GREAT DESIGNS IN STEEL

ON THE ADVANTAGES OF FORTIFORM® 980 GI - A 3RD GENERATION AHSS GRADE WITH SUPERIOR WELDABILITY

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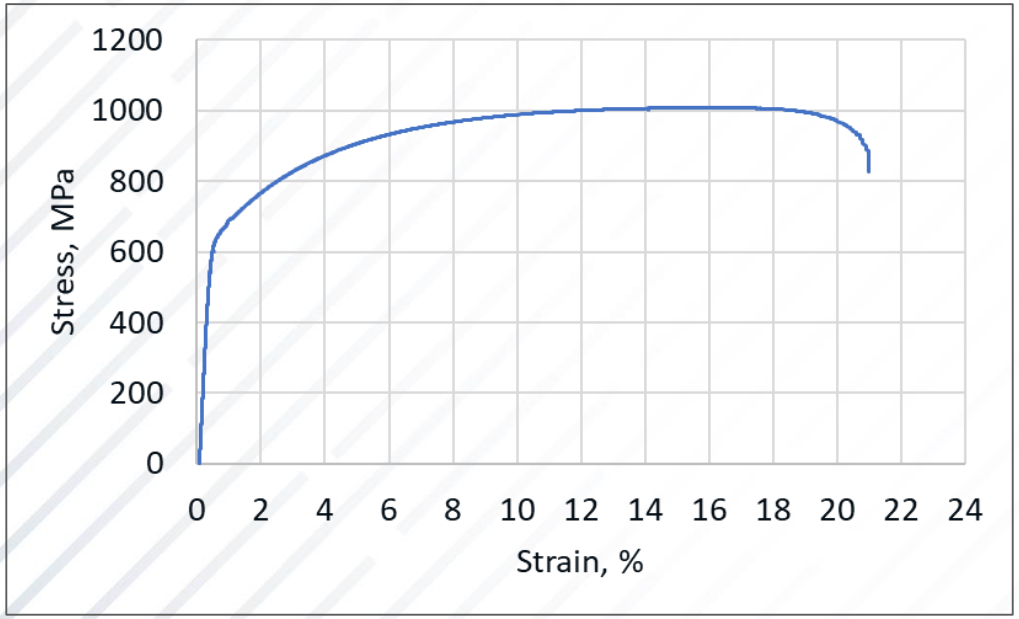
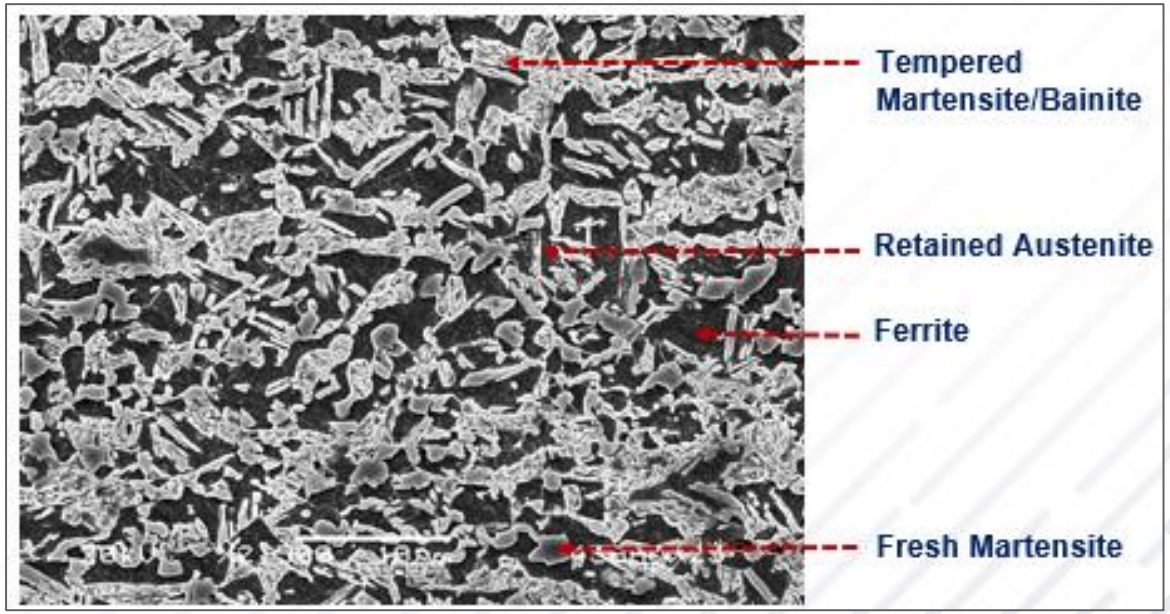
FORTIFORM® 980 GI
MECHANICAL PROPERTIES & MICROSTRUCTURE DESIGN

Engineered product - Excellent mechanical properties with improved LME resistance

	Targeted Mechanical Properties				Bendability
	YP (MPa)	TS (MPa)	TE (%)	HER (%)	
FORTIFORM® 980 GI	670	1005	22	23	V-bend < 2 r/t



Engineering Stress-Strain Curve



Microstructure

WELDABILITY
SPOT WELDING

Stackup: **1.6mm GI980HF / 1.5 mm GI EDDS / 1.5mm GI EDDS**
Welding Condition: SEP1220-2

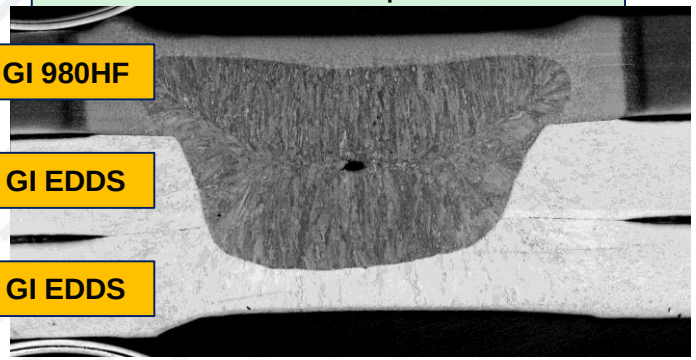
Max. Welding Current (Imax);
Just Below Expulsion

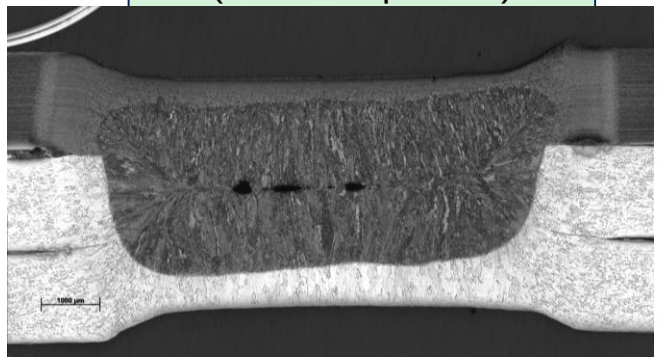
10% Above Imax
(Above Expulsion)

