

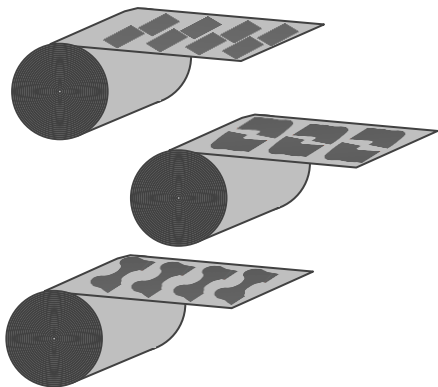
ArcelorMittal Tailored Blanks: Laser welded blank solutions for subframe chassis



What is a Laser Welded Blank ?

Step - 1

Blanking



Step - 2

Welding



Step - 3

Stamping



Part integrations



Mass optimization



CO2eq reduction

ArcelorMittal XCarb[®] offer

Sustainability at ArcelorMittal

Targets & ambition



ArcelorMittal
net zero 2050

2030
CO₂ ↓ Group - 25%
Europe - 35%



Decarbonisation
projects in EU
underway

5 levers for decarbonisation

2 technology pathways to
decarbonise steel making

Smart carbon route

- with circular carbon
- integration of CCU/S
- Carbalyst / Torero

DRI route

- green H₂
- 2025: DRI investments confirmed in SP, BE, FR

XCarb® towards carbon neutral steel

XCarb®
Green steel certificate

XCarb®
Recycled and renewably
produced

XCarb®
Innovation fund

Benchmark & Standards



First steel plants
in the world to obtain
certification!



Benchmark for our
suppliers

The Net-Zero Steel Pathway
Methodology Project



Support sector initiatives

wbcscd Automotive Carbon
Transparency initiative.

XCarb® brings together all of ArcelorMittal's reduced CO₂ solutions into a single effort focused on achieving demonstrable progress towards carbon neutral steel

Partnering with ArcelorMittal,
Customers can **ACTNOW** on
the footprint of the supply chain!

XCarb®

Green steel certificate

2020: Launch of XCarb® green steel certificates

- For steel made in BF route
- mass balancing of CO₂ savings
- CO₂ savings from new and audited projects which are reducing the CO₂ emissions from fossil fuels.
- **Available in all products and grades**

XCarb®

Recycled and renewably
produced

2022: Launch of XCarb® recycled and renewably produced

- **Physical low CO₂ footprint** steel made in electric arc furnace
- Using 100% renewable energy
- High recycled content
- **Product offer:**
 - HRP&O: FB & HSLA
 - Usibor®1500+AS
- Product offer expanding

XCarb®

Brand to be
developed

From 2025: New XCarb® products to be launched

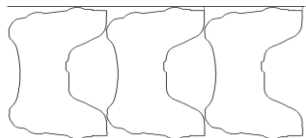
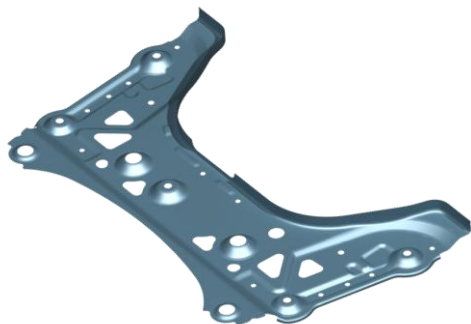
- **Physical** decarbonised steel
- Based on DRI technology (Direct Reduced Iron)
- **Available in all products and grades**

More low-carbon emissions XCarb® solutions will be launched as new decarbonisation technologies are deployed

Short Front Subframe Chassis

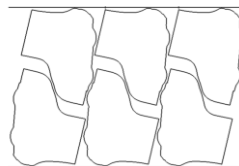
LWB applications for Short Subframe design: main solutions

Reference
FB580– 2,3mm



Nesting optimization

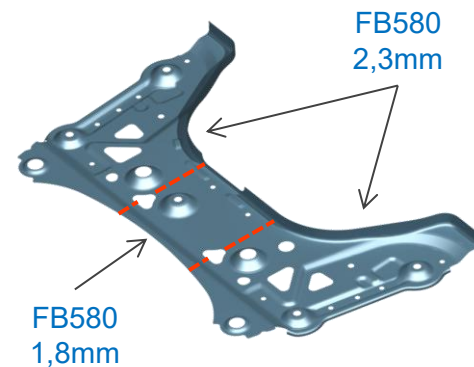
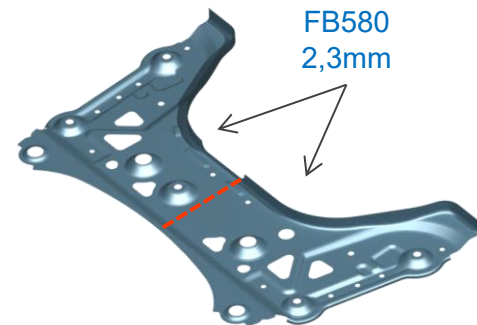
LWB 1 weld



Performance & Thickness optimization

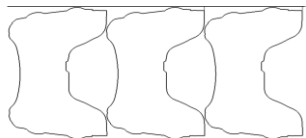
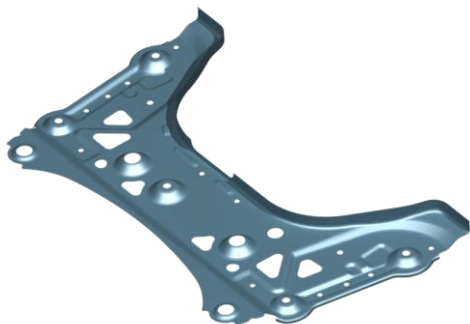
LWB 2 Welds

