Designed for Aluminum

- **Stamping feasibility (formability contour): draw, trim, piercing, hemming & flanging**



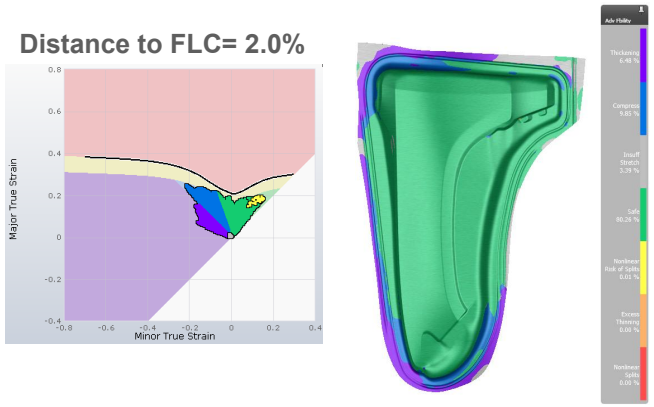
Fender, Safety Factor: 3.5 Times Better for BH210 vs. Aluminum

- Draw, formability comparison of 0.9mm aluminium vs. 0.8mm BH210 with different coatings
- Feasibility using aluminum die setup with the binder gap reduced from 0.05 mm for aluminum to 0 mm for steel
- Safety factor (distance to FLC): 2.0% for Al vs 10.3% for EG BH210, 13.0% for GA BH210 and 7.0% for GI BH210

❑ **3.5 to 6.5 times safer (safety factor ratio) for steel vs. aluminum using the same die for aluminum**

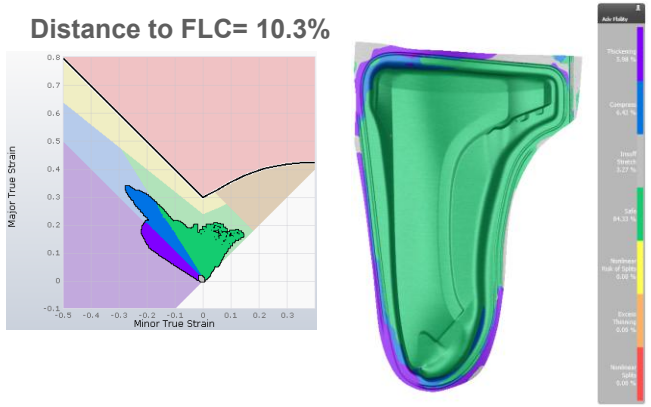
6000 Series-T4- Aluminum, 0.9mm

Distance to FLC= 2.0%



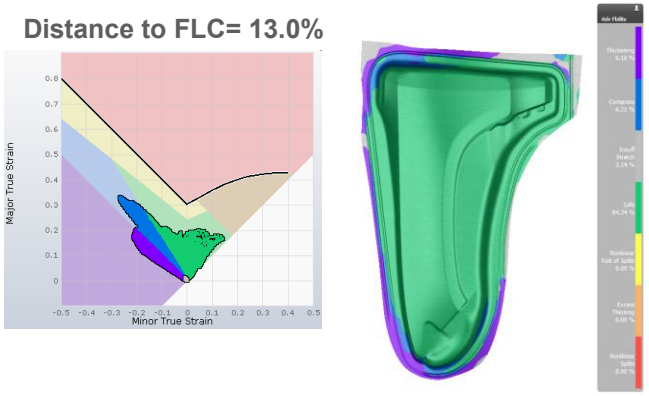
EG BH210, 0.8mm

Distance to FLC= 10.3%



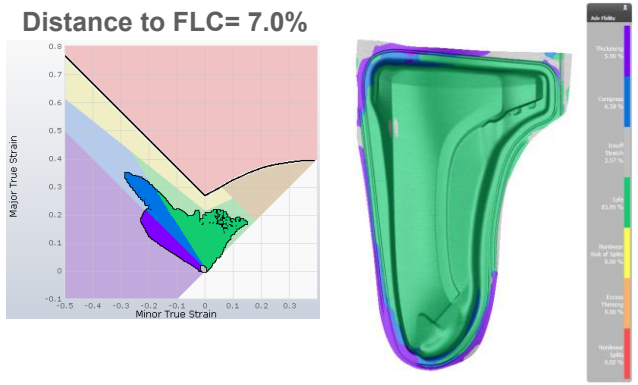
GA BH210, 0.8mm

Distance to FLC= 13.0%



GI BH210, 0.8mm

Distance to FLC= 7.0%

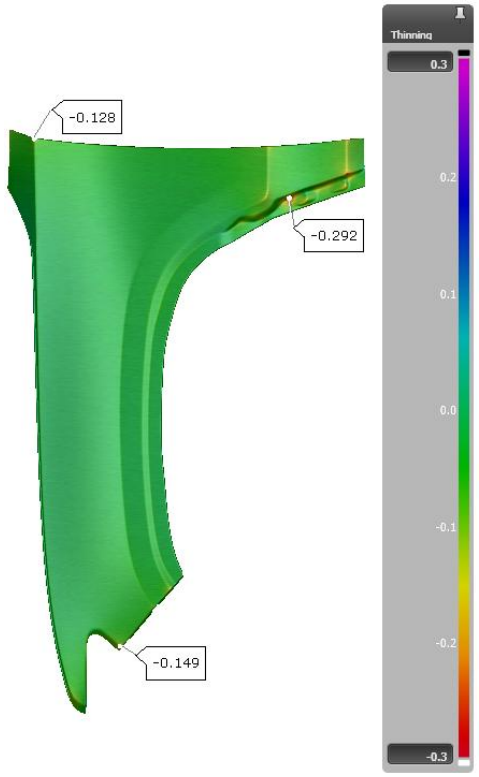


Fender, Thinning Safety Factor: 9% Better for BH210 vs. Aluminum

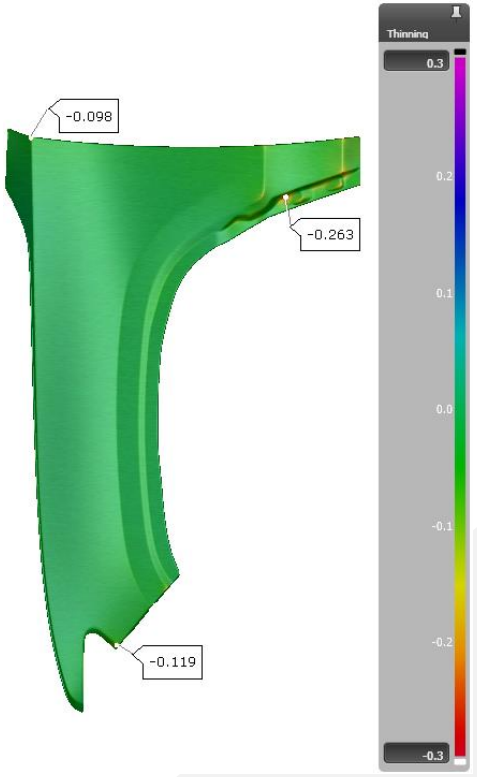
- Trimmed & flanged, formability comparison aluminium vs. BH210
- Feasibility using aluminum die setup with reduced binder gap from 0.05mm to 0.0 mm for steel
- Safety factor (max thinning): 29.2% for Al vs 26.3% for EG BH210, 26.4% for GA BH210, and 27.1% for GI BH210

❑ **On average the max. thinning for the steel with different coatings is 9% less than that of aluminum**