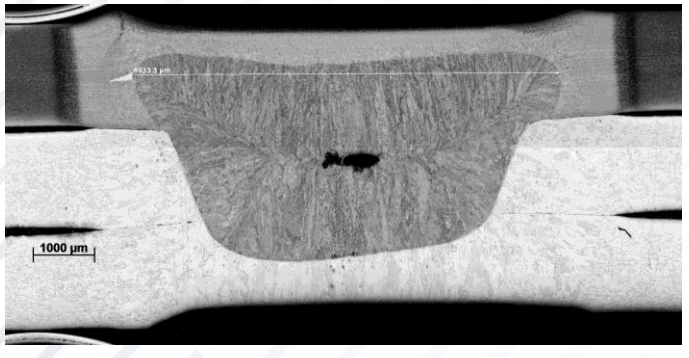
GI 980HF

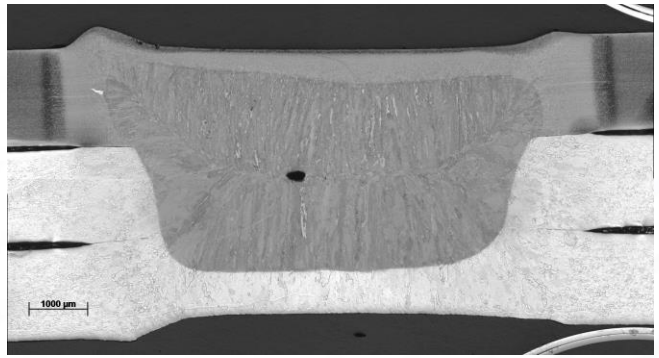
GI EDDS

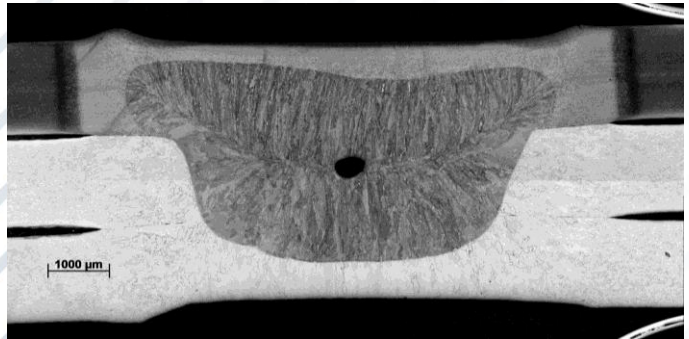
GI EDDS

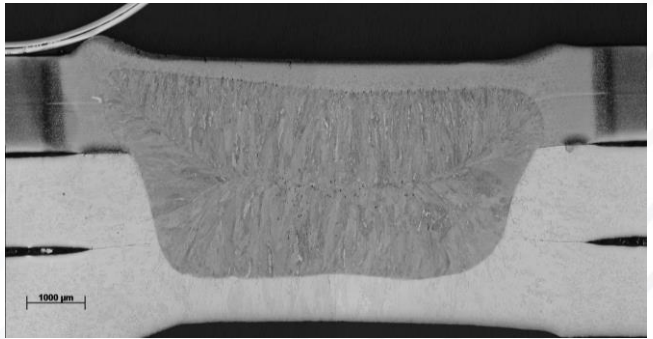










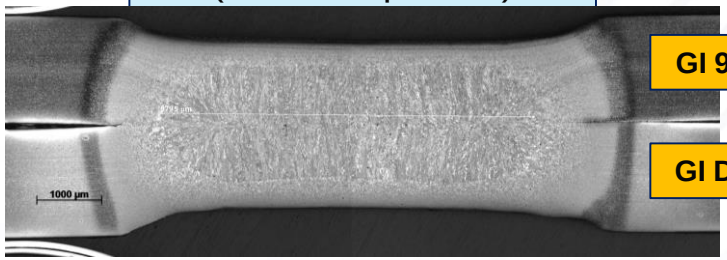


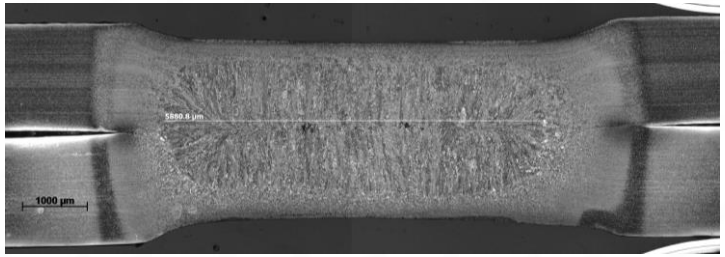
Stackup: **1.6mm GI980HF / 1.6 mm DP980GI**
Welding Condition: SEP1220-2

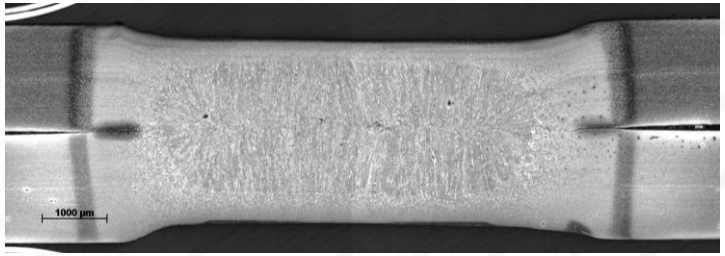
10% Above Imax
(Above Expulsion)