Performances to be validated case by case



LWB applications for Short Subframe design: material savings

Reference
FB580– 2,3mm



Engaged material: -18%



Mass saving: 0%



Cost saving: -5%



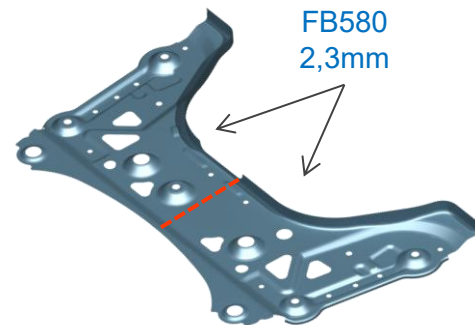
Engaged material: -20%



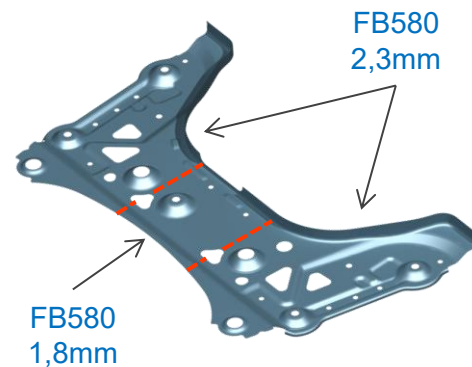
Mass saving: -4%



Cost saving: +5%



FB580
2,3mm

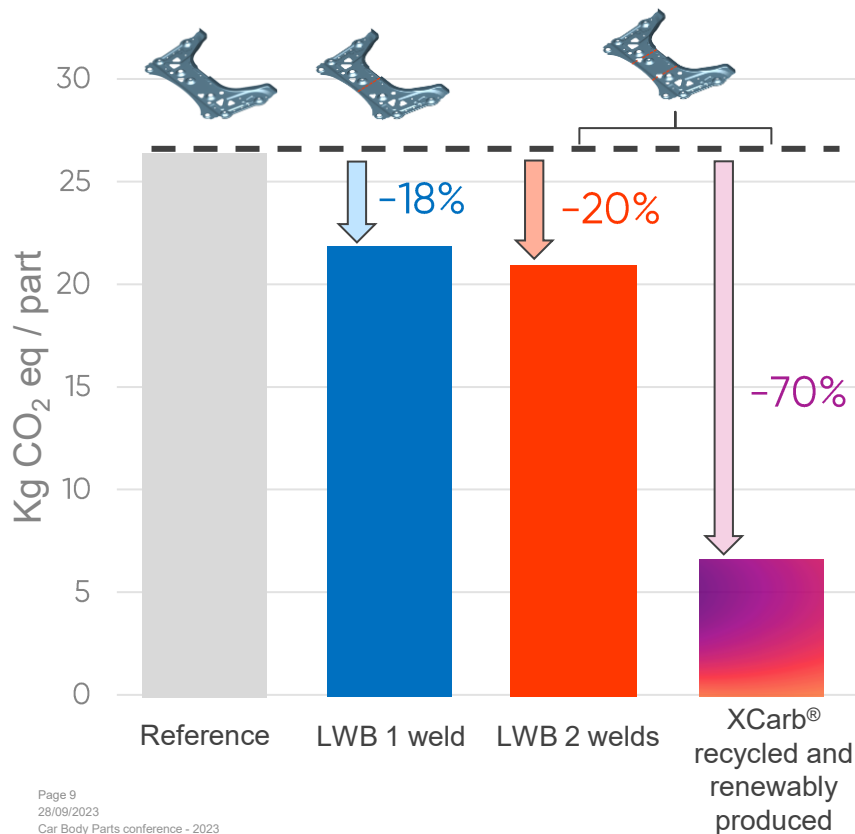


FB580
2,3mm

FB580
1,8mm

LWB applications for Short Subframe design: CO₂eq

LCA – Without Scrap credit
Component manufacturing

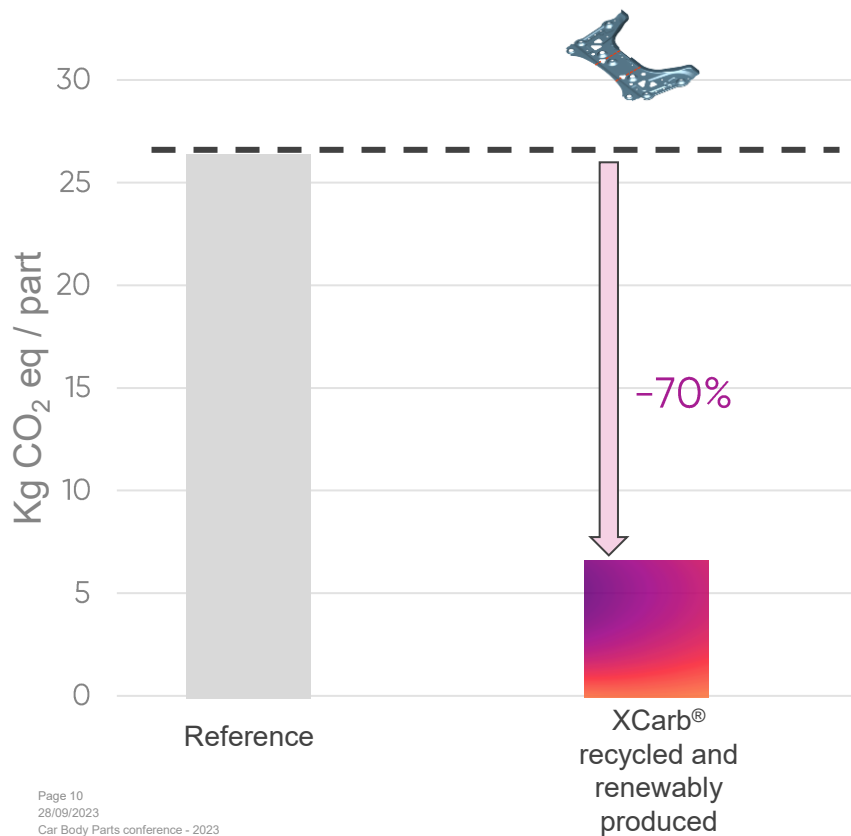


Hypothesis:

- **Manufacturing context:** EU-28
- **Metal production:**
 - Data from World Steel Association and European Aluminum Association
 - Representative of **current** European market
- **LCA cut off methodology :**
 - Internal model used for calculation with databases from Gabi and Literature
 - LCA calculation in line with ISO 14040/44:2006 principles and SPE-14040-14 LCA guidelines for auto parts
- Impact of laser welding not considered, the impact is very limited compared to the material production and part manufacturing
- In this case, the difference of CO₂eq for the use phase is very limited compared to the difference for material production

LWB applications for Short Subframe design: CO₂eq

LCA – Without Scrap credit
Component manufacturing



Hypothesis:

- **Manufacturing context:** EU-28
- **Metal production:**
 - Data from World Steel Association and European Aluminum Association
 - Representative of **current** European market
- **LCA cut off methodology :**
 - Internal model used for calculation with databases from Gabi and Literature
 - LCA calculation in line with ISO 14040/44:2006 principles and SPE-14040-14 LCA guidelines for auto parts
- Impact of laser welding not considered, the impact is very limited compared to the material production and part manufacturing
- In this case, the difference of CO₂eq for the use phase is very limited compared to the difference for material production

Long Front Subframe Chassis

New challenges for front axle subframes in BEVs

Ford Mustang MACH – E IABC Frankfurt 2021 / Jamil Alawan

ICE vehicle

Boundary Conditions Allowed:

- Sub-frame Detachment
- Backup structure controlled Intrusion

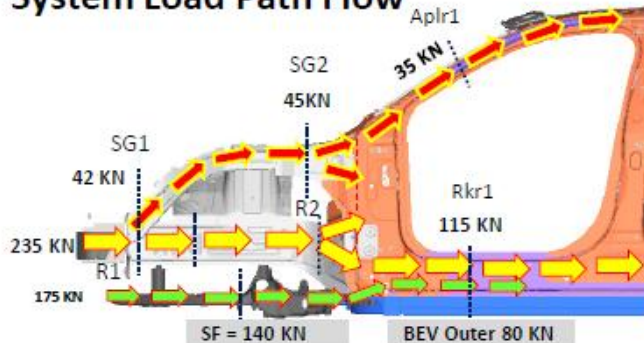


New BEV Battery Boundary Conditions dictated the following Strategy

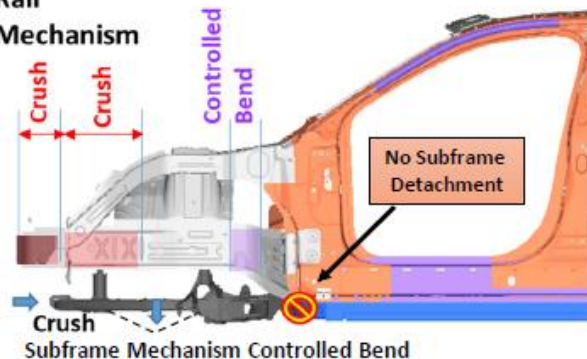
- Sub-frame Non-Detachment
- Minimize Backup structure intrusion above Battery Boundary

