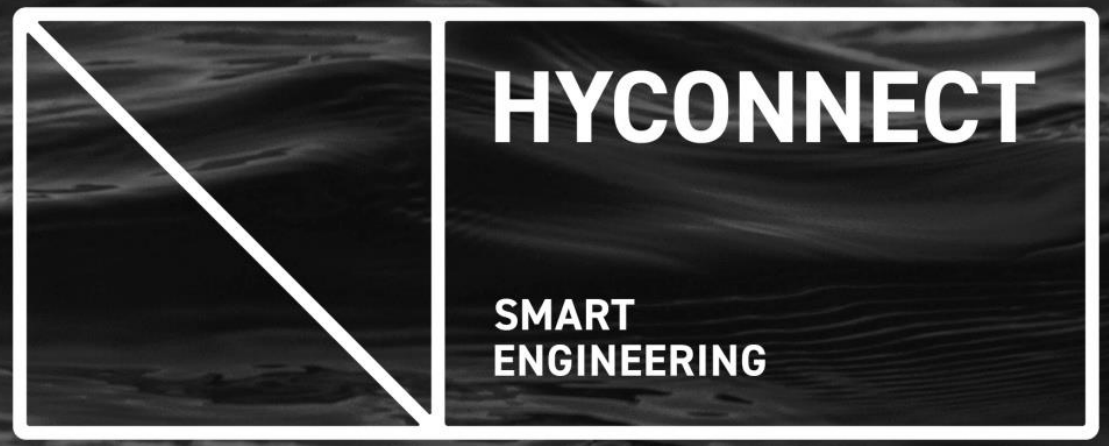

HYCONNECT
SMART
ENGINEERING

We know how to connect

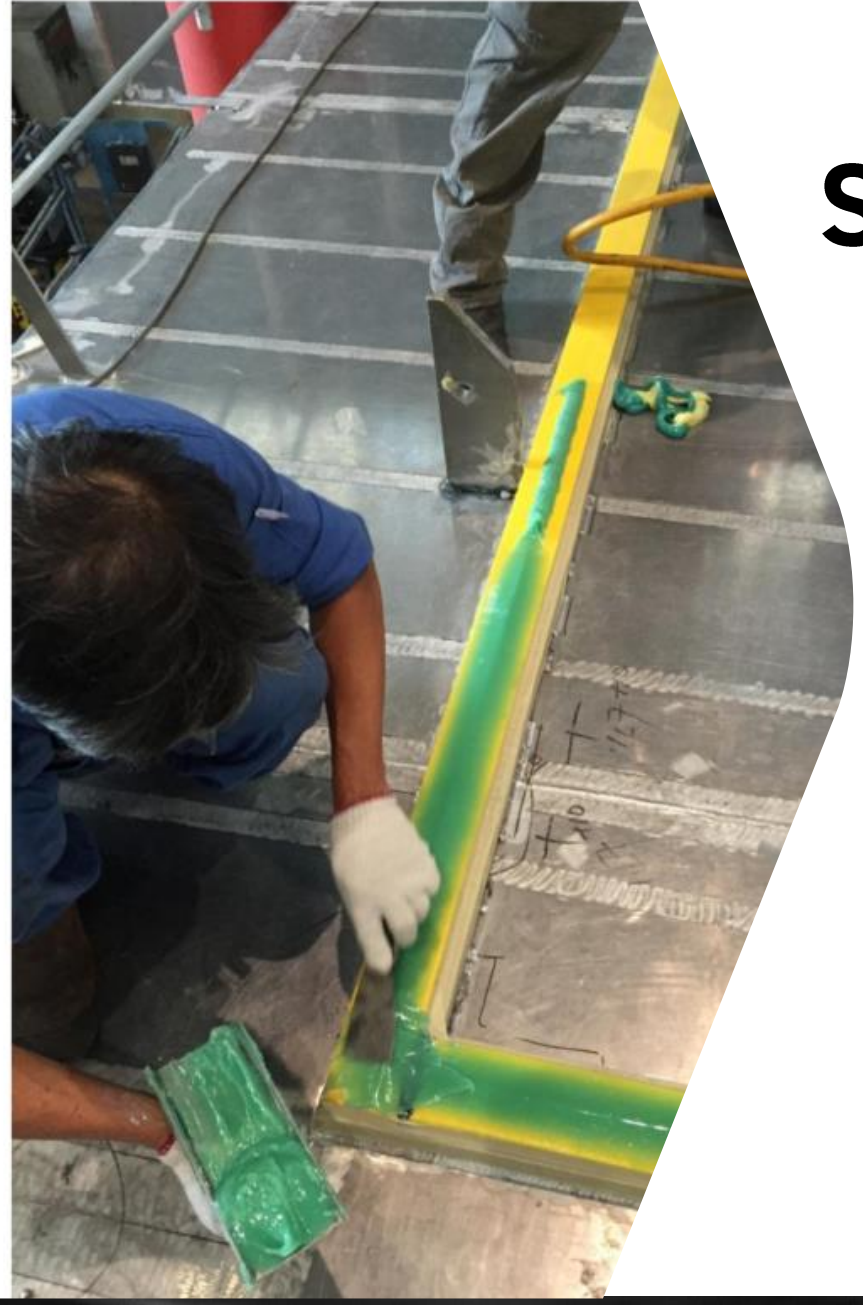
With our FAUSST technology, we enable industry to break new ground in order to successfully master current and future challenges: through sustainable lightweight construction.