GI 980HF

GI DP980

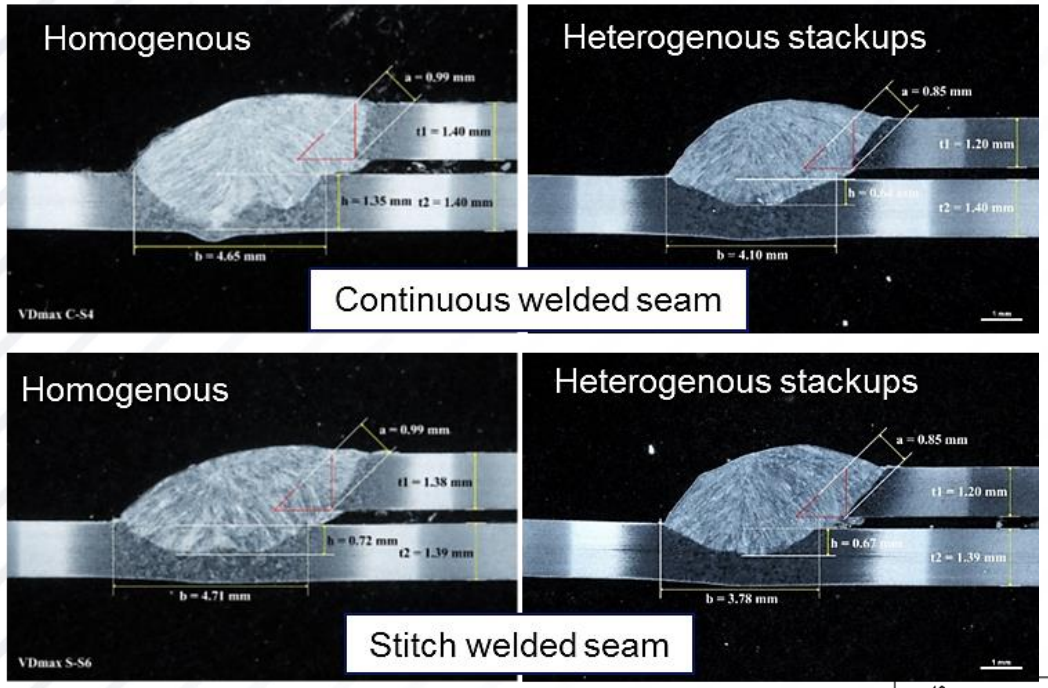






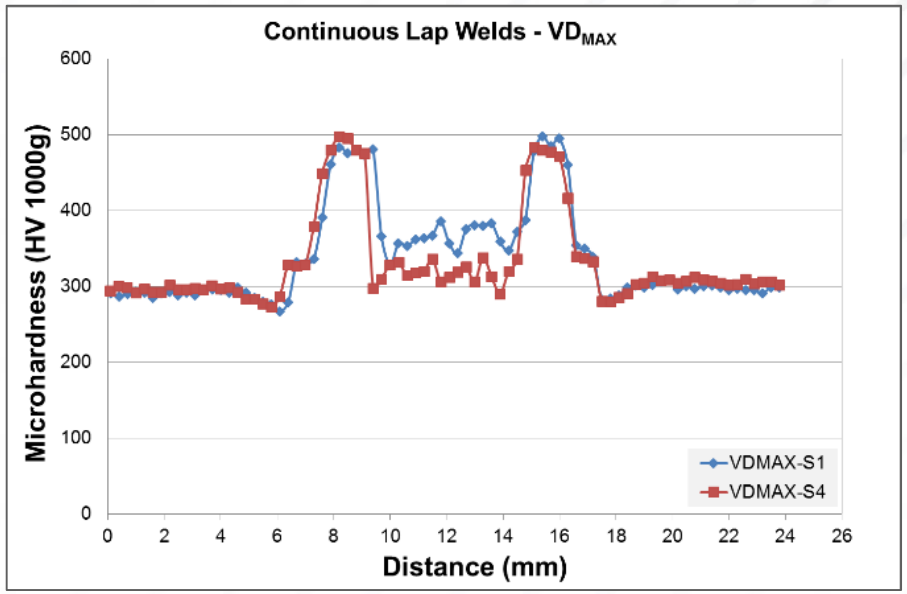
No surface cracking in high thickness heterogenous stackups with mild steel; even at Expulsion

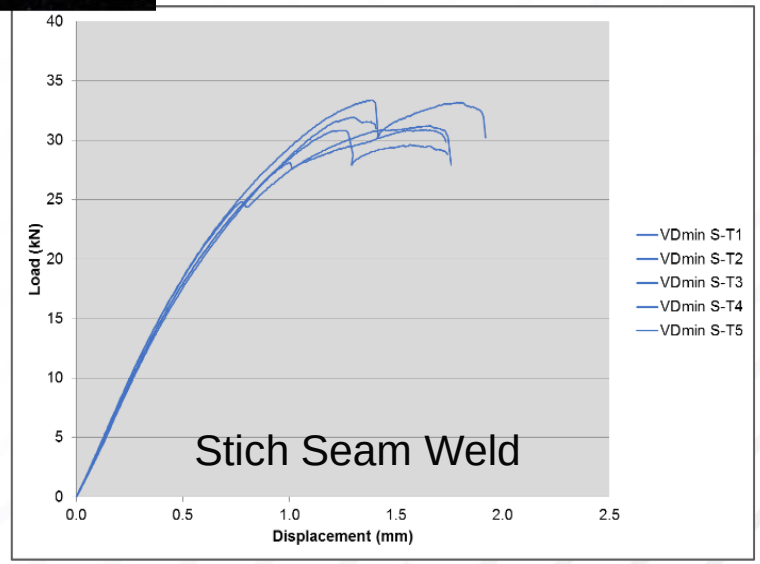
WELDABILITY
GAS METAL ARC WELDING (GMAW)

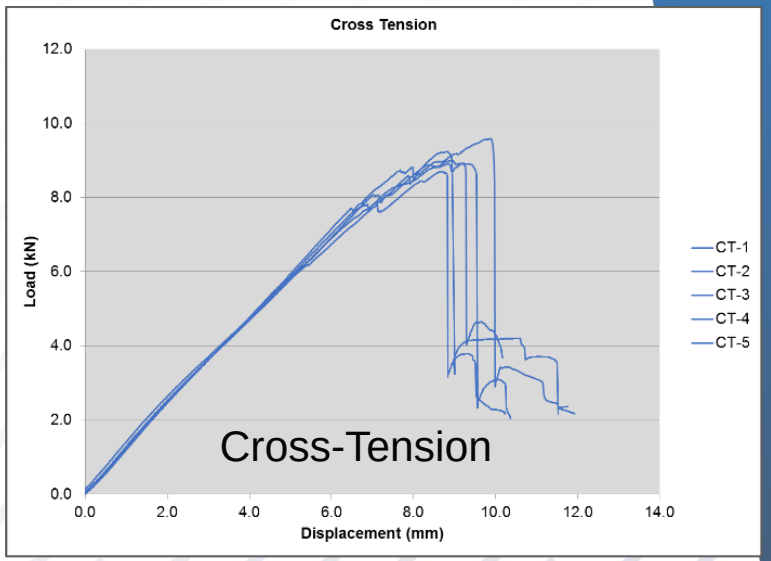


Cross-section Images at Maximum Penetration

Microhardness plots





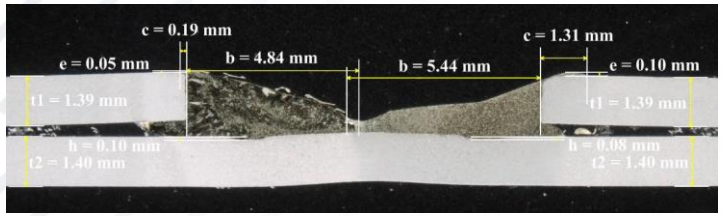


No Surface Cracks for all the different welded geometries studied

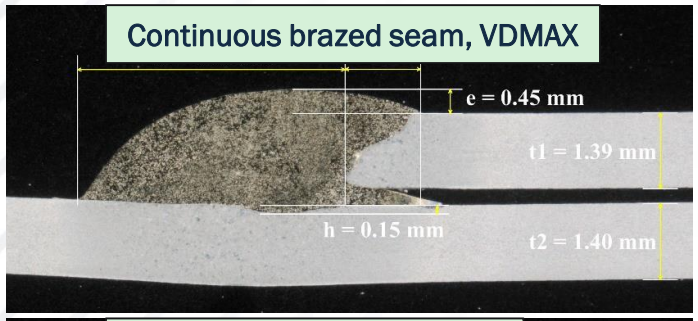
WELDABILITY
MIG BRAZING AND LASER WELDING