BEV vehicle

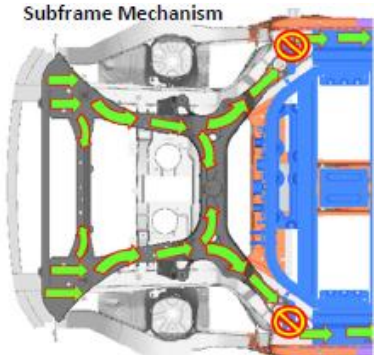
System Load Path Flow



Rail Mechanism



Subframe Mechanism



→ Lower load path: 38%

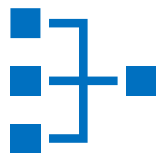
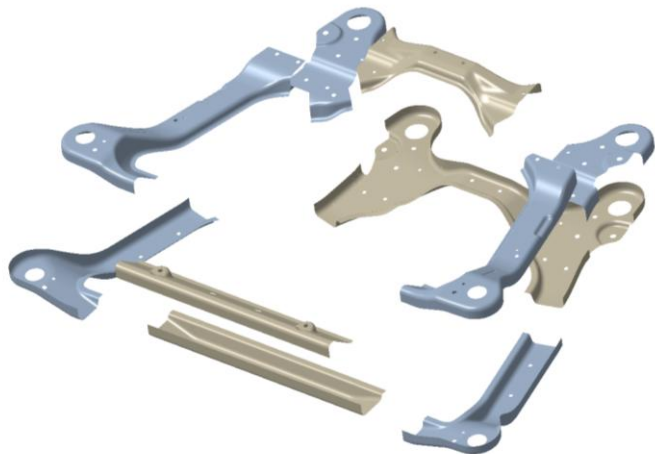
→ Mid Load Path: 52%

→ Upper Load Path: 10%

Designs of subframes would have to support and transfer loads in frontal crash taking into account the battery protection.

ArcelorMittal Multipart Integration® for chassis applications

From **10** cold stamped parts...



...to **2** cold stamped LWB!



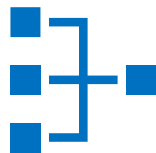
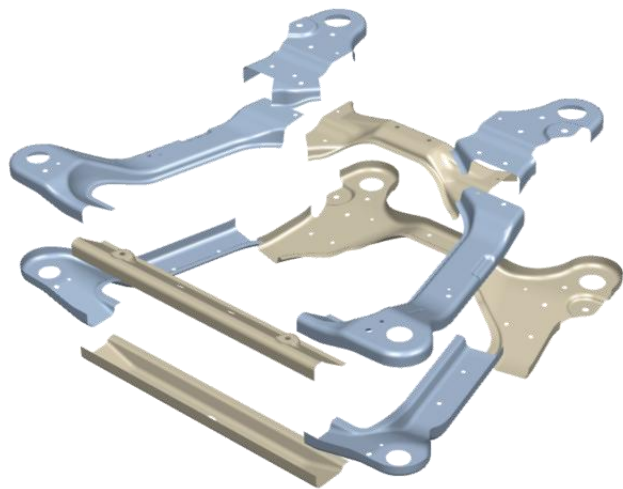
Integration

Simplification

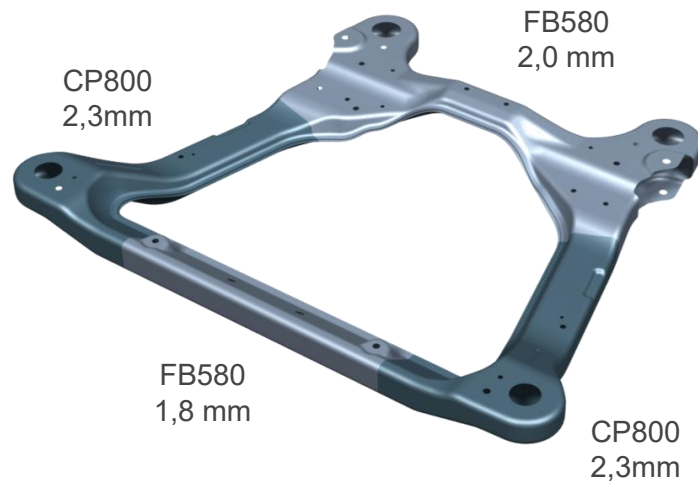
Iso – function

ArcelorMittal Multipart Integration® for chassis applications

From **10** cold stamped parts...



...to **2** cold stamped LWB!



Integration

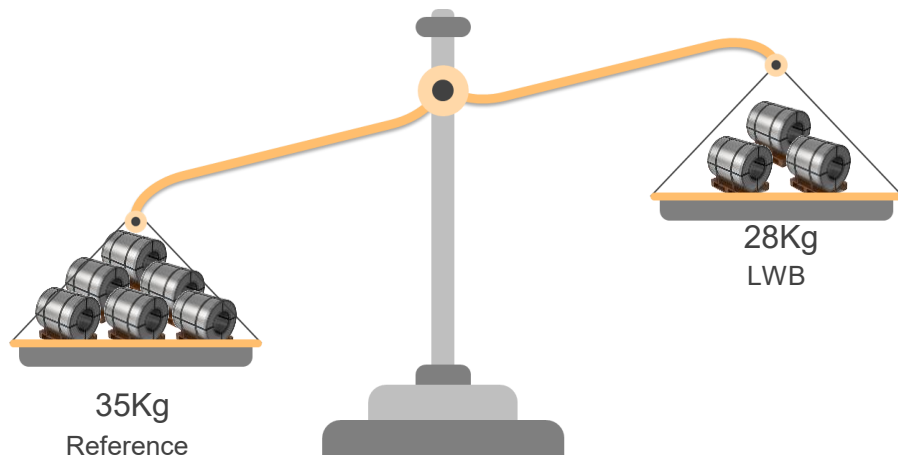
Simplification

Iso – function

Mass optimization thanks to LWB and ArcelorMittal steel portfolio

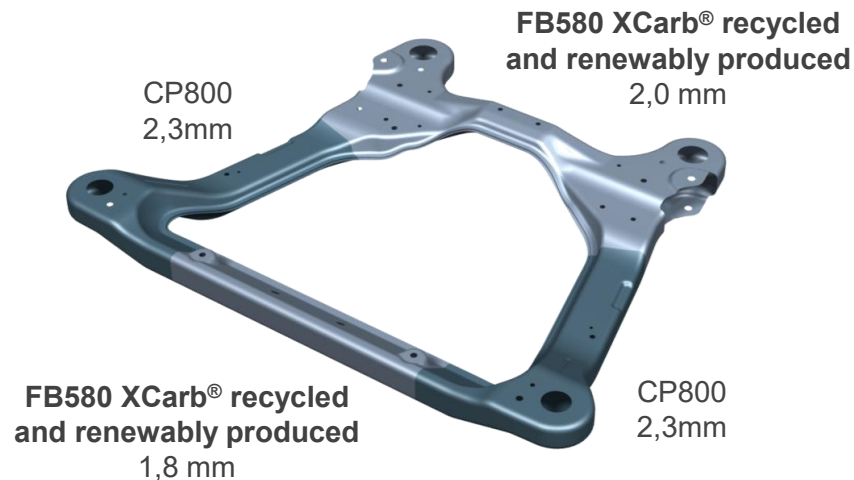
Mass of material supplied
-7Kg / Veh (-21%)