New joining technology FAUSST

- Joining element consisting of a hybrid fabric (reinforcement and metal fibres) welded in one or more layers to a metal profile.
- Is directly integrated into the manufacturing process of the fibre composite material (FRP).
- High strength and weldable connection point in the fibre composite.

The challenge

Mobility and infrastructure are changing in our world; and with them design and materials. In order to implement the challenges of sustainability and efficiency, optimised material combinations are used today.
Metal structures must be connected with lightweight components such as fibre composites. A complex task that today is mainly solved with adhesives.

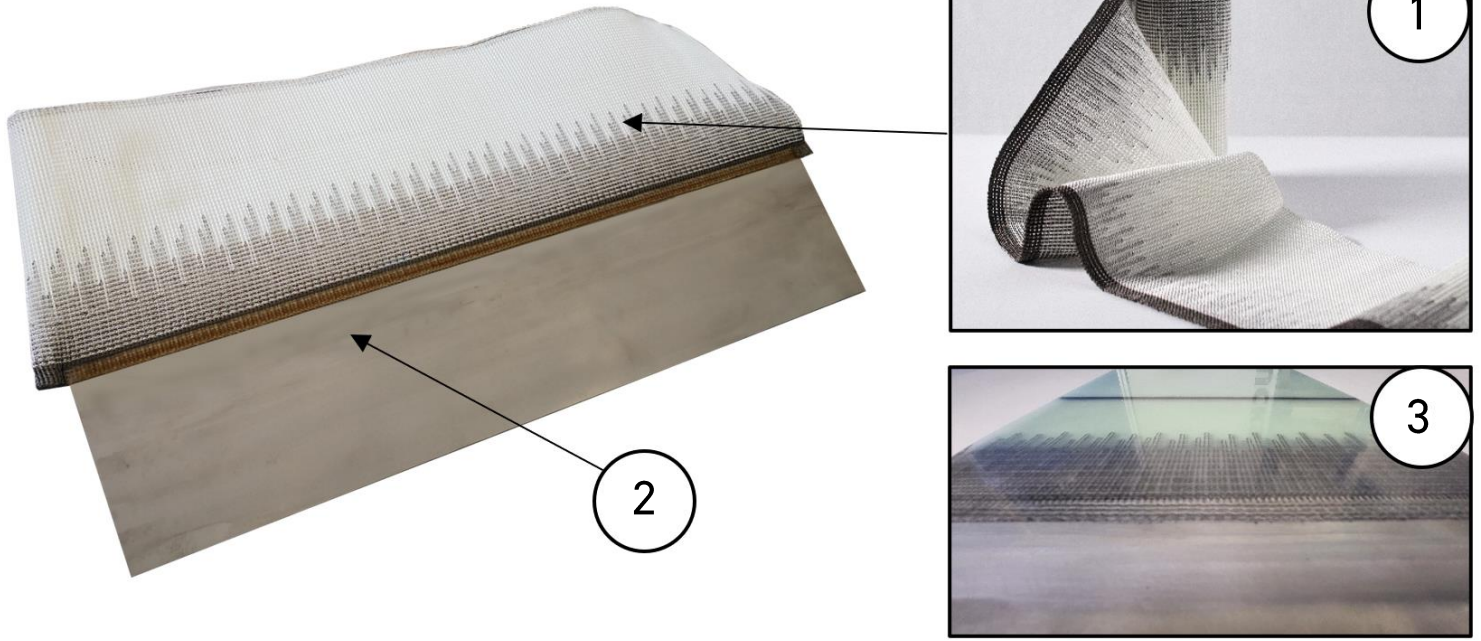


State of the Art

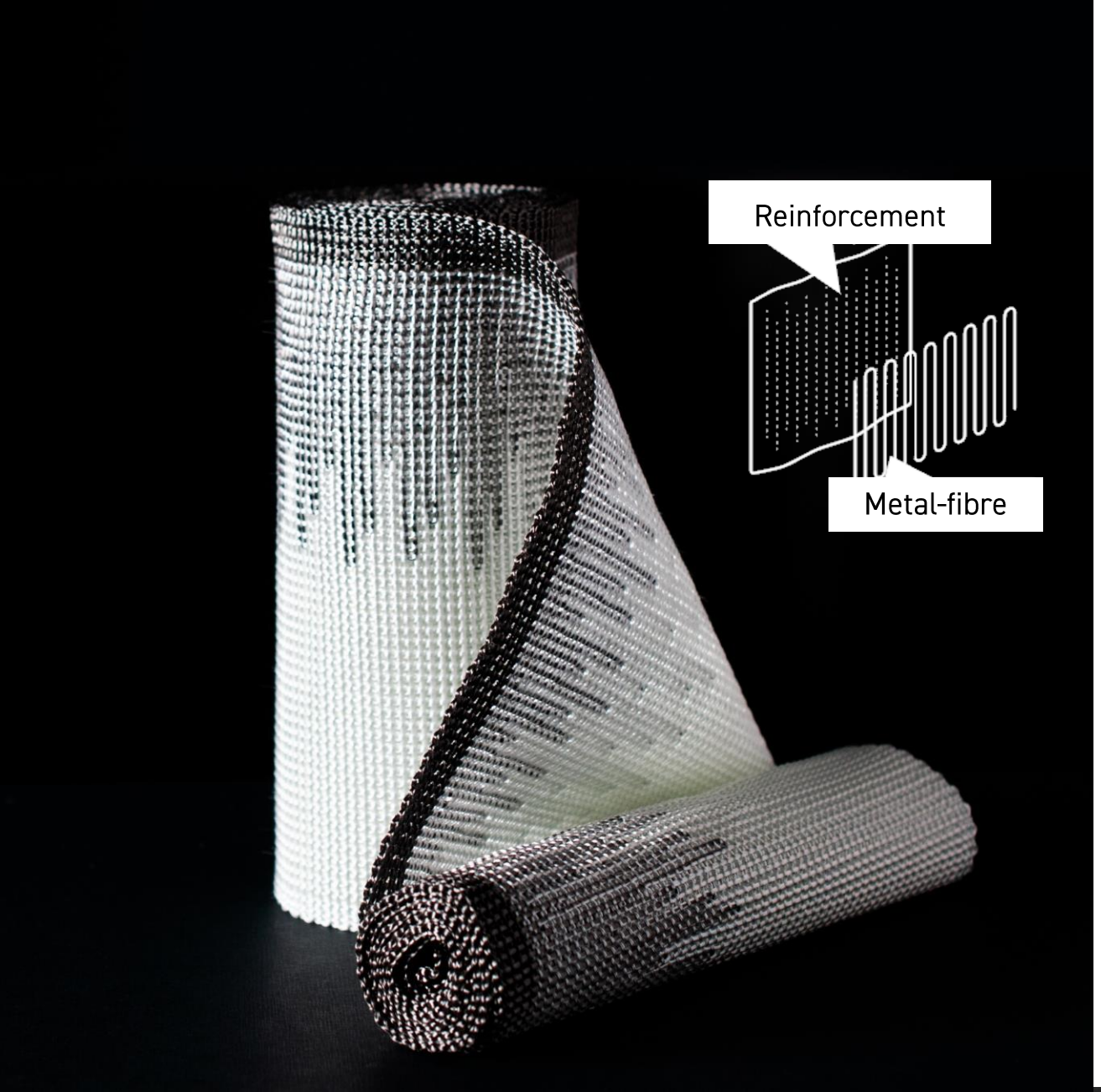
Complex and work intense installation work via adhesives:

- Quality
- Environment
- Qualification
- Inspection
- Certification

Next generation of joining: The FAUSST connector



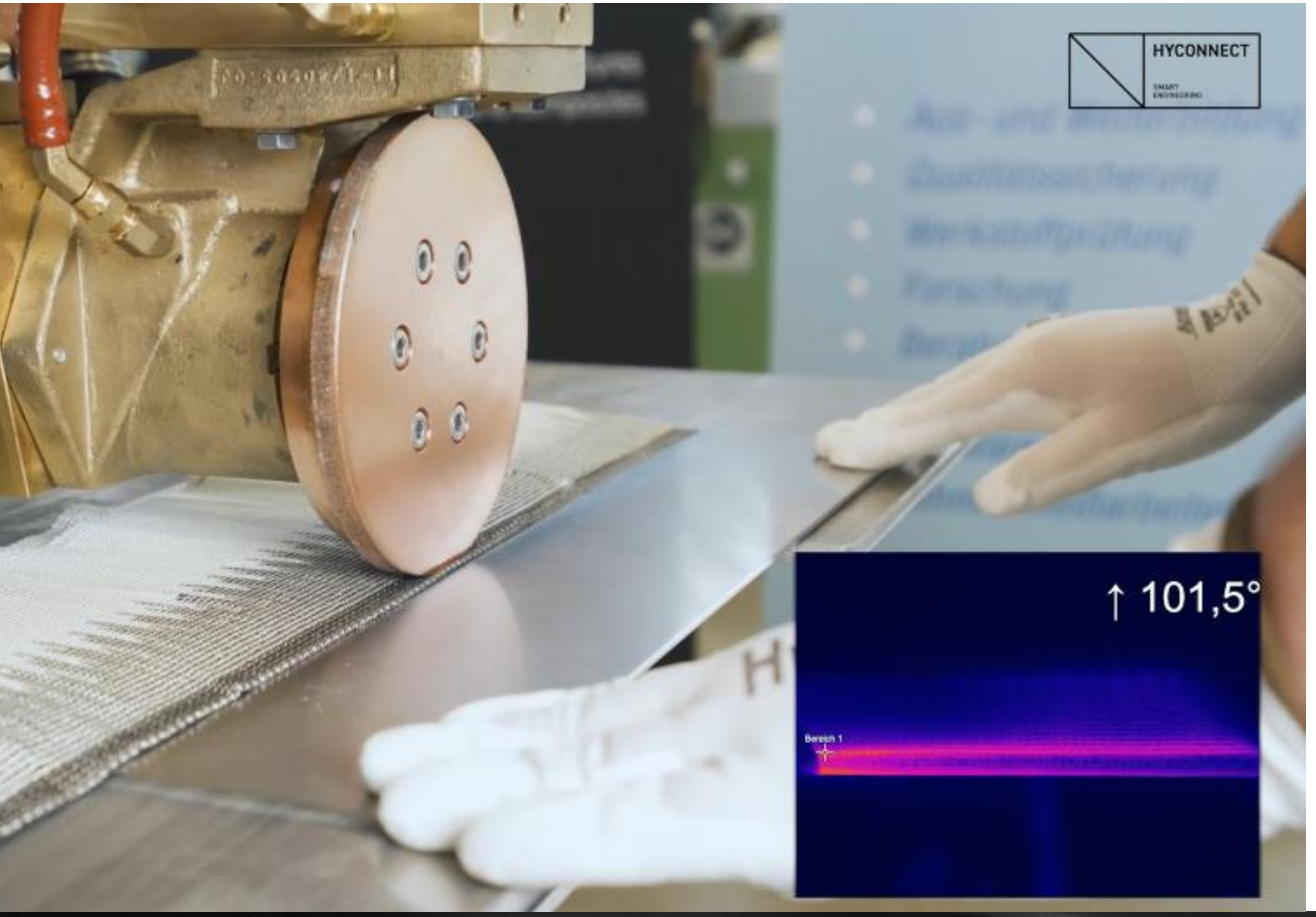
1. **Hybrid fabric FAUSST:**
   Reinforcing fibres and metal fibres are interwoven.
2. **The FAUSST conector:**
   The metal fibre side of the fabric is welded to a metal profile.
3. **Weldable composite:**
   The connector and and the composite are laminated; this makes the fibre composite structure weldable. Simple design, fast process.