GDIS

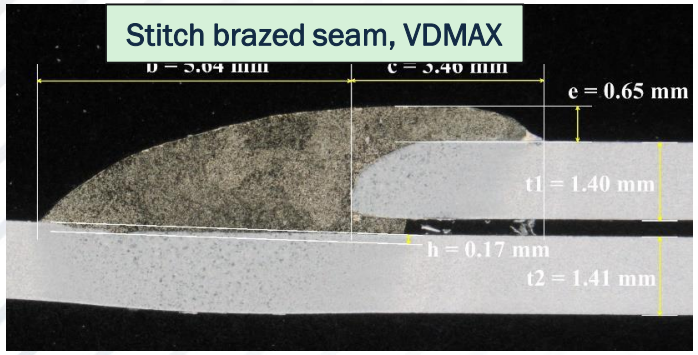
Stitch brazed cross tension, VD_{MIN}



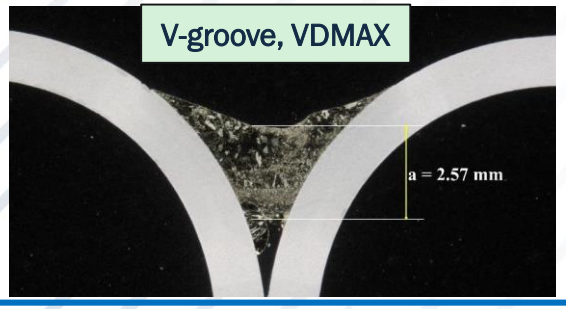
Continuous brazed seam, VDMAX



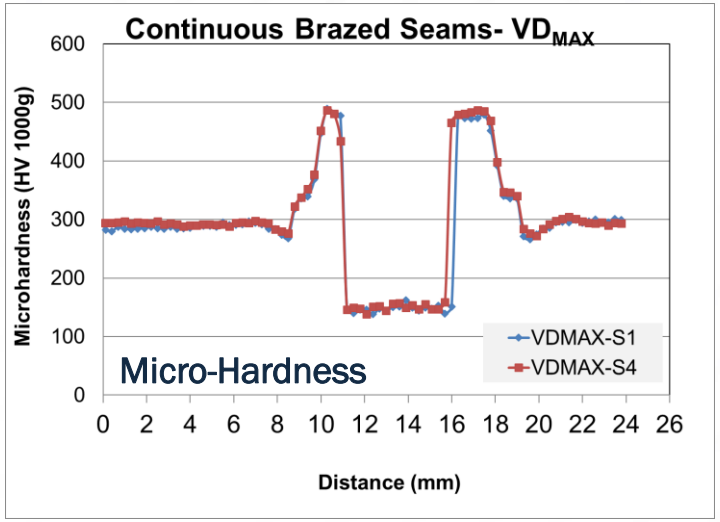
Stitch brazed seam, VDMAX



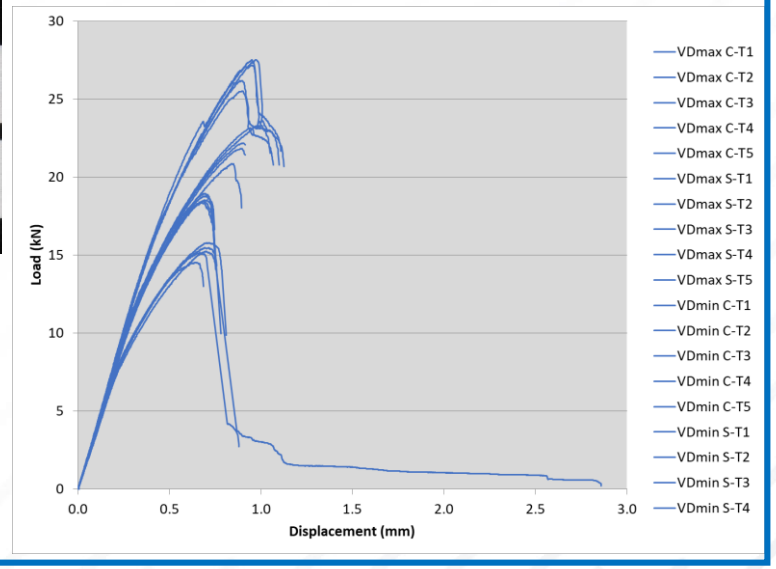
V-groove, VDMAX



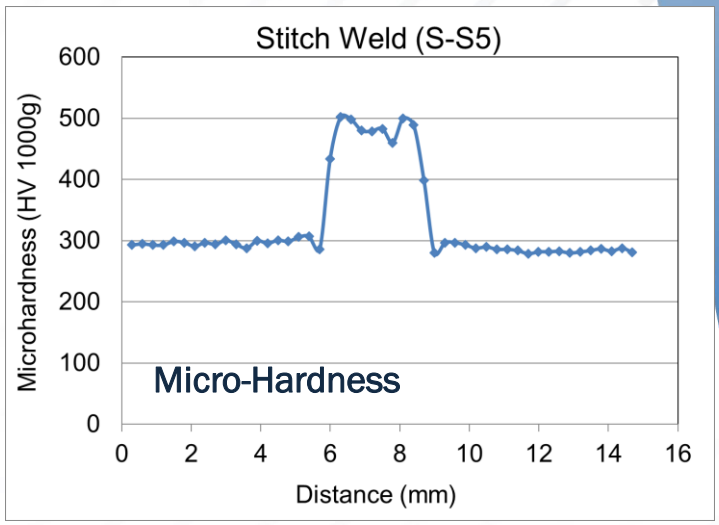
MIG Brazing



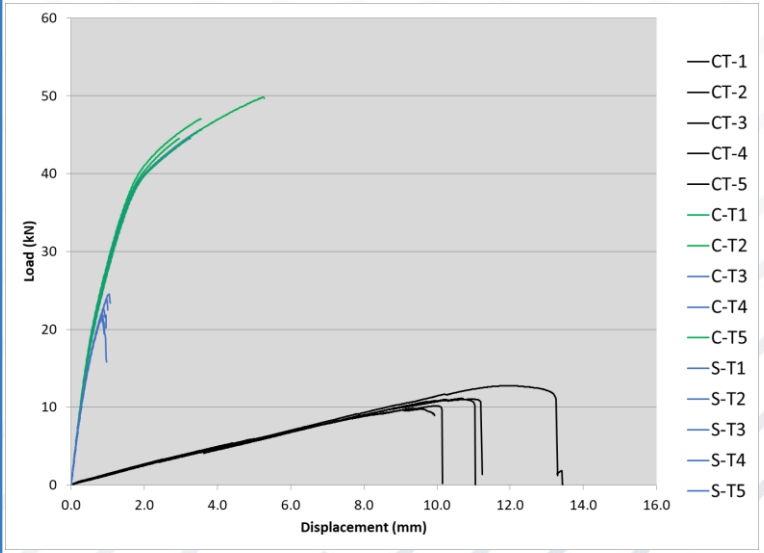
Load-Displ.; continuous, stich seam and CT