Net part mass
-1,6Kg / Veh (-10%)



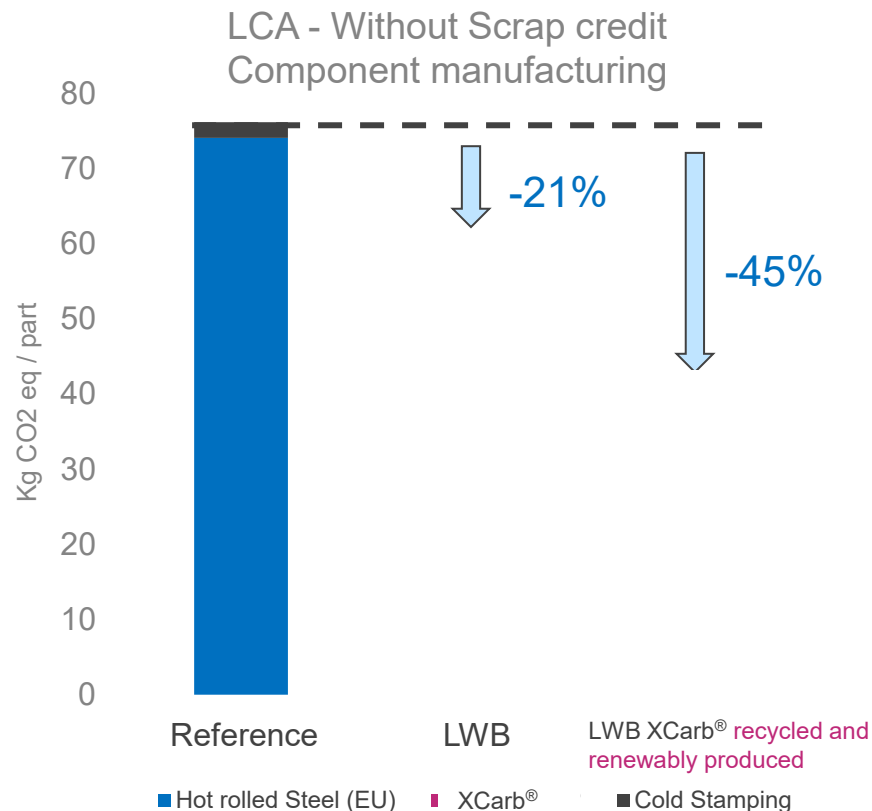
- Thickness reduction
- From Progressive forming to 2 shape blanks
- No overlapping parts connection

ArcelorMittal XCarb® offer enables to reach low CO2eq for Subframe applications



Thanks to Laser Welded Blanks design and use of XCarb® recycled and renewably produced, the level of CO₂ eq could be reduced about 45%.

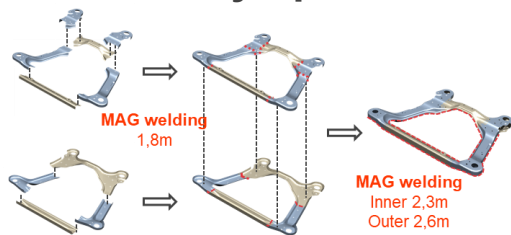
**Hypothesis similar to the previous LCA analysis (slide 13)*



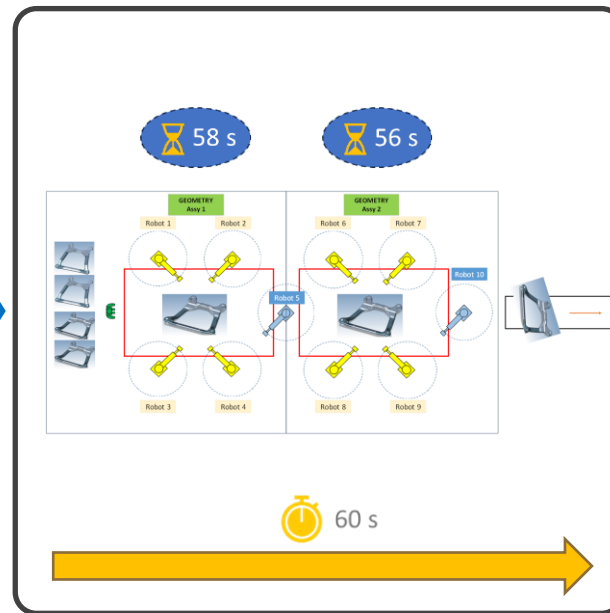
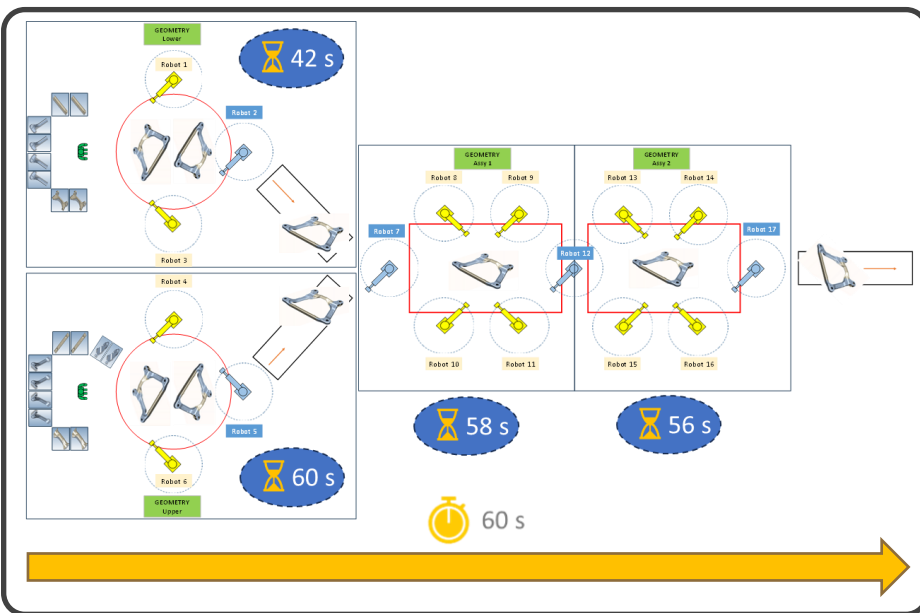
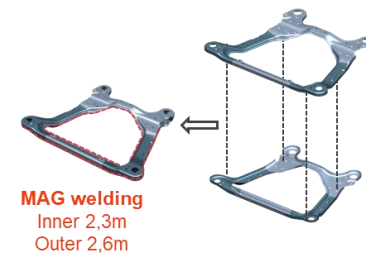
Less MAG assembly operations Thanks to LWB



Reference



LWB solution



Assembly investment

-50%

Assembly cost

-48%

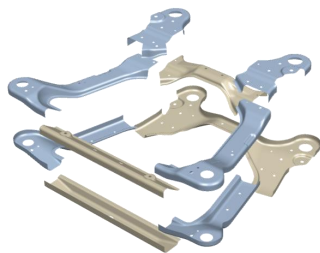
Surface

-50%

Hybrid welding process

Welding technology landscape

Multipart design

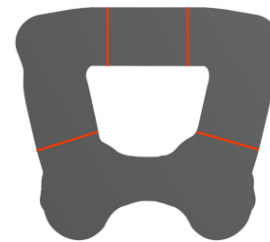


GWAM overlap



Vs.