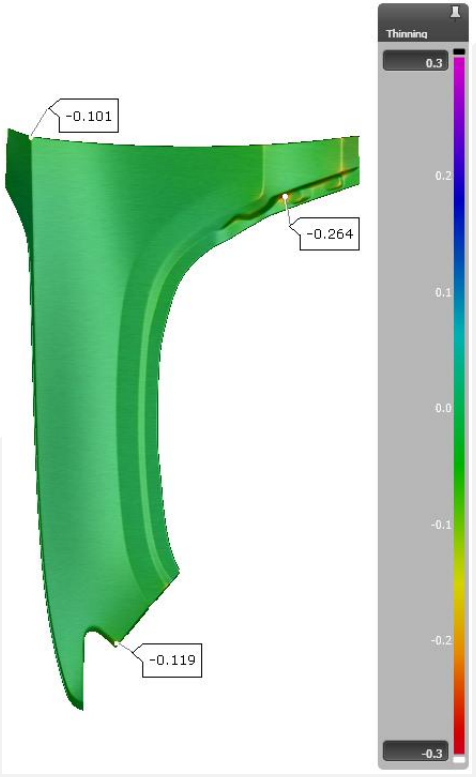
6000 Series-T4- Aluminum, 0.9mm



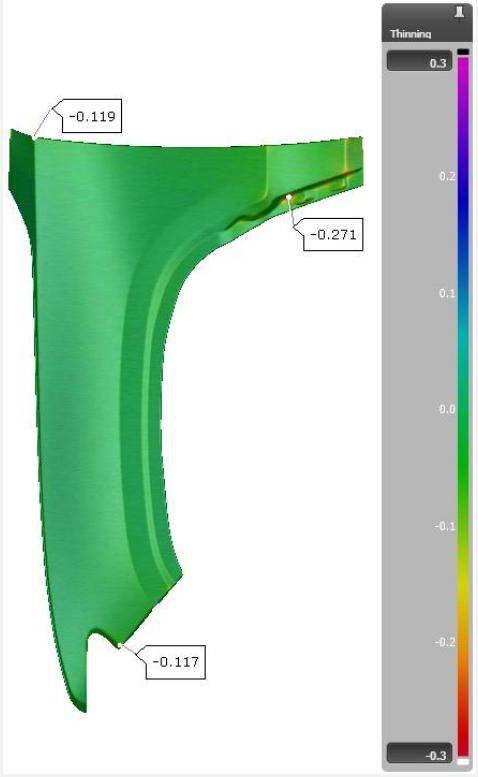
EG BH210, 0.8mm



GA BH210, 0.8mm



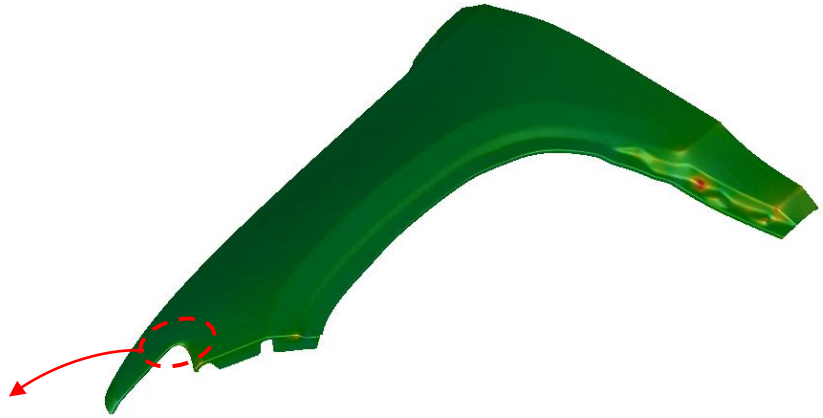
GI BH210, 0.8mm



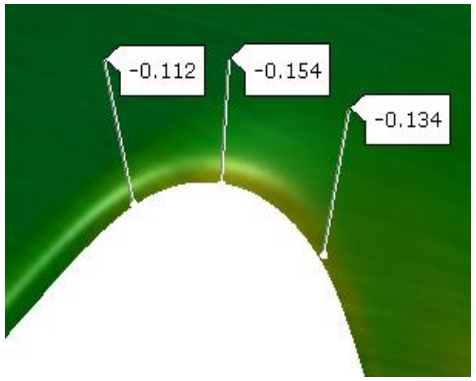
Fender, Edge Thinning Safety Factor: 23% Better for BH210 vs. Aluminum

- Finished panel, edge thinning comparison BH210 vs aluminium
- Feasibility using aluminum die setup with reduced binder gap from 0.05mm to 0mm for steel
- Safety factor (max edge thinning): 15.4% for Al vs 11.7% for EG BH210, 12.2% for GA BH210, and 11.5% for GI BH210

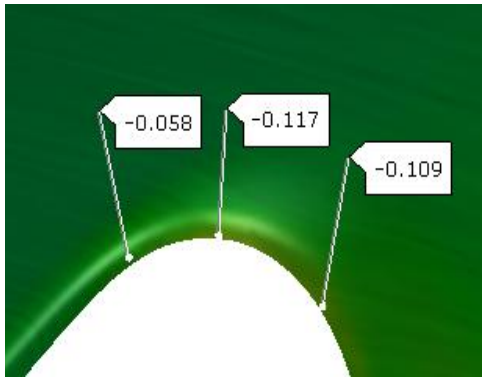
❑ **On average the maximum edge thinning for steels with different coatings is 23% less than that of aluminum**



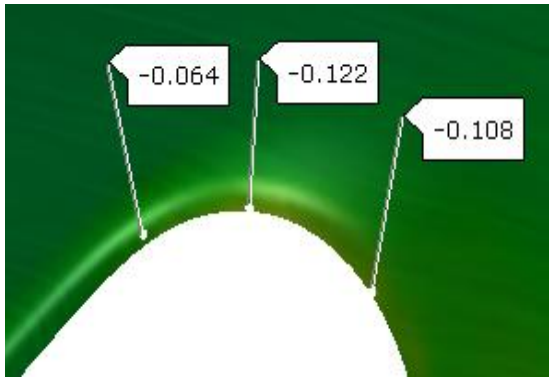
6000 Series-T4- Aluminum, 0.9mm



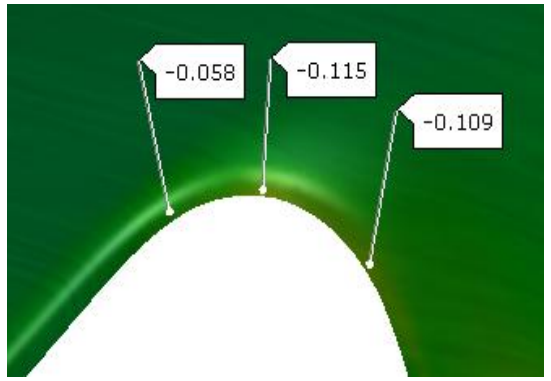
EG BH210, 0.8mm



GA BH210, 0.8mm



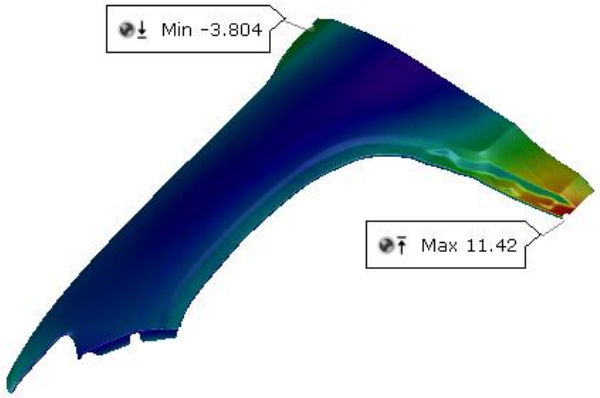
GI BH210, 0.8mm



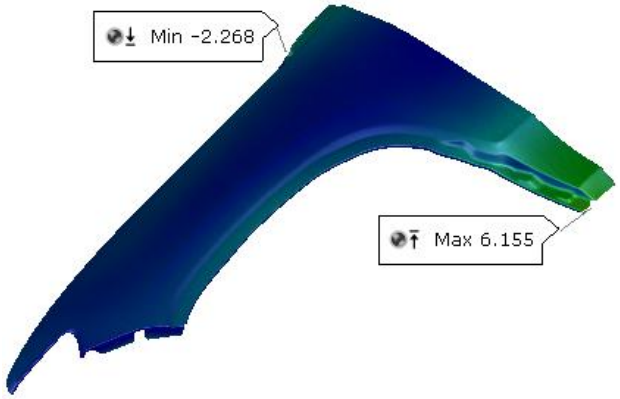
Fender, Springback 45% Better for BH210 vs. Aluminum

- Springback prediction using die for aluminum, with binder gap reduced from 0.05 mm to 0.0 mm for steel
- Shape and dimension control for assembly: **average 45% less springback for steel vs. aluminium**