Laser Welding



Load-Displ.; continuous, stich seam and CT

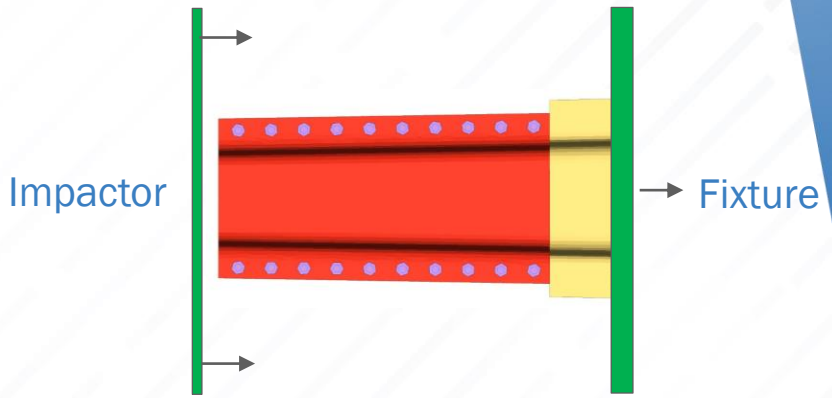


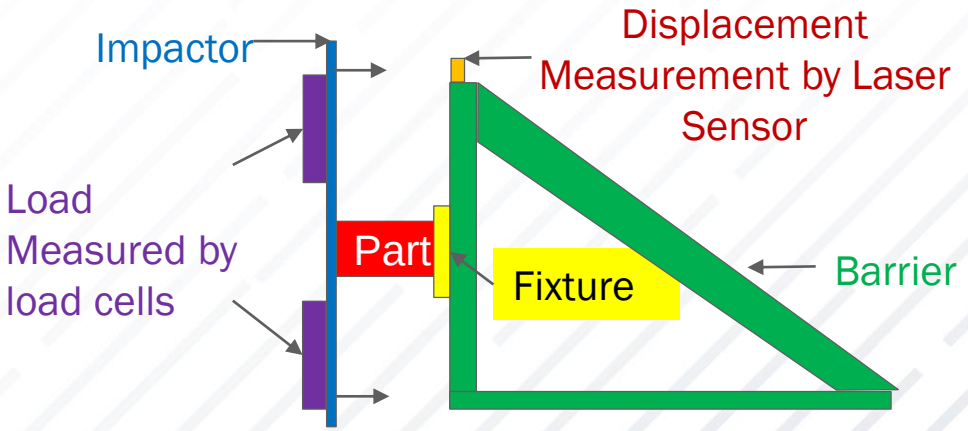
EVALUATION OF SPOT WELDABILITY
AXIAL CRUSH TEST

To assess the Resistance Spot Weld (RSW) performance in a dynamic event

- A double hat section was used to ensure spot welds are subjected to peel loading mode
- 3 gauges tested - 1.4mm , 1.6mm and 1.2mm
- Parts baked at 180° C for 27 mins
- Weld pitch - 25 mm & 20 mm
- Test Speed of 9.0 mph & a target energy of 15kJ

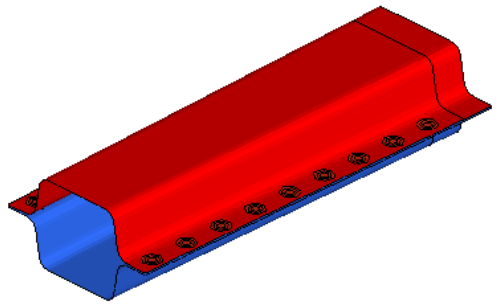
Welding Schedule	Welding – RE#452
	Welding Mode: MFDC
	Weld force: 5.5 KN
	Tip Face Diameter: 7 mm
	Welding Schedule(cycles): W/T-12, SQZ-70, H/T-10, Cool-2, Pulse-2
	Nugget Size: 6.2 mm
	Welding Current: 7.85 K.A.
	Weld pitch: 25 mm