Tailored Blanks



GWAM butt to butt

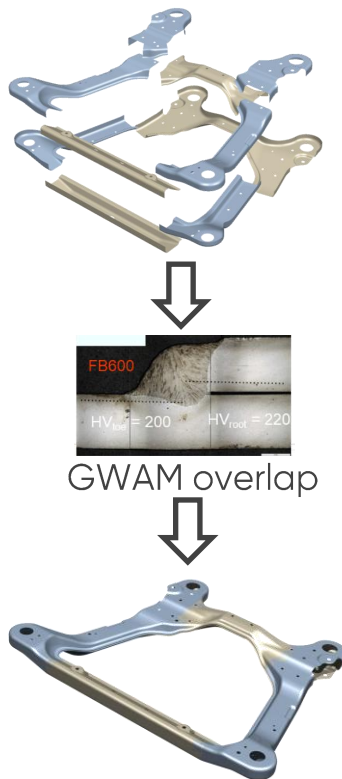


AMTB Process



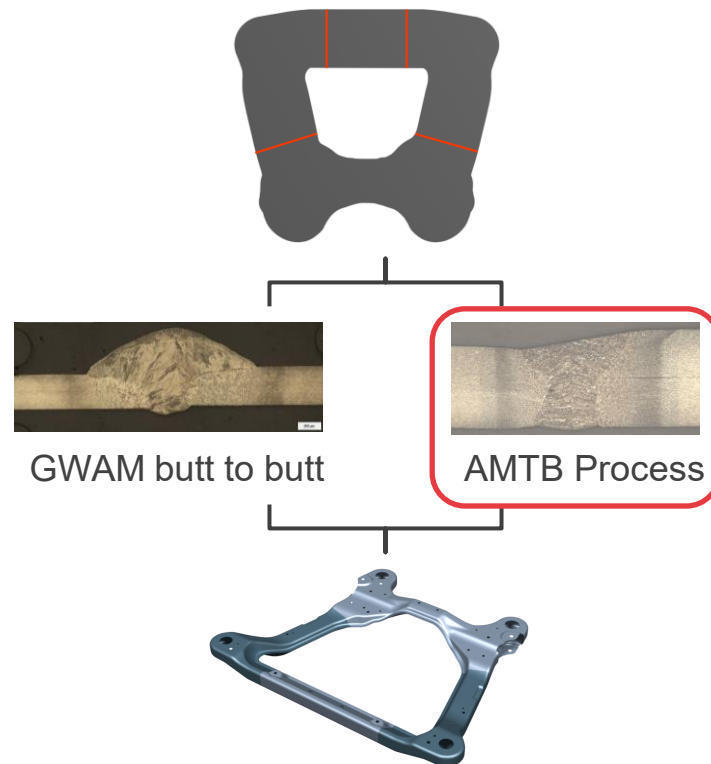
Welding technology landscape

Multipart design

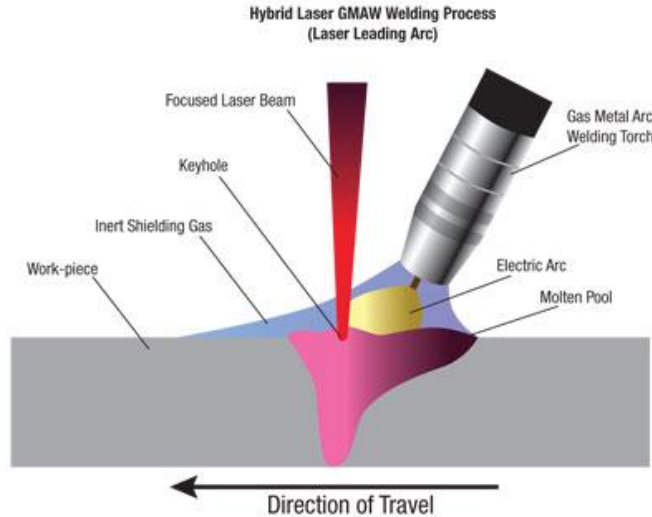


Vs.

Tailored Blanks



New hybrid welding process for LWB applications, dedicated for chassis applications.



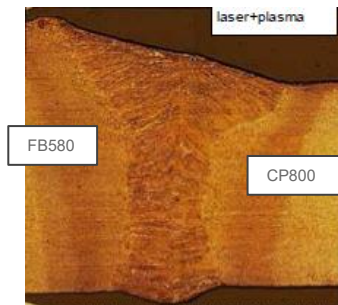
The Hybrid process enable to combine advantages of both technologies:

Laser → allows a better penetration and a fastest speed

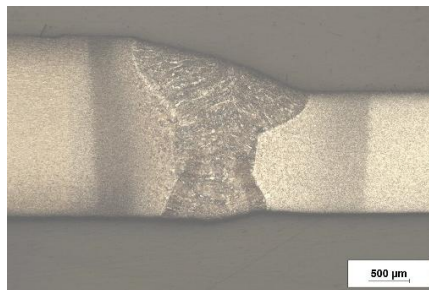
Plasma Arc welding → low undercuts, wide weld, lower positioning accuracy, better homogeneity of the molten pool

Several LWB configurations have been tested

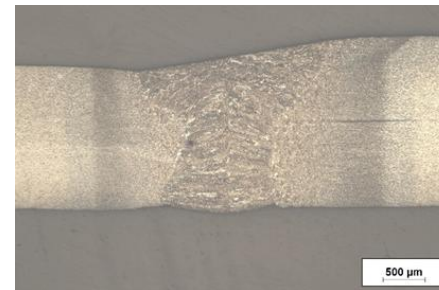
The AMTB welding process leads to very good fatigue performances due to a soft geometry of the weld in each combinations of thickness tested.