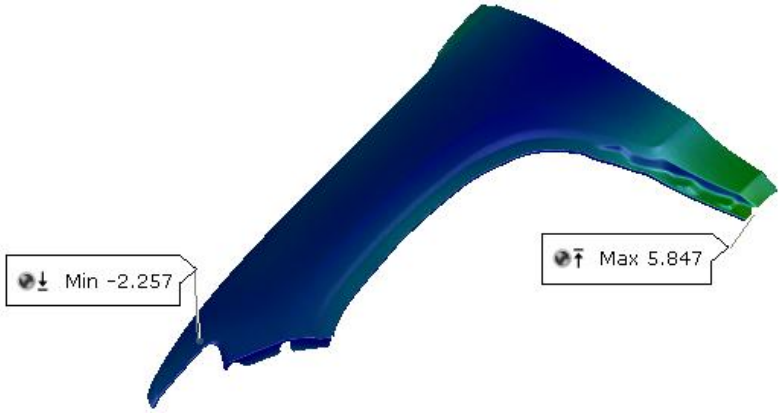
6000 Series-T4- Aluminum, 0.9mm



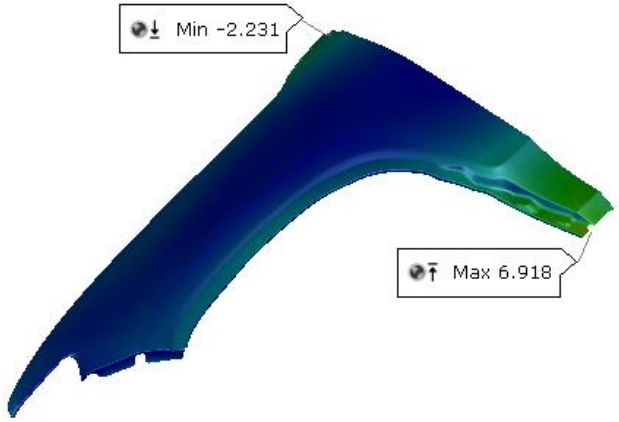
EG BH210, 0.8mm

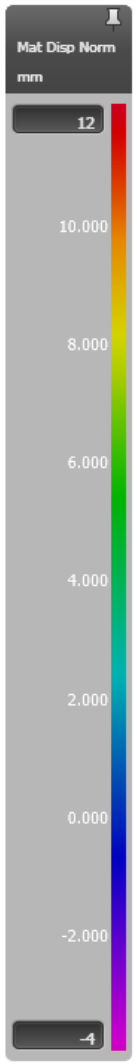


GA BH210, 0.8mm



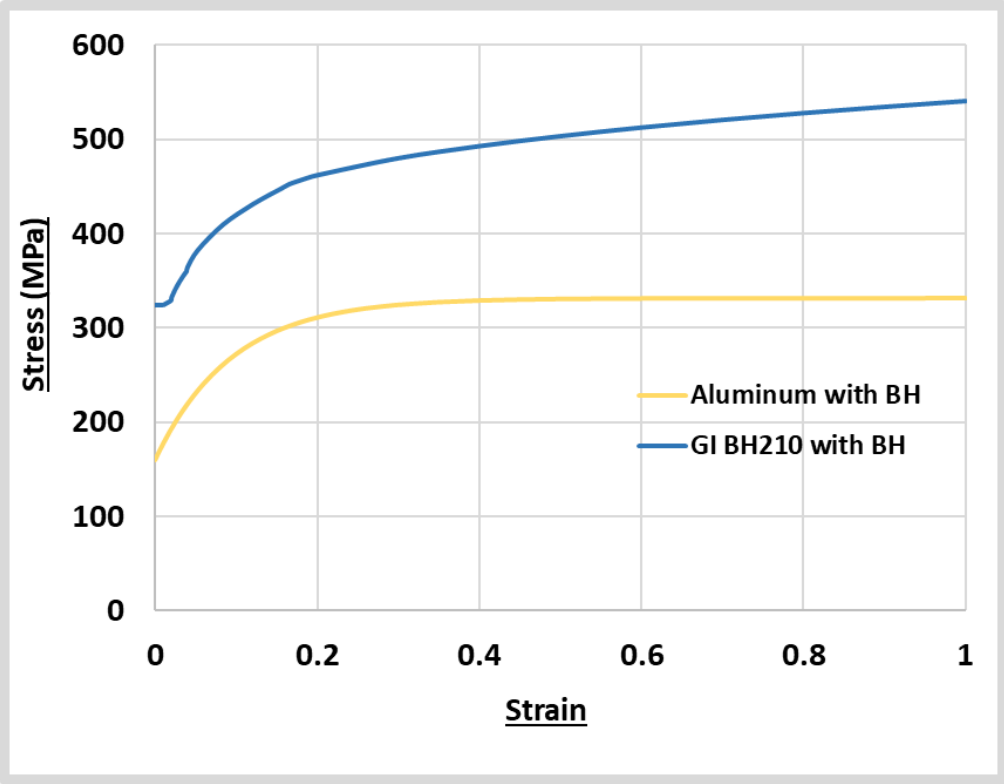
GI BH210, 0.8mm





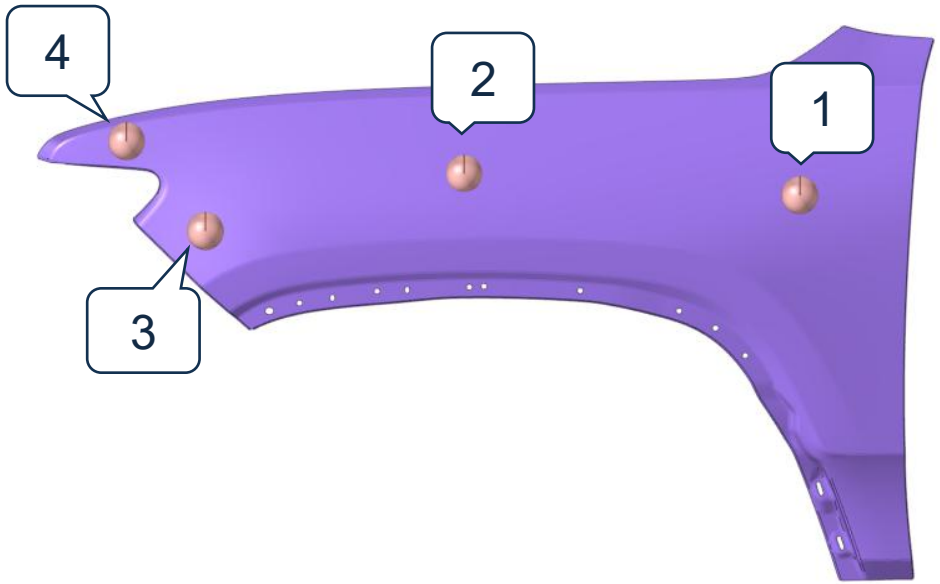
Fender, Dent Performance CAE for BH210 vs. Aluminum

- BH210 vs. 6000 Aluminum, 2 Times Higher Strength: 324MPa vs. 160MPa, YS with Bake Hard:
- Gauges:
  - 0.9mm 6000A vs. 0.8mm GI BH210
  - 0.9mm 6000A vs. 0.63mm GI BH210



- Strain stress curves of BH210 and 6000T with bake hardening

- Impactor load of 200N, 50 mm diameter.
- Simulations are performed on after bake materials.
- Permanent displacement is compared at 4 locations.



Dent Resistance: Permanent Displacement 0.8mm BH210 vs. 0.9mm Aluminum

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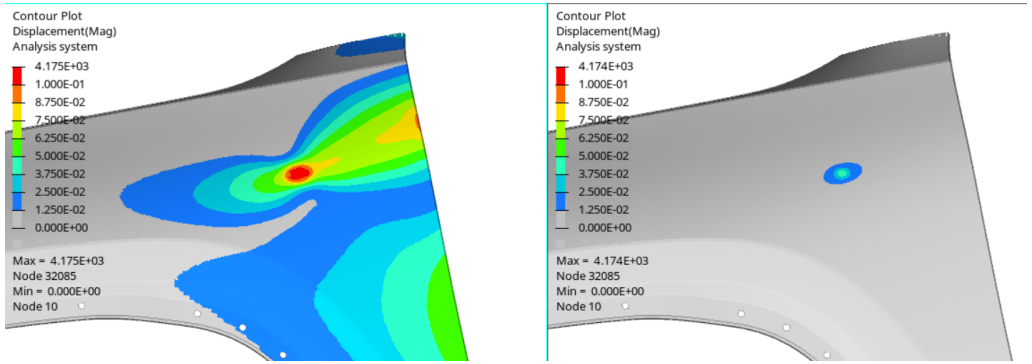
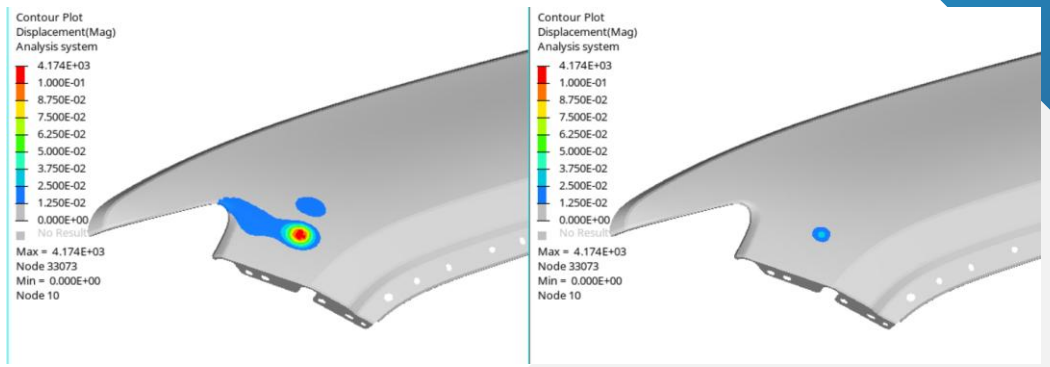
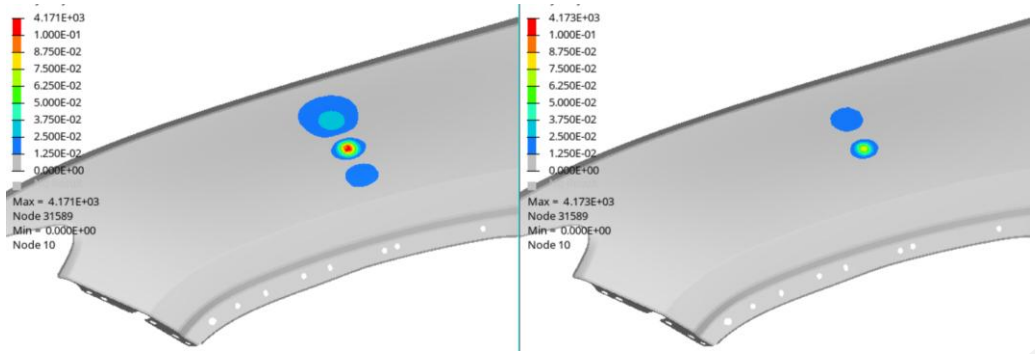
Aluminum 6000, 0.9mm vs. BH210, 0.8mm