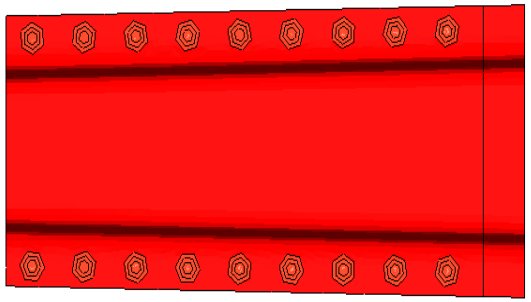


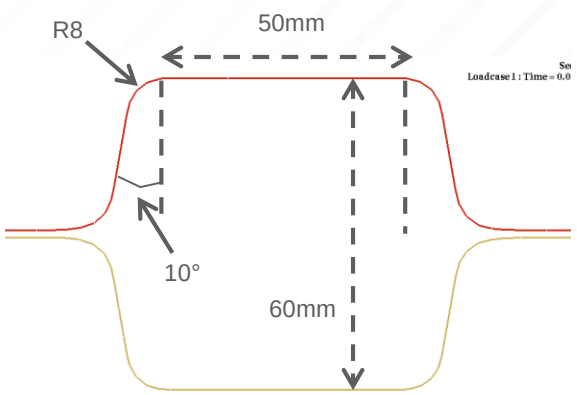


Test Setup

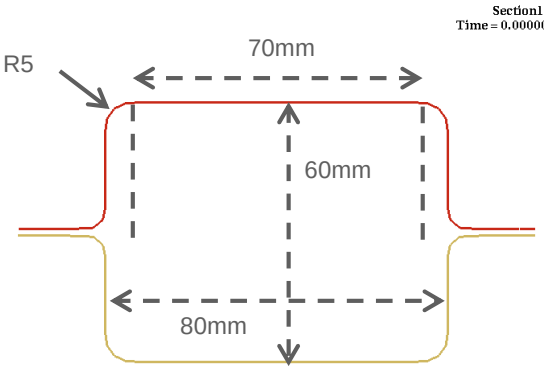
AXIAL CRUSH TEST GEOMETRY SELECTION



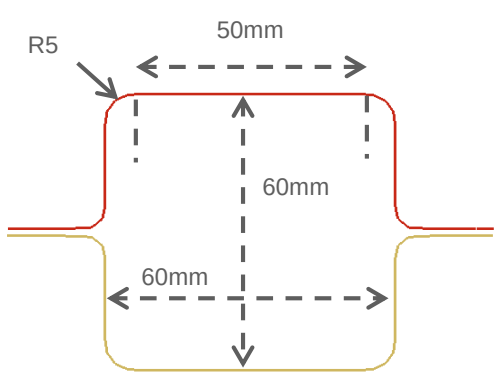




Geometry 1



Geometry 2



Geometry 3

Geometry 1 selected to ensure repeatability

AXIAL CRUSH TEST SUMMARY

Sample Thickness	Sample Configuration	Weld Nugget Size	Weld Pitch	Observations
1.4mm	Unbaked	6.2mm	25mm	• Exhibited mainly HAZ & base metal failure • Effect of baking is not significant
	Baked			
1.4mm *Effect of Weld Pitch vs Nugget Size*	Baked	5.0mm	20mm	• Crush performance of 20mm weld pitch with 5mm weld nugget size is GREATER THAN 25mm weld pitch, 6.2mm weld nugget size
1.6mm	Unbaked	6.7mm	25mm	• Exhibited mainly HAZ failure on the welds • Effect of baking is not very significant
	Baked			
1.2mm	Unbaked	5.3mm	25mm	• Effect of baking on lower gage (1.2mm thickness) is more pronounced on weld toughness • Unbaked samples showed failures - interfacial & HAZ
	Baked			

FORTIFORM® 980 GI 1.4MM SAMPLES

Un-Baked Sample
25mm Weld Pitch, 6.2mm Nugget Size

Baked Sample
25mm Weld Pitch, 6.2mm Nugget Size

Sample 1

Sample 2

Test provided repeatable crush pattern. Effect of Baking is not significant at 1.4mm thickness