HR440Y580T-FB 4mm (FB580) /
HR660Y760T-CP 3mm(HR-CP800SF)



HR660Y760T-CP 2,2mm (HR-CP800SF) /
CR340LA 1,5mm



HR440Y580T-FB 2mm (FB580) /
HR440Y580T-FB 1,8mm (FB580)

HR-CP800SF	YS	> 660 Mpa	Ultra high yield Good cut edges properties Excellent fatigue properties Good hole flanging capacity
	UTS	> 760 Mpa	
	A%	> 13%	
FB580	YS	> 440 Mpa	Very high yield Good cut edges properties Excellent fatigue properties Good compromise strength/ductility
	UTS	> 580 Mpa	
	A%	> 17%	

ArcelorMittal products dedicated for
chassis applications

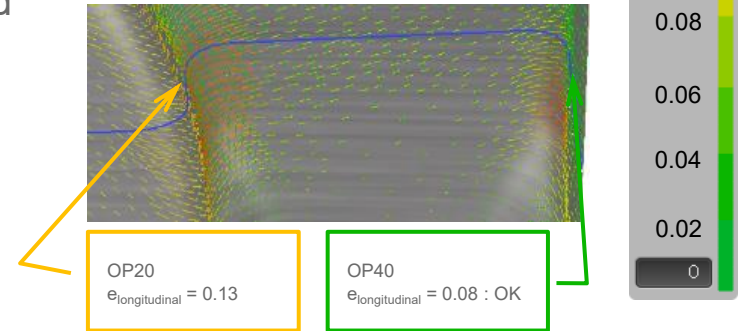
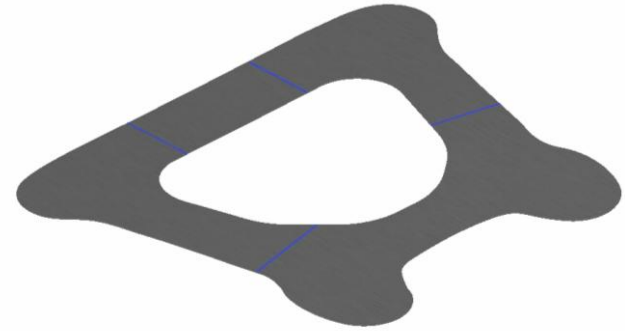
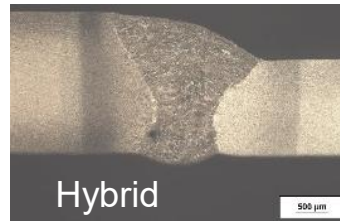
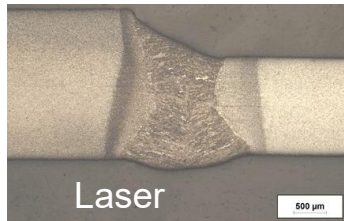
Forming analysis – dedicated methodology

Numerical methodology regarding weld formability:

- Step modeled
- Fine mesh apply around the weld
- Check of the strain concentration around the weld
- Blank / design optimized to reduce strain distribution

This methodology is pessimistic compared to reality

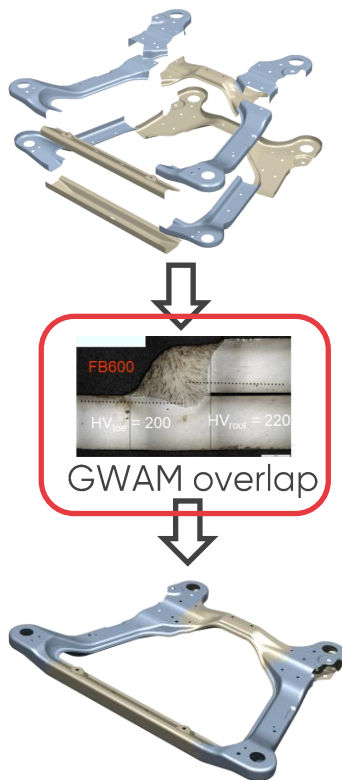
- Hybrid weld geometry smoother than standard Laser weld
→ more suitable for fatigue performance



Example of simulation results

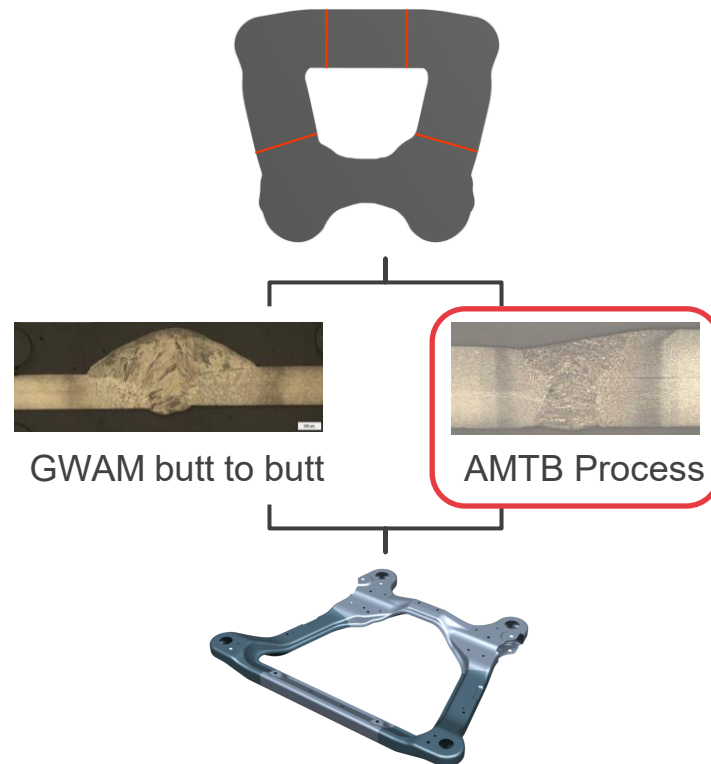
Welding technology landscape

Multipart design



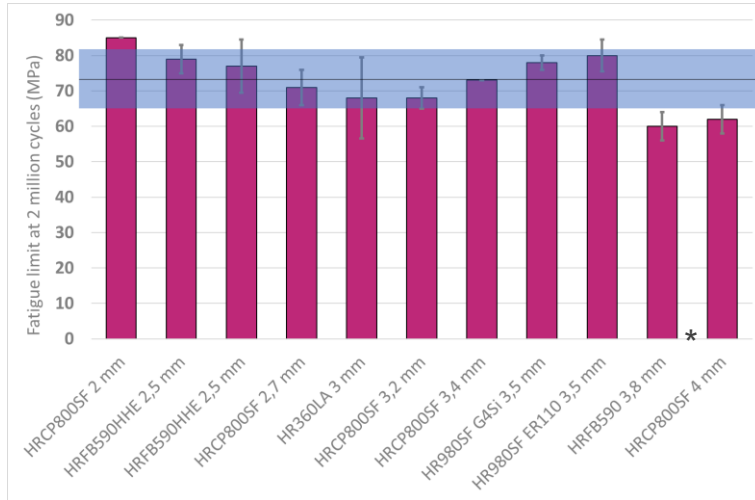
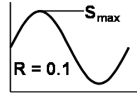
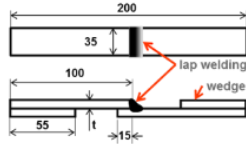
Vs.