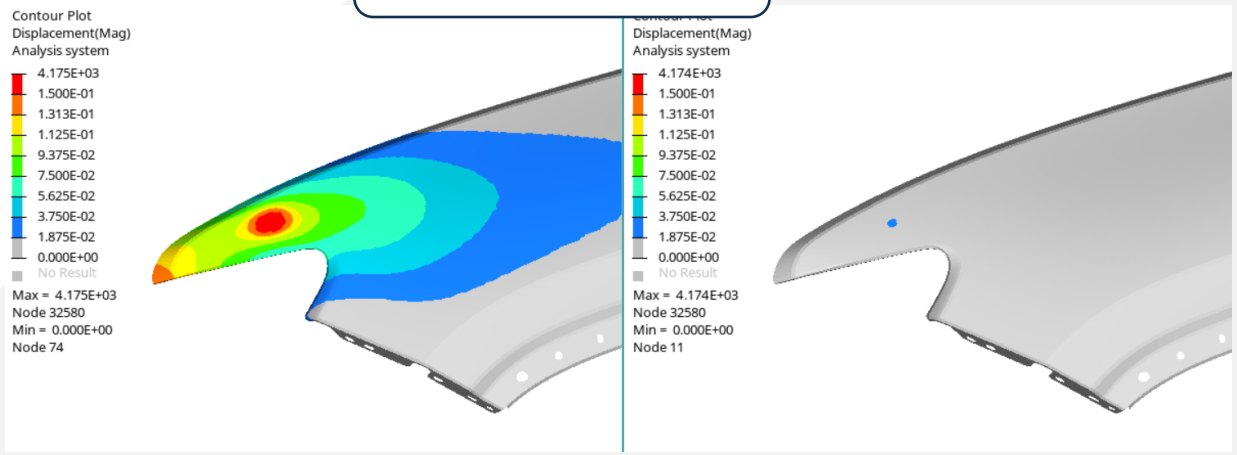


Location 1



Location 3





Location 2

Fender

Location 4

Dent Resistance: Permanent Displacement 0.63mm BH210 vs. 0.9mm Aluminum

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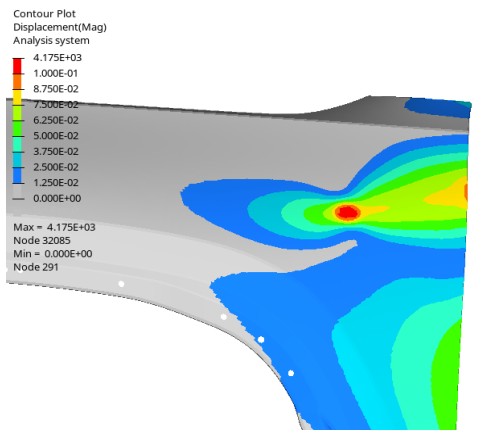
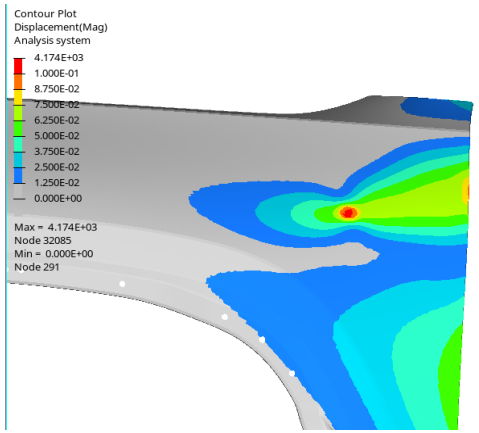
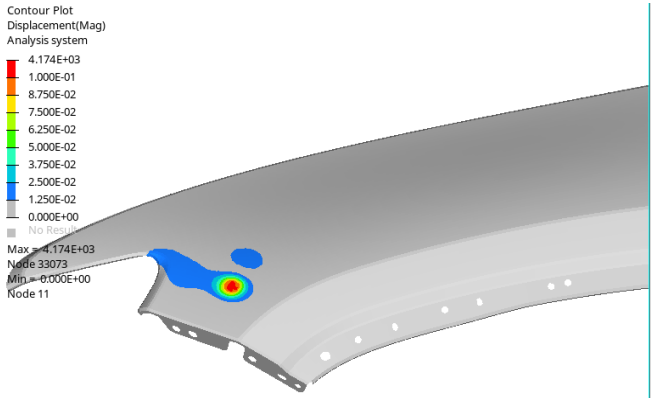
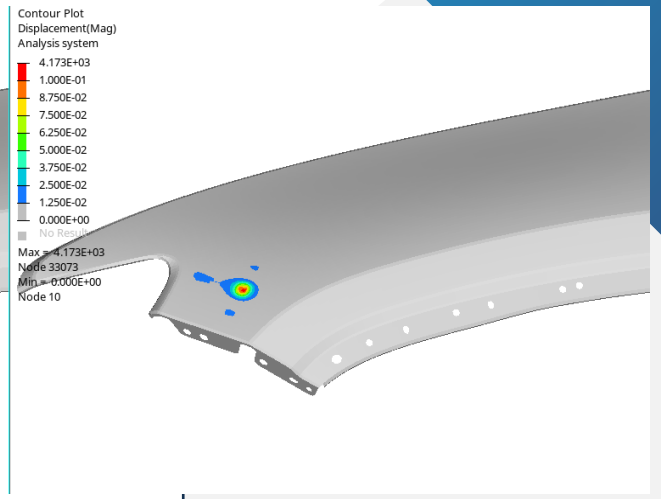
Aluminum 6000, 0.9mm vs. BH210, 0.63mm