FORTIFORM® 980 GI 1.4MM SAMPLES

Effect of Weld Pitch vs Nugget Size

GDIS

Baked Sample
25mm Weld Pitch, 6.2mm Nugget Size

Baked Sample
20mm Weld Pitch, 5.0mm Nugget Size

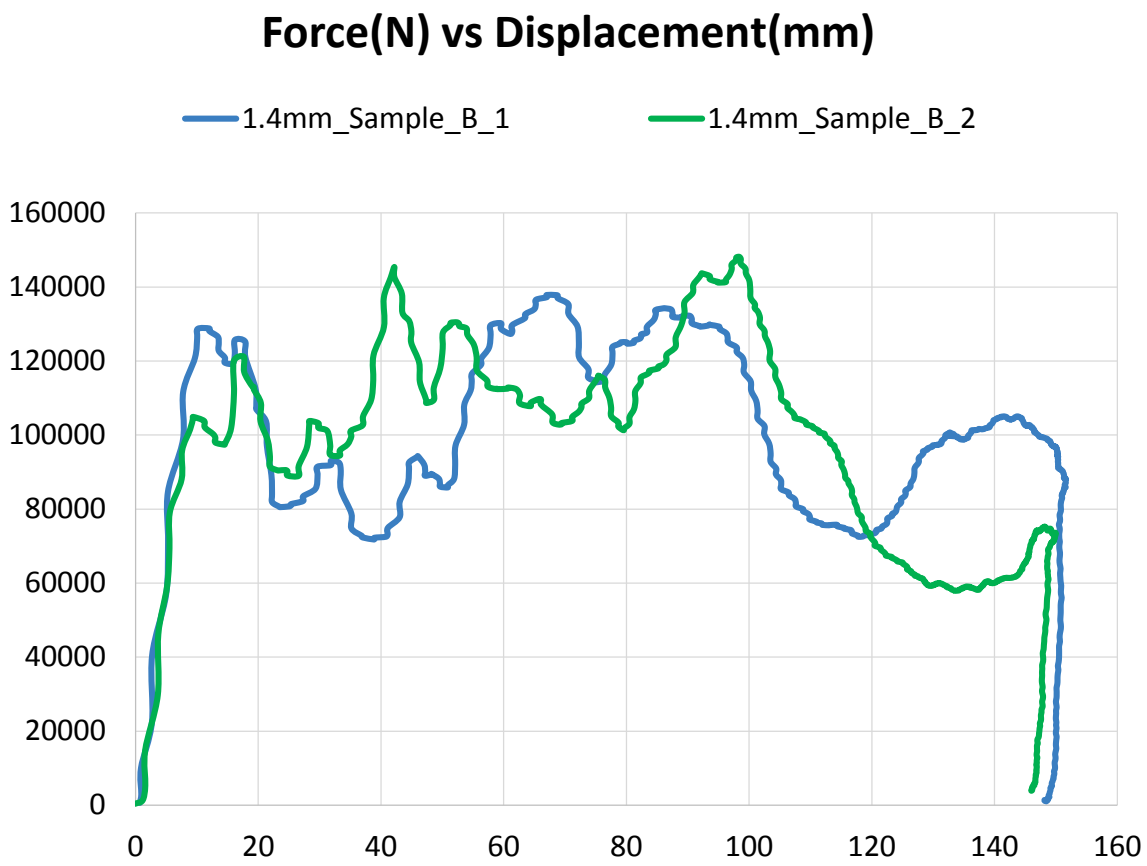
Sample 1

Sample 2

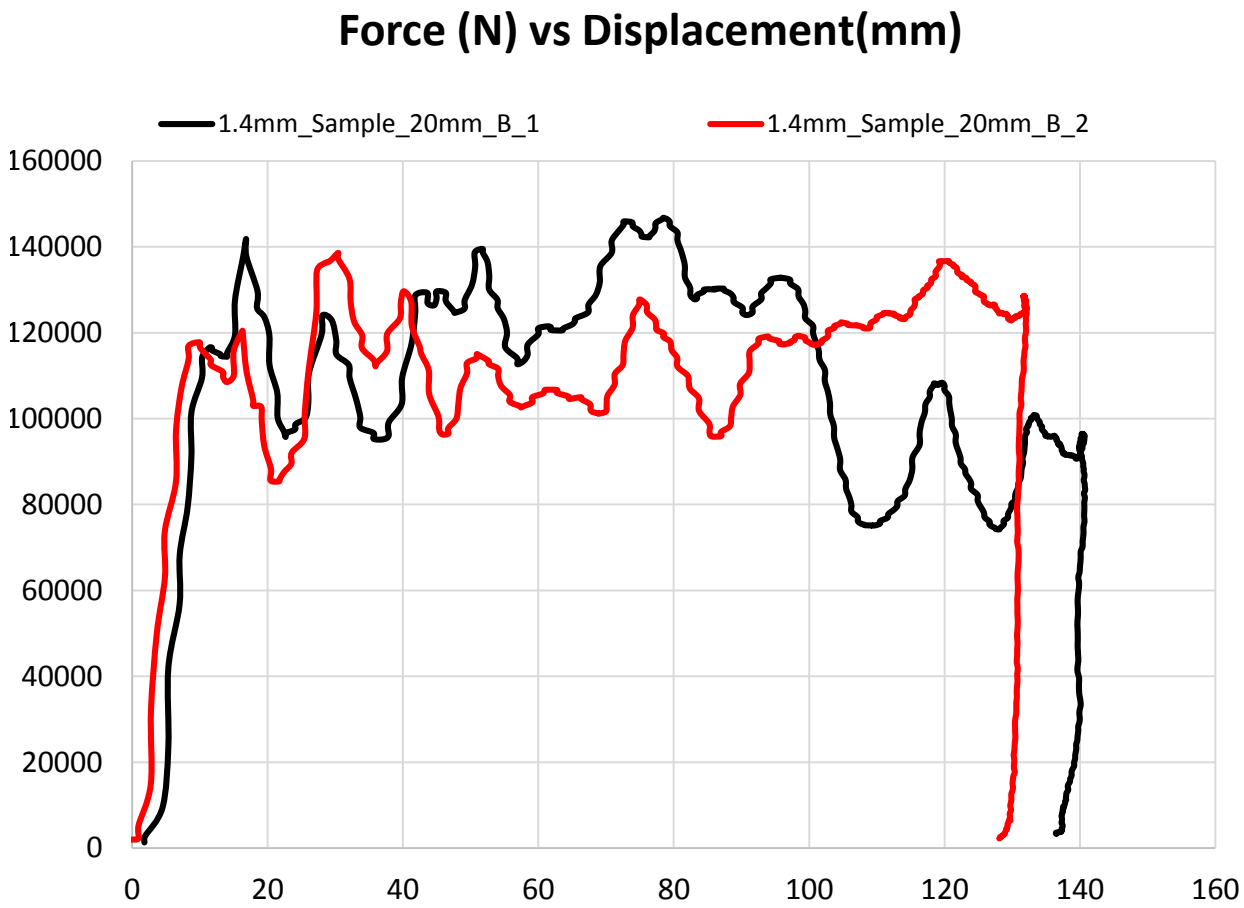
Effect of weld pitch is higher than the weld nugget size

FORTIFORM® 980 GI 1.4MM SAMPLES

Effect of Weld Pitch vs Nugget Size



25mm Weld Pitch samples



20mm Weld Pitch samples

Samples with 20mm pitch, even at a lower nugget size, maintain consistent average force

FORTIFORM® 980 GI 1.6MM SAMPLES

GDIS

Un-Baked Sample
25mm Weld Pitch, 6.7mm Nugget Size

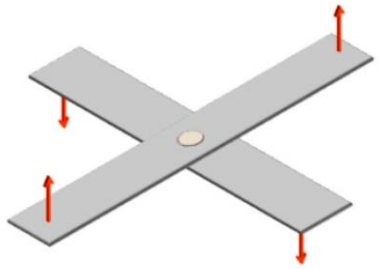
Baked Sample
25mm Weld Pitch, 6.7mm Nugget Size

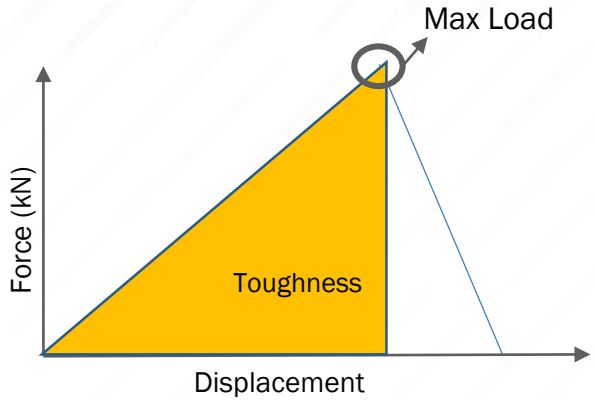
Sample 1

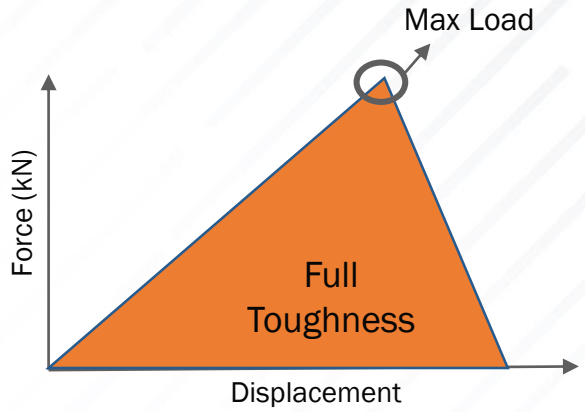
Sample 2

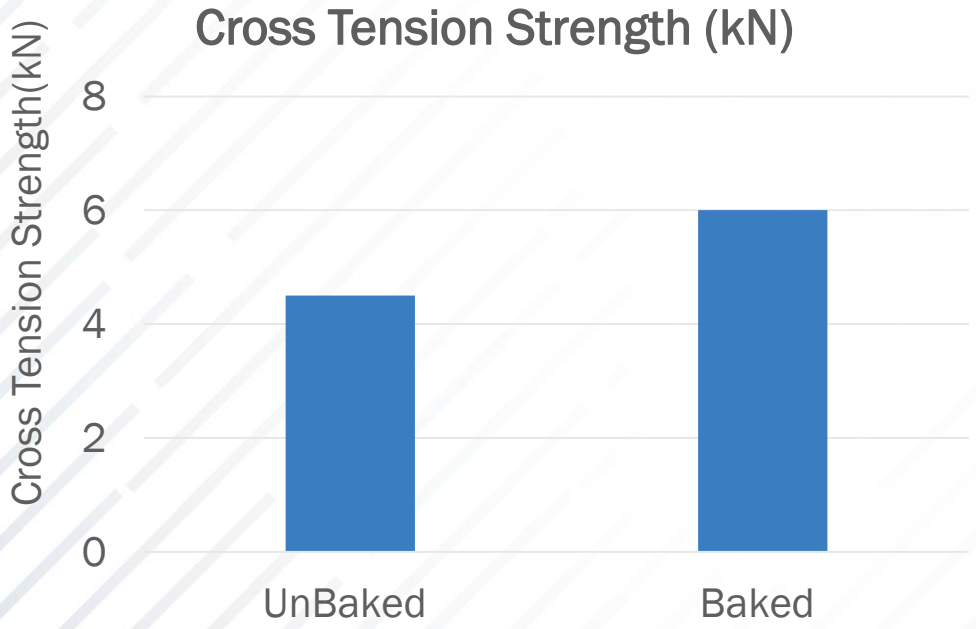
Repeatable crush pattern is observed. Effect of baking is not significant at 1.6mm thickness