Tailored Blanks



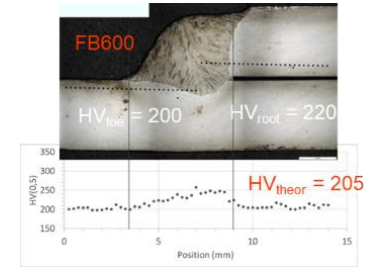
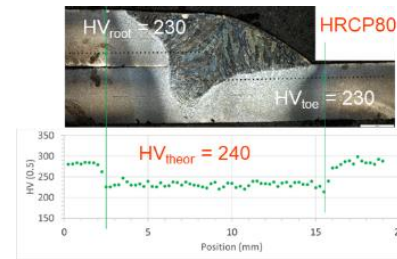
State-of-the art on fatigue of GMAW assemblies: Overlap

- At similar thickness, **the fatigue strength at 2 million cycles obtained from welded specimens is almost the same whatever the grade** (mean value of about 75 MPa):

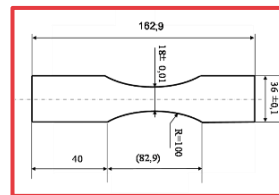
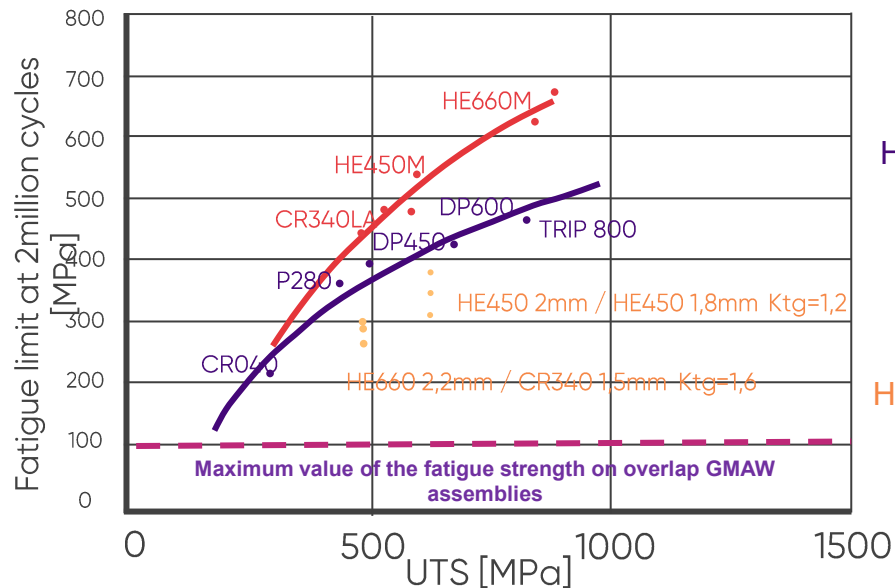


* Decrease for thicknesses > 3.5 mm is due to higher stress concentration factor at the weld toe

- HRCP800SF and HRCP980SF are at the same level than conventional HSLA or FB grades
- Use of G4Si wire for most of the cases
- The geometry of the weld is mainly driving the fatigue behavior



Impact of the welding process geometry on the fatigue performances



Base material

Fatigue performances only influence by the steel grade & thickness

Homogenous butt to butt hybrid assembly



Heterogenous butt to butt hybrid assembly



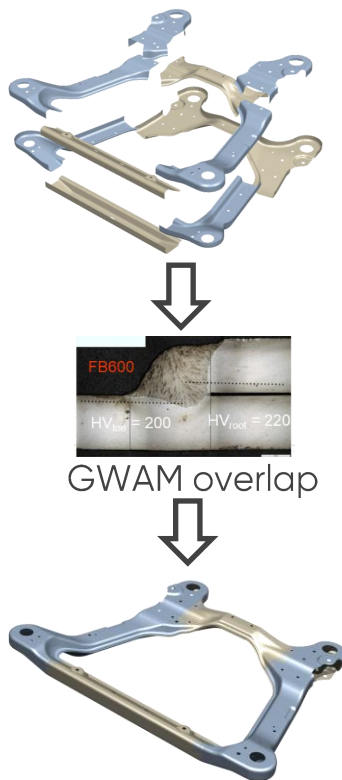
Thanks to process parameters used, the smooth weld geometry enables to improve the fatigue performances compared to Overlap GMAW process

Overlap GMAW Ktg ~ 4

GMAW assemblies' fatigues performances do not exceed 100MPa

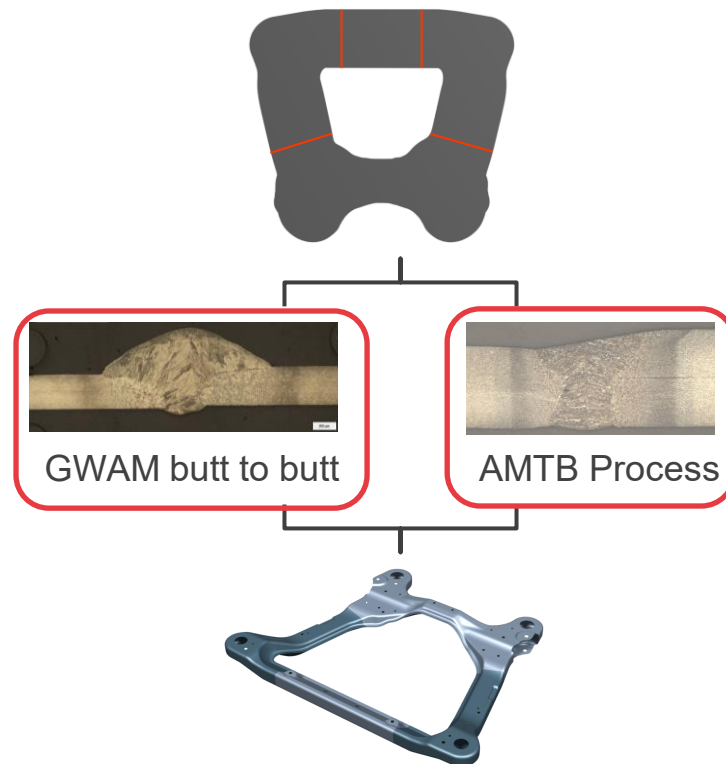
Welding technology landscape

Multipart design



Vs.

Tailored Blanks



New hybrid welding process for LWB applications, dedicated for chassis applications.