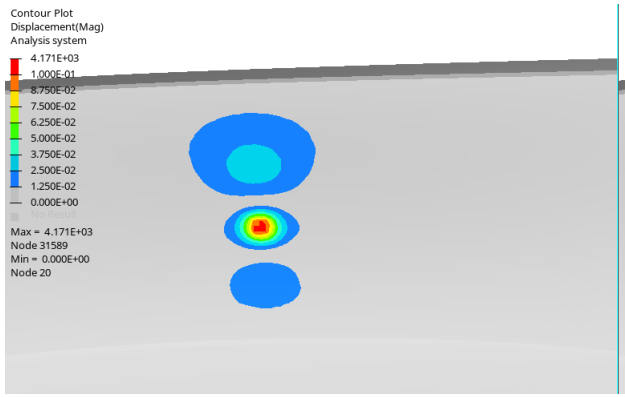


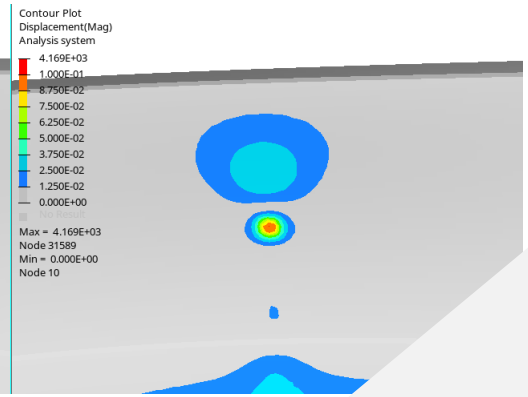
Location 1



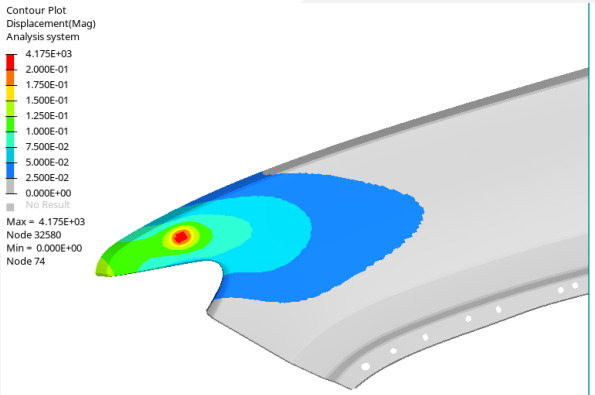


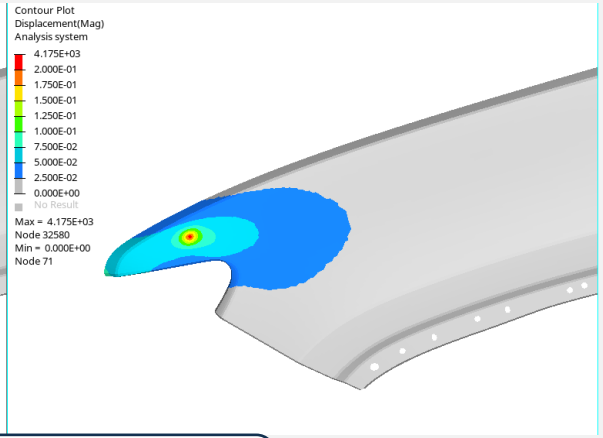
Location 3





Location 2





Fender

Location 4

Fender, Better Dent Resistance for BH210 vs. Aluminum

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Permanent Displacement

40% Better for 0.8mm BH210 vs. 0.9mm Aluminum

	6000 series aluminum 0.9mm	GI BH210 0.8mm	Performance improvement
Loc 1	0.217mm	0.051mm	76%
Loc 2	0.154mm	0.087mm	44%
Loc 3	0.183mm	0.033mm	82%
Loc 4	0.289mm	0.026mm	91%

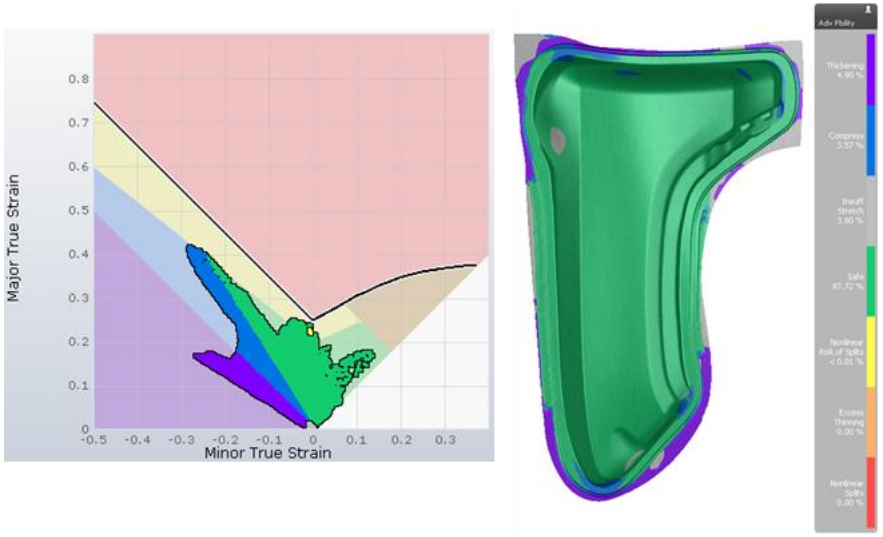
20% Better for 0.63mm BH210 vs. 0.9mm Aluminum

	6000 series aluminum (0.9mm)	GI BH210 (0.63mm)	Performance improvement
Loc 1	0.217mm	0.167mm	23%
Loc 2	0.154mm	0.122mm	21%
Loc 3	0.183mm	0.126mm	31%
Loc 4	0.289mm	0.214mm	25%

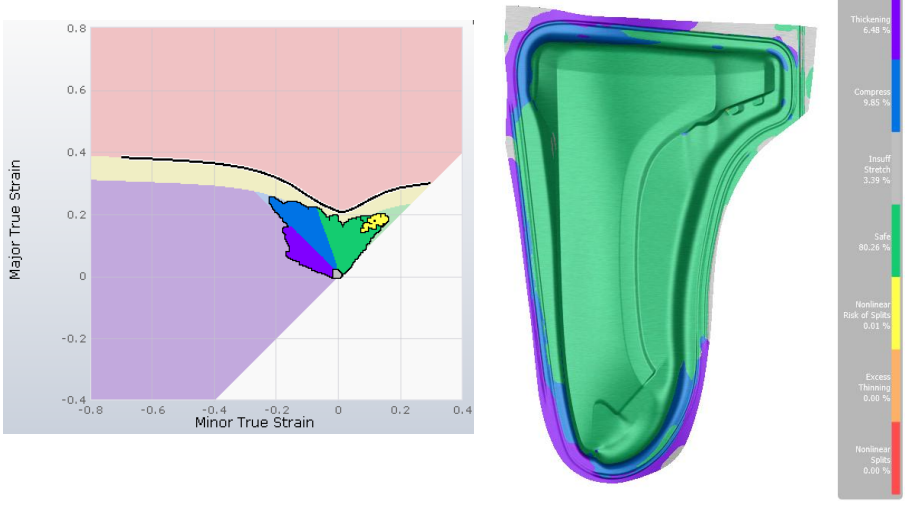
Draw Die Designed for BH210: Formability vs. Aluminum, Formability

- Draw formability: Safety factor (distance to FLC):
  - 0.9mm aluminium: 2%
  - 0.63mm GI BH210 using die for steel and smaller blank size: 2%

GI BH210, 0.63mm
Safety factor: 2%



6000 Series-T4- Aluminum, 0.9mm
Safety factor: 2%



Fender, Blank Size Reduction and Material Utilization Improvement

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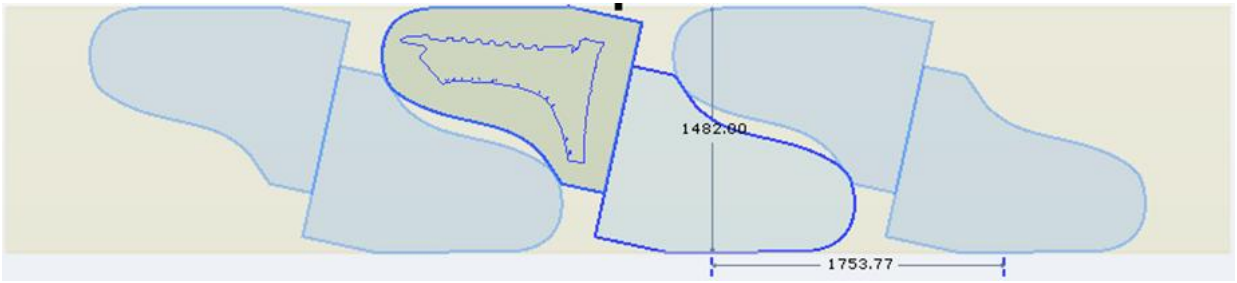
- 20.6% blank size reduction with die developed for steel with smaller addendum

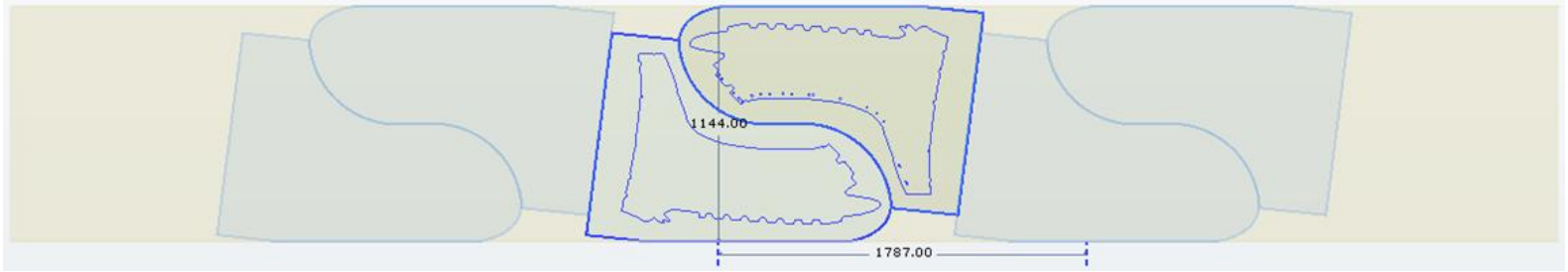
$$\left(1-\frac{1787\times1144}{1482\times1753}\right)\% = 20.6\%$$