FAUSST hybrid fabric

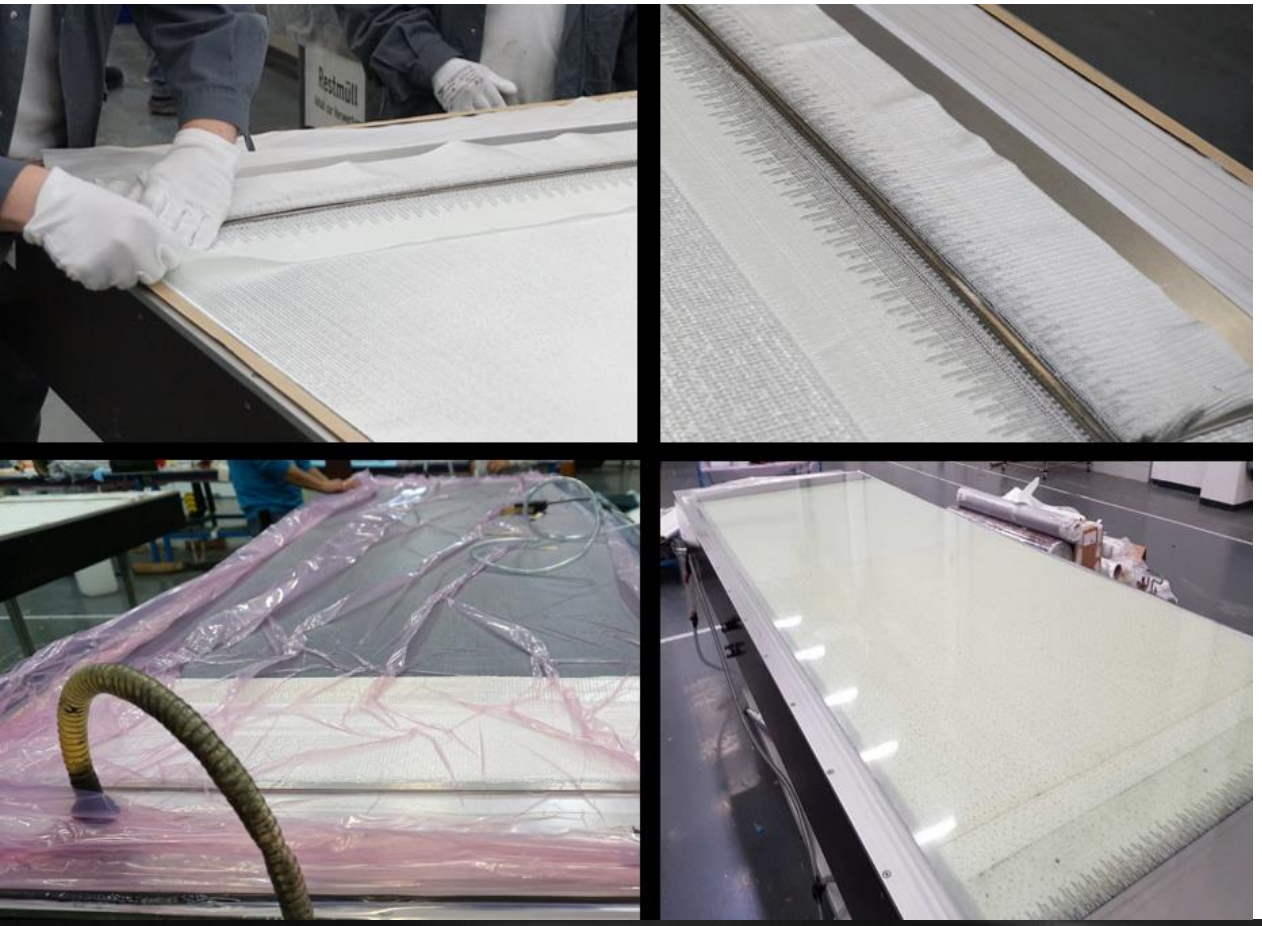
- Metal fibres are interwoven with reinforcing fibres (e.g. glass) to form a fabric.
- The fabric has a material gradient from 100% reinforcing fibres to 100% metal fibres.
- The metal fibre seam can be welded.