FORTIFORM® 980 GI
WELD TOUGHNESS IMPROVEMENT – BAKING EFFECT

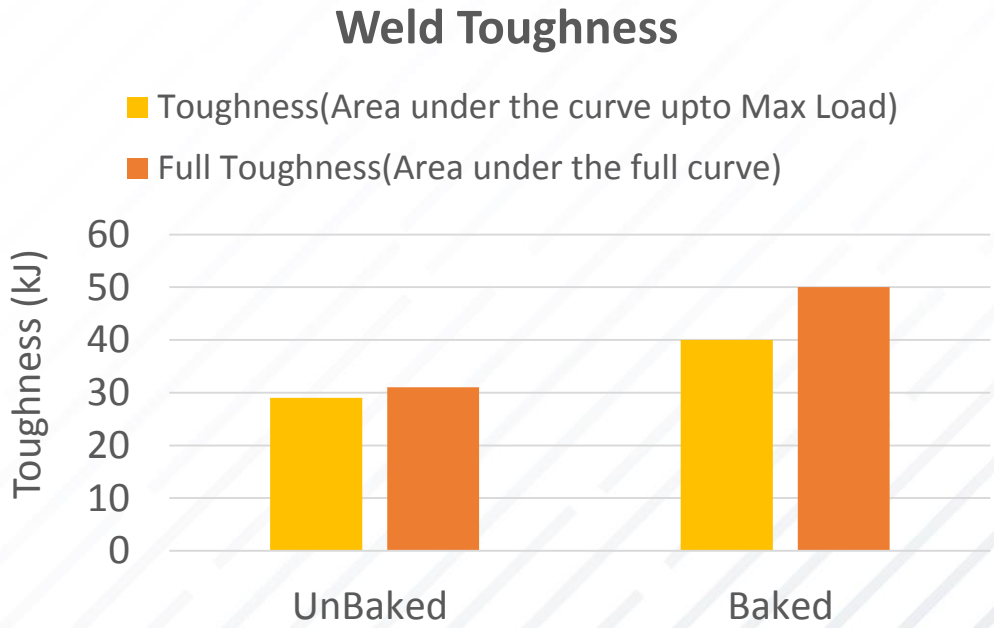








1.2mm Coupon



1.2mm Coupon

FORTIFORM® 980 GI 1.2MM SAMPLES

GDIS

Un-Baked Sample
25mm Weld Pitch, 5.3mm Nugget Size

Baked Sample
25mm Weld Pitch, 5.3mm Nugget Size

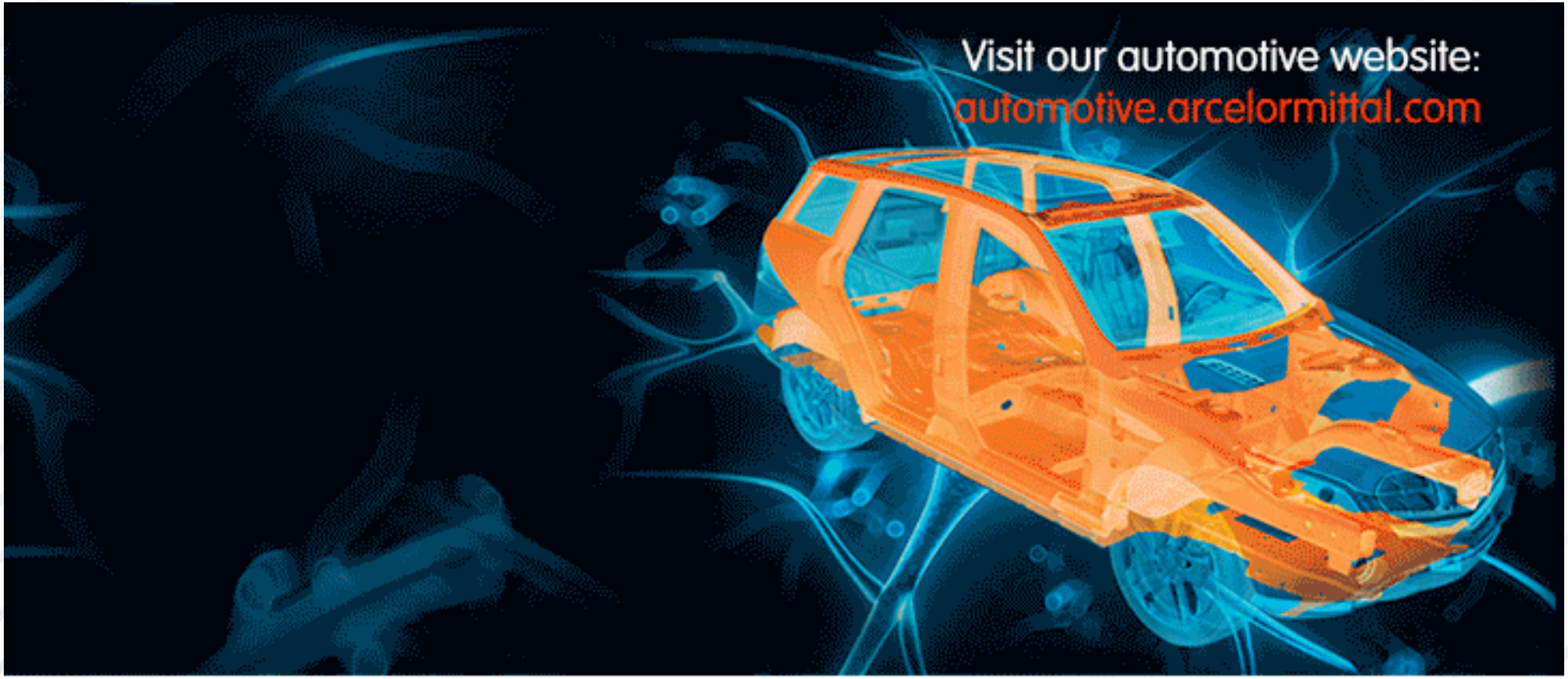
Sample 1

Sample 2

Repeatable crush pattern is observed. Effect of baking is significant at 1.2mm thickness

SUMMARY

- Over all Fortiform® 980 GI 3rd GEN product,
  - Combines excellent strength & formability and offers light weighting opportunities
  - Product can absorb energy during crash events and deform in a controlled manner similar to currently used steel grades
  - Exhibits superior weldability
  - Effect of baking on weld performance during crash is more pronounced at lower thickness
    - Gen3 samples should always be baked when testing samples
- Four different welding types of Resistance Spot-Welding (RSW), Laser Welding, MIG Brazing and Gas Metal Arc Welding (GMAW) have been examined with no signs of surface cracks in critical zones
- Important to note that Fortiform® 980 GI 3rd GEN is compatible with the current welding technology used in the industry

For More Information about ArcelorMittal Fortiform® grades:

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