- 20% material utilization improvement for steel with improved nesting

Aluminum: Material Utilization= 36.86% Width=1482 mm Pitch=1753 mm



Steel: Material Utilization= 46.23% Width=1144 mm Pitch=1787 mm

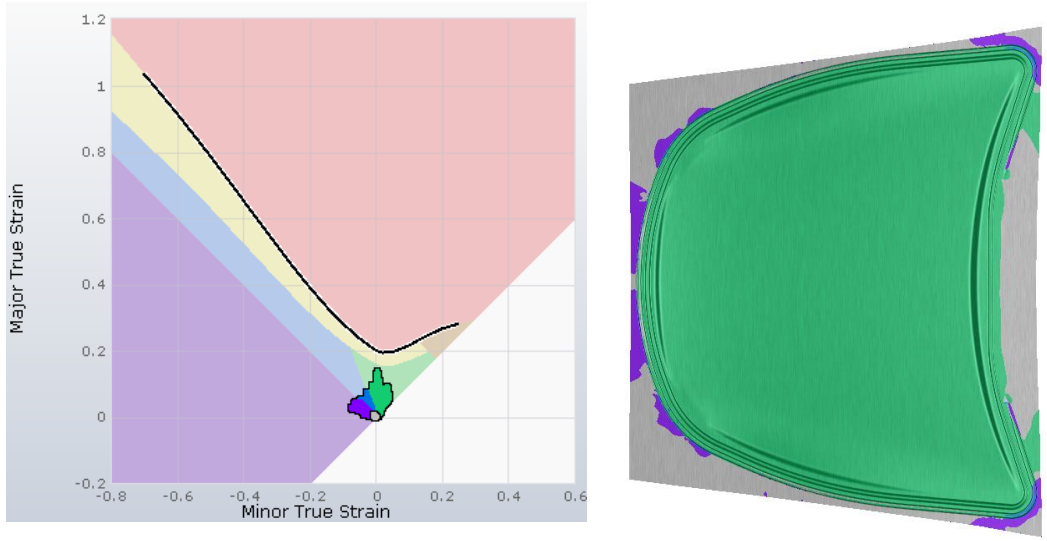


Hood Outer, Safety Factor: 80% Better for Steel vs. Aluminum with Aluminum Die

- Draw formability comparison of 0.9 mm aluminium vs. 0.8 mm GI BH210
- Same blank size for Aluminum and Steel.
- Safety factor (distance to FLC): 6.1% for Aluminium vs 11% for GI BH210

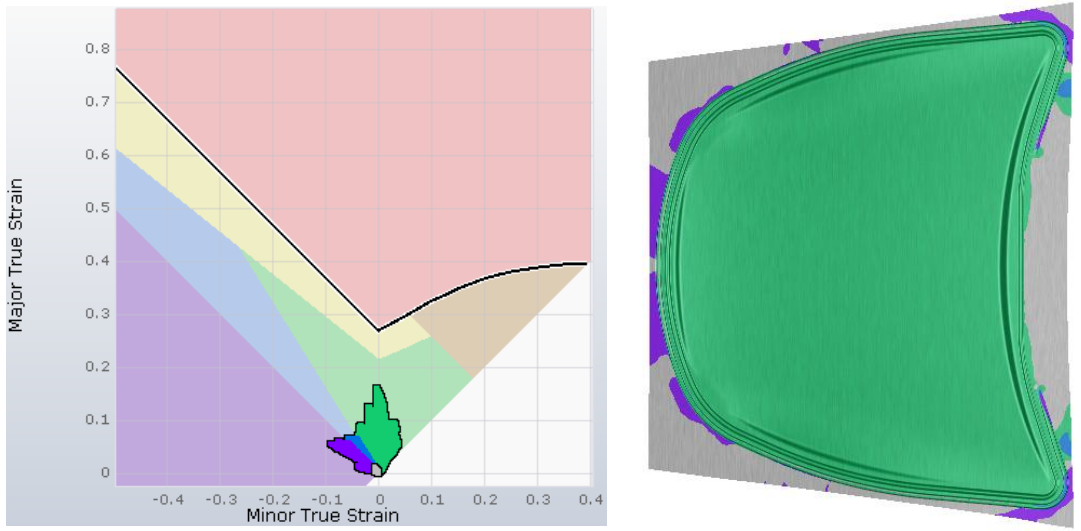
6000 Series-T4- Aluminum, 0.9 mm

Distance to FLC= 6.1%



GI BH210, 0.8 mm

Distance to FLC= 11%

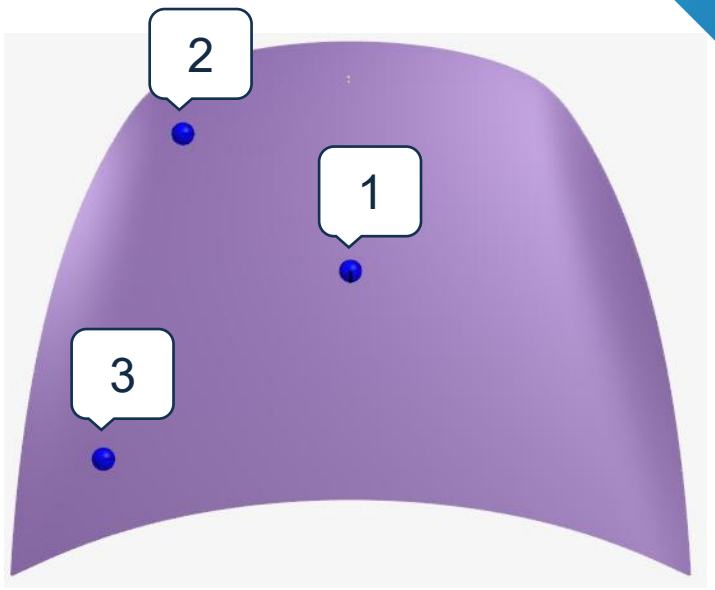


Hood Outer, Better Dent Resistance for Steel vs. Aluminum

GDIS

Permanent Displacement

- Impactor load of 200N, 50 mm diameter.
- Simulations are performed on after bake materials.
- Permanent displacement is compared at 3 locations, using hood assembly.



70% Better for 0.8mm Steel vs. 0.9mm Aluminum

	6000 series aluminum 0.9mm	GI BH210 0.8mm	Performance improvement
Loc 1	0.80	0.20	75%
Loc 2	0.91	0.25	73%
Loc 3	0.88	0.19	78%

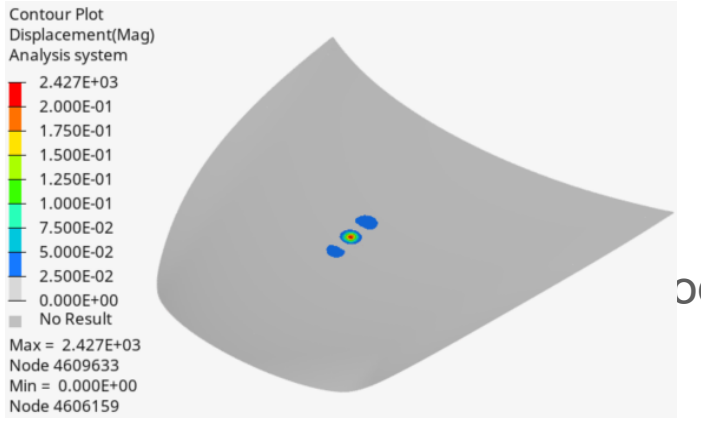
30% Better for 0.63mm Steel vs. 0.9mm Aluminum

	6000 series aluminum 0.9mm	GI BH210 0.63mm	Performance improvement
Loc 1	0.80	0.57	29%
Loc 2	0.91	0.67	26%
Loc 3	0.88	0.58	34%