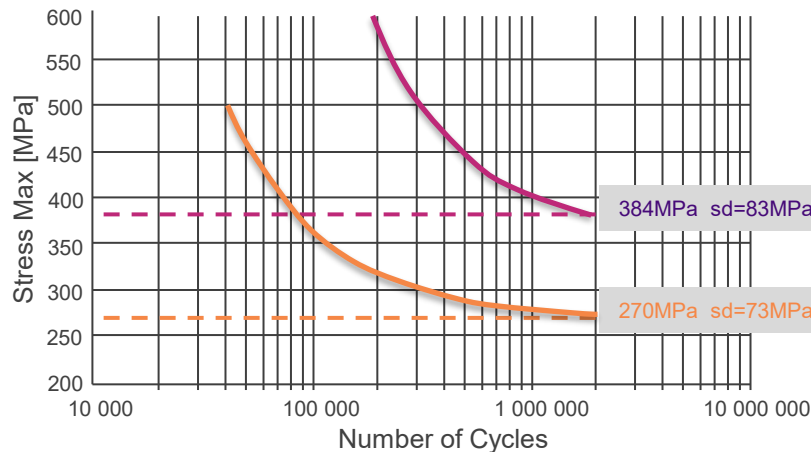
Fatigue results



FB 580 – 2,0mm / FB 580 – 1,8mm
MAG



FB 580 – 2,0mm / FB 580 – 1,8mm
AMTB Process



Process used under serial production

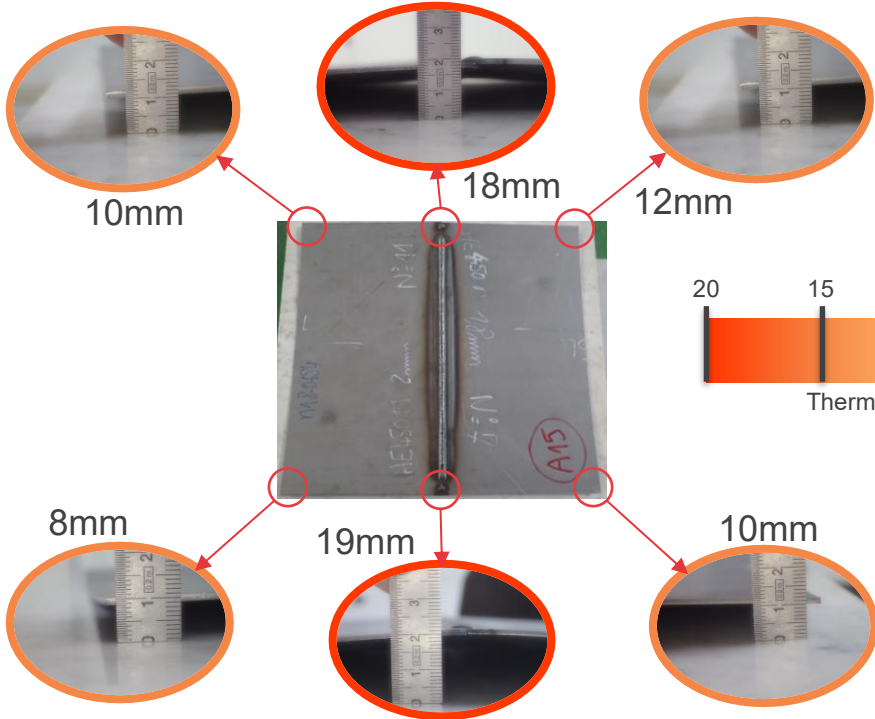
- ✓ For thick chassis part, hybrid welding offer a weld with a fatigue resistance like plasma.
- ✓ Less sensitive to edge quality and gap than single laser process.
- ✓ Fatigue performances of the weld
- ✓ Geometry of the weld compared to ARC welding , positively impact on stamping process
- ✓ Geometry of the blanks after stamping (low energy, less deformation on parts)

Plasma + laser is the most robust process technology for chassis application in term of fatigue of the welds.

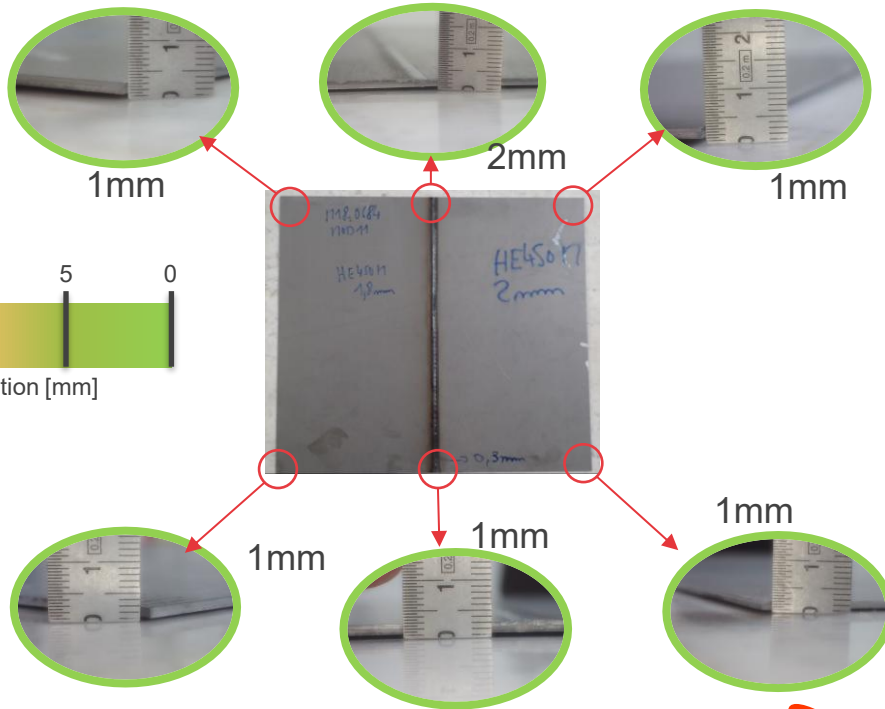
The welding process developed by ArcelorMittal enables to reach good fatigue performances.

Geometrical deformation

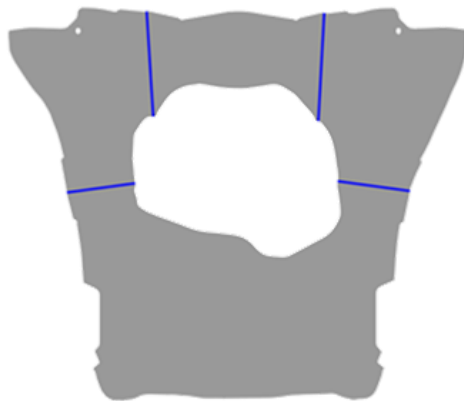
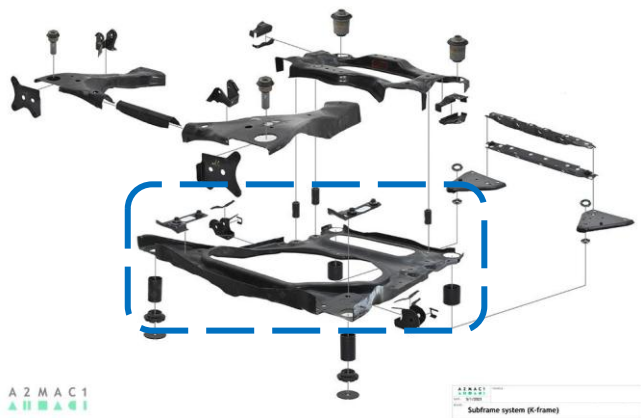
GWAM butt to butt



AMTB Process



On the road LWB applications !



Part under production using AMTB welding process

Main take away



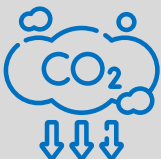
New welding process combining Plasma + laser, suitable for Chassis application

- Good fatigue performance
- Low thermal deformation



LWB solutions for front subframe could bring several advantages:

- Material optimization
- Part integration
- CO₂_{eq} reduction
- Cost optimization



ArcelorMittal XCarb® offer already available to support Automotive customer in their decarbonization strategy.
More solutions to come...

Multi Part Integration

Discover the power of less with MPI

In a rapidly evolving automotive industry, flexibility wins. Multi Part Integration maximises automotive manufacturers' ability to adapt through the power of less: less parts, less time less process, less floor space, less material, less CO₂ and less assembly cost.

Harness the strength of steel and the power of less.

For more, head to
mpi.arcelormittal.com