Welding of hybrid Fabric

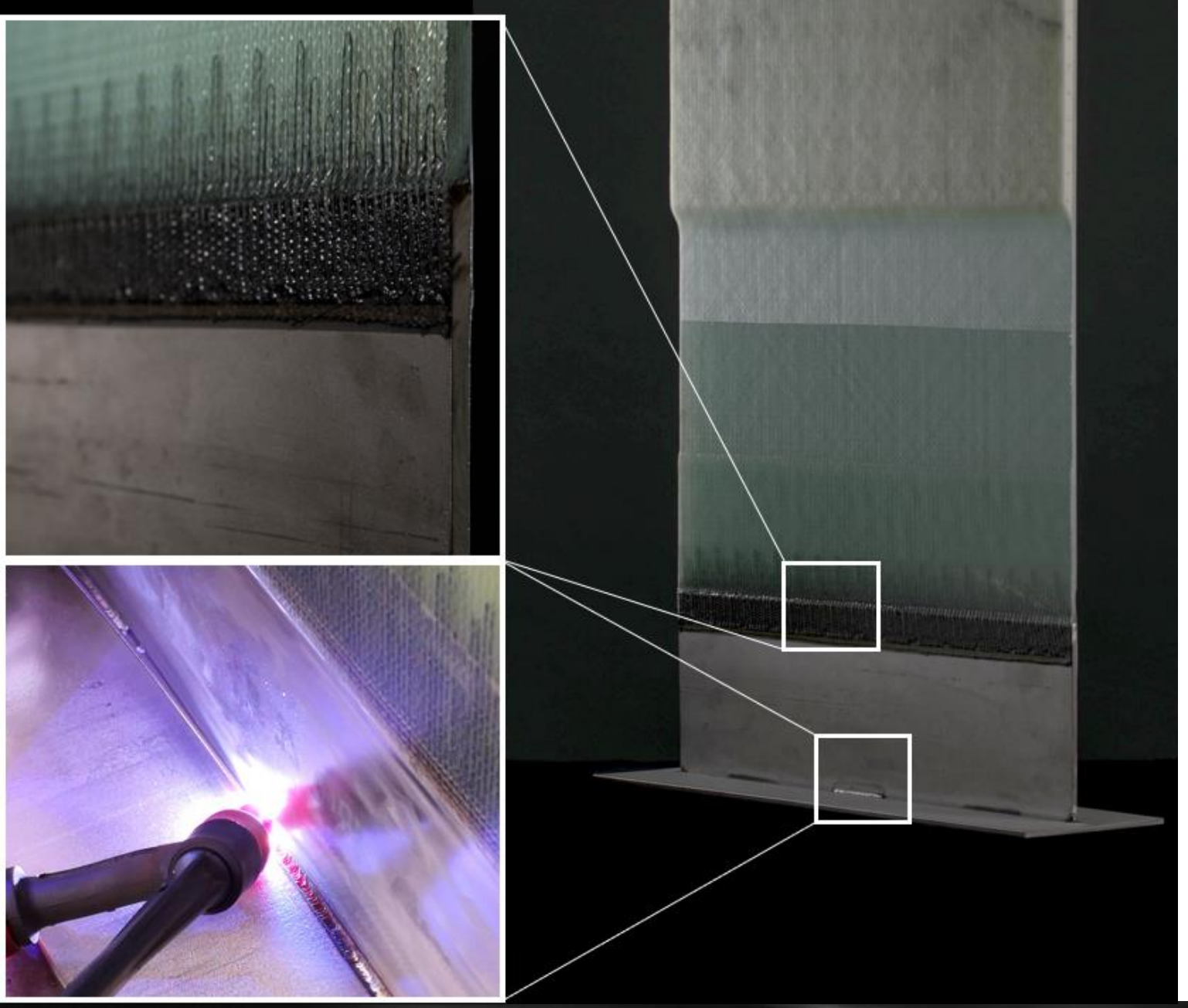


- The fabric is joined in one or more layers to a profile by means of resistance pressure welding.
- Different profiles and materials can be used:
  - Construction steel
  - Stainless steel
  - Aluminum
  - ...
- Material thicknesses from 0.5 mm to 8.0 mm are currently standard.

Integration into the composite

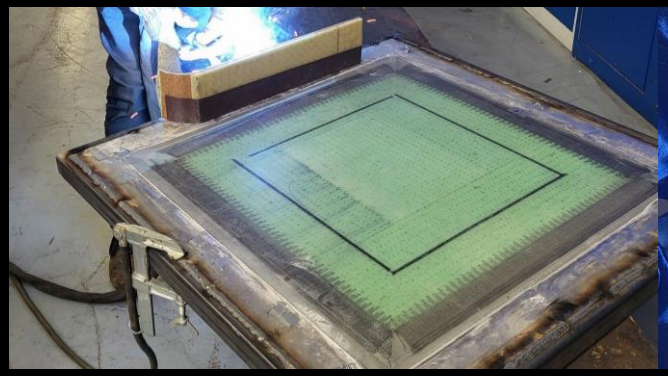


- The FAUSST connector is inserted during the production of the FRP structure.
- The reinforcement fibre layers are laid alternately over the FAUSST knitted fabric and the connector.
- Connectors and fibre layers are then infused together.
- Different processes (e.g. RTM, etc.) and resin-fibre variants are possible.