Dent Resistance: Permanent Displacement 0.8mm Steel vs. 0.9mm Aluminum

GDIS

- BH210: 0.8 mm hood outer and 0.9 mm hood inner



Location 1

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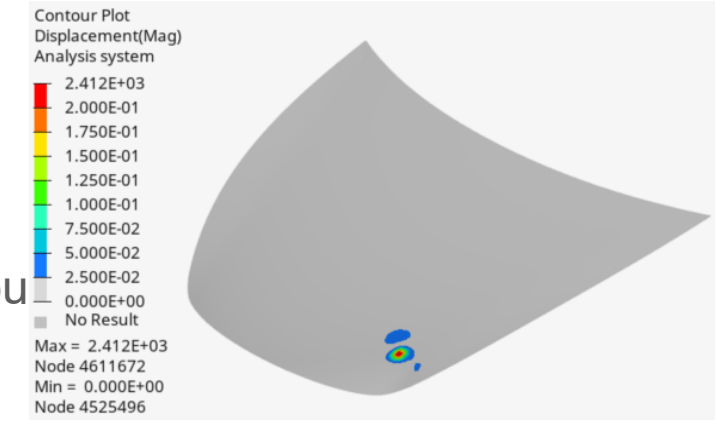
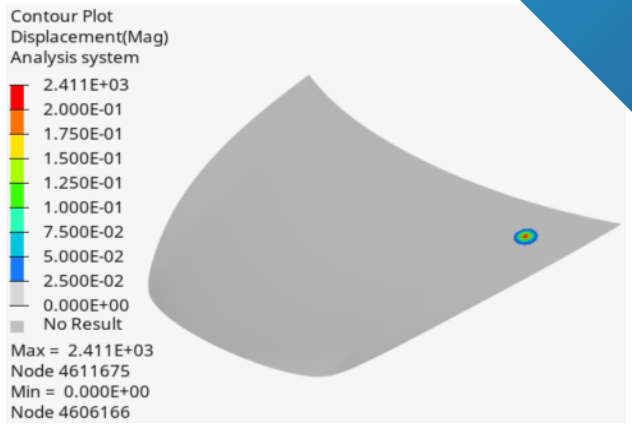
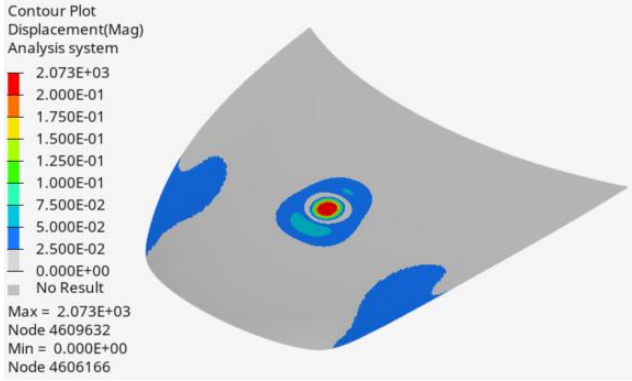


Location 2

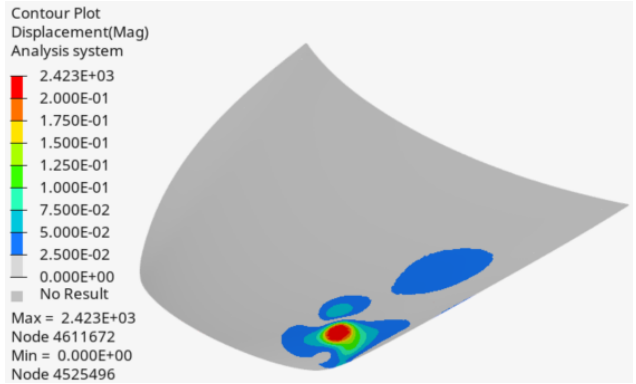


Location 3

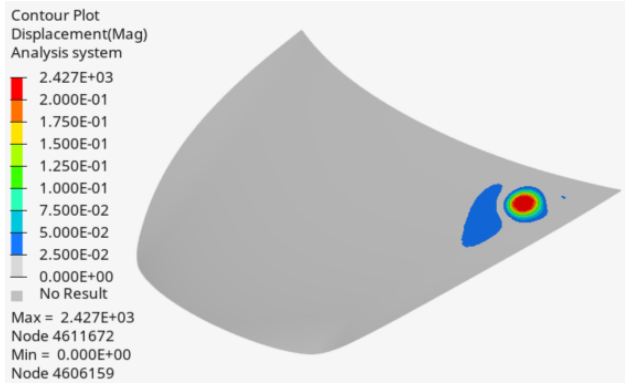
- Aluminum 6000: 0.9 mm hood outer and 0.9 mm hood inner



Location 1



Location 2

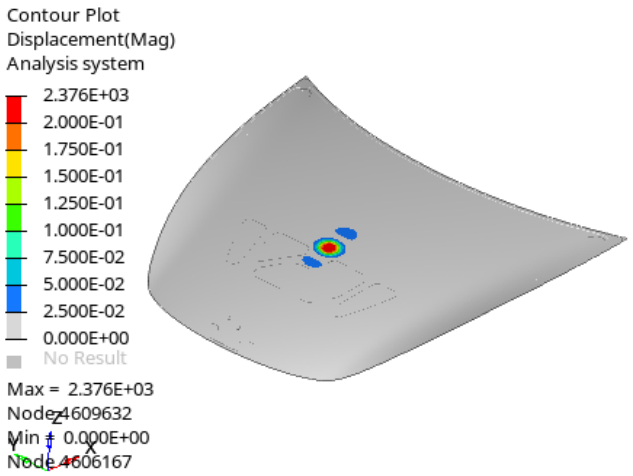


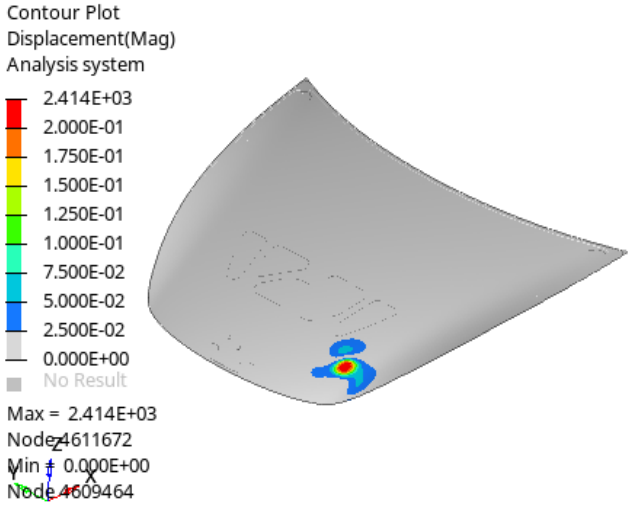
Location 3

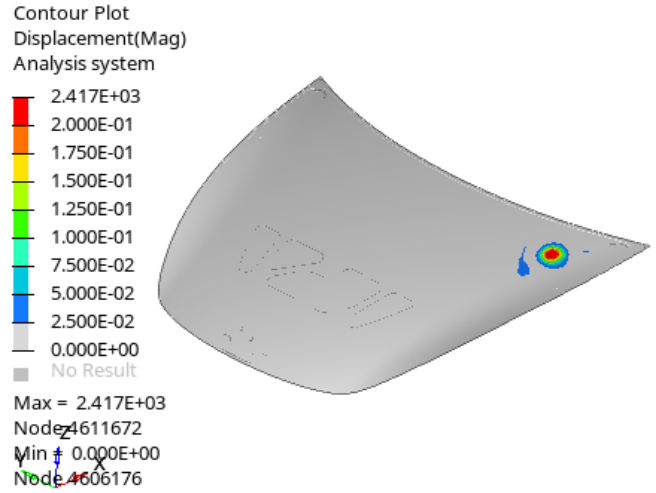
Dent Resistance: Permanent Displacement 0.63mm BH210 vs. 0.9mm Aluminu

GDIS

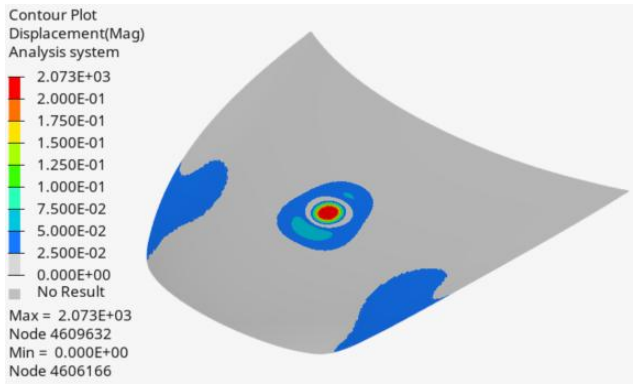
- BH210: 0.63 mm hood outer and 0.9 mm hood inner



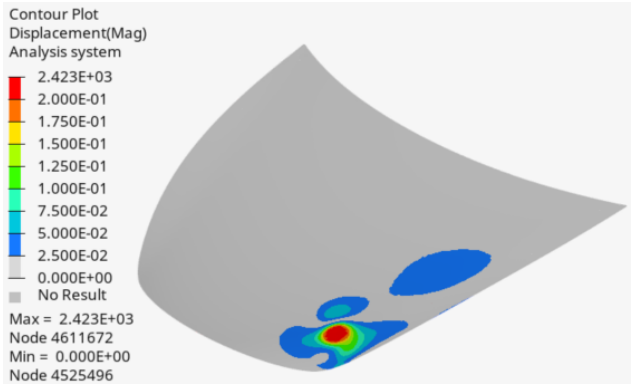




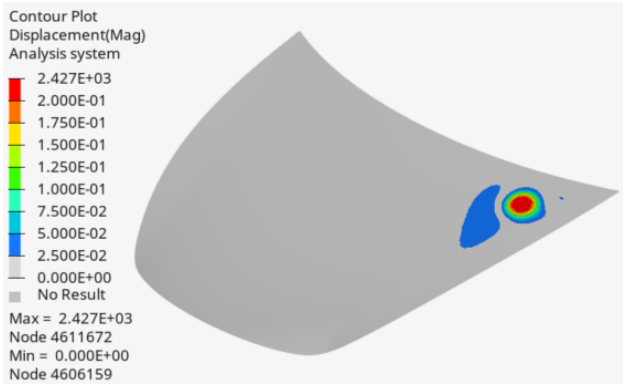
- Aluminum 6000: 0.9 mm hood outer and 0.9 mm hood inner



Location 1



Location 2



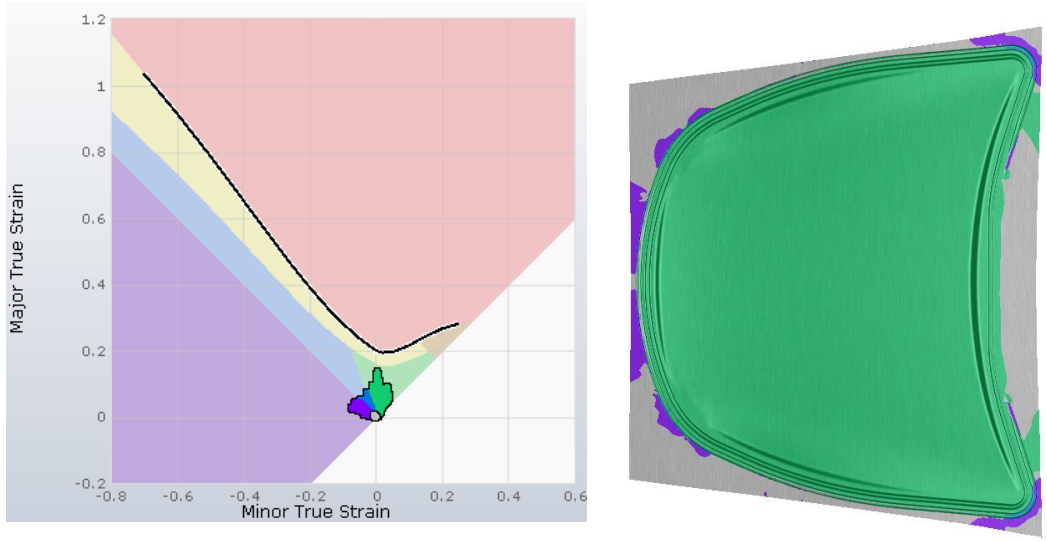
Location 3

Hood Outer, Safety Factor: 65.5% Better for Steel vs. Aluminum with Smaller Blank and Die Developed for Steel

- Draw formability comparison of 0.9 mm aluminium vs. 0.63 mm GI BH210
- Steel blank size is reduced by 6.6% with die designed for steel
- Safety factor (distance to FLC): 6.1% for Aluminium vs 10.1% for GI BH210

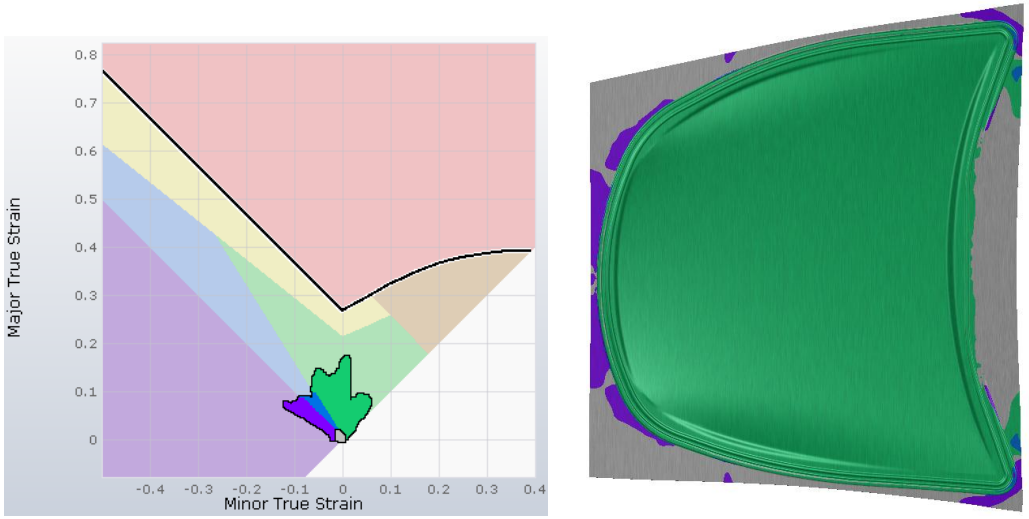
6000 Series-T4- Aluminum, 0.9 mm

Distance to FLC= 6.1%



GI BH210, 0.63 mm

Distance to FLC= 10.1%



Hood Outer, Blank Size Reduction and Material Utilization Improvement

GDIS

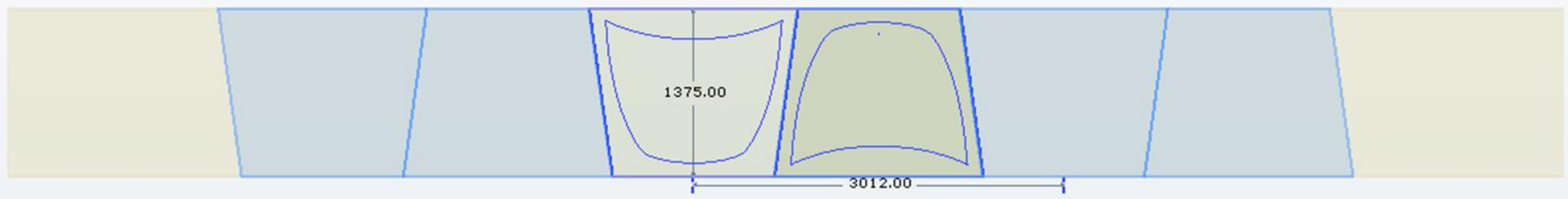
- 6.6% blank size reduction with die developed for steel with smaller addendum

$$\left(1-\frac{3012\times 1375}{3113\times 1425}\right)\%=6.6\%$$

- 7% material utilization improvement for steel

Aluminum: Material Utilization= 55.91% Width=1425 mm Pitch=3113 mm

Steel: Material Utilization= 59.89% Width=1375 mm Pitch=3012 mm



Cost Savings Replacing Aluminum with Steel Using Current Die

GDIS

- Fender with same blank size for Aluminum and Steel: 25.12%
  - Gauge reduction from 0.9mm to 0.8mm
  - Blank weight: steel 8.17kg vs. aluminium 3.14kg
  - Cost savings: 1-($1000 x (8.17kg / 3.14kg)) / $3475 = 25.12%

- Hood Outer with same blank size for Aluminum and Steel: 25.8%
  - Gauge reduction from 0.9mm to 0.8 mm
  - Blank weight: steel 13.95kg vs. aluminium 5.41kg
  - Cost savings: 1-($1000 x (13.95kg / 5.41kg)) / $3475 = 25.8%

Current market price per *https://www.investing.com*
Aluminium $3450~3500/ton vs. steel $950~$1050/ton

Cost Savings Replacing Aluminum with Steel Using Die Designed for Steel

GDIS

- Fender with reduced blank size for steel: 53.6%
  - 20% blank size reduction, gauge reduction from 0.9mm to 0.63mm
  - Blank weight: steel 5.06kg vs. aluminium 3.14kg
  - Cost savings: 1-($1000 x (5.06kg / 3.14kg)) / $3475 = 53.6%

- Hood Outer with reduced blank size for steel: 45.5%
  - 6.6 % blank size reduction, gauge reduction from 0.9mm to 0.63mm
  - Blank weight: steel 10.25kg vs. aluminium 5.41kg
  - Cost savings: 1-($1000 x (10.25kg / 5.41kg)) / $3475 = 45.5%

Current market price per *https://www.investing.com*
Aluminium $3450~3500/ton vs. steel $950~$1050/ton

Conclusion

- Aluminum supply chains continue to be stressed, both domestically and globally
- Cliffs has proven itself as the leader in supporting steel substitutions for aluminum by being first to market
- Cliff's technical data and trials prove that steel can be implemented into processes designed for aluminum
  - Formability is improved
  - Structural performance is enhanced
  - Cost savings are significant
  - CHG emissions are negligible
  - Fuel economy impacts are negligible
- Cliff's U.S. manufacturing footprint, coating line redundancy and available capacity allowed for expedited steel supply
- OEMs are now looking beyond emergency supply and have made the transition to steel permanent in many cases.

GDIS

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