FRP welding

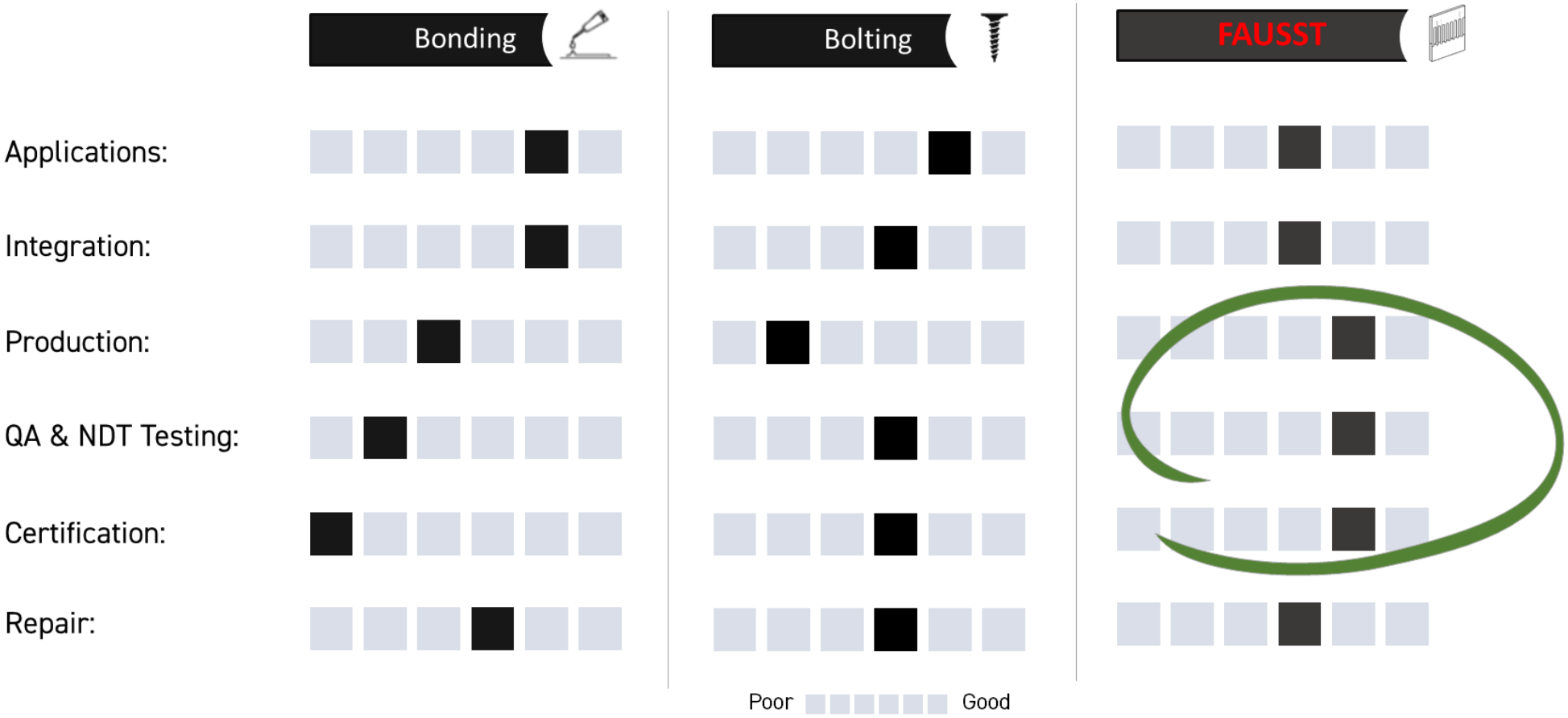
- Due to the integrated FAUSST connector, FRP components can be welded or bolted to metal strucutres.
- Slim and force-optimised design.
- The profile width is adapted to the welding process and sheet thickness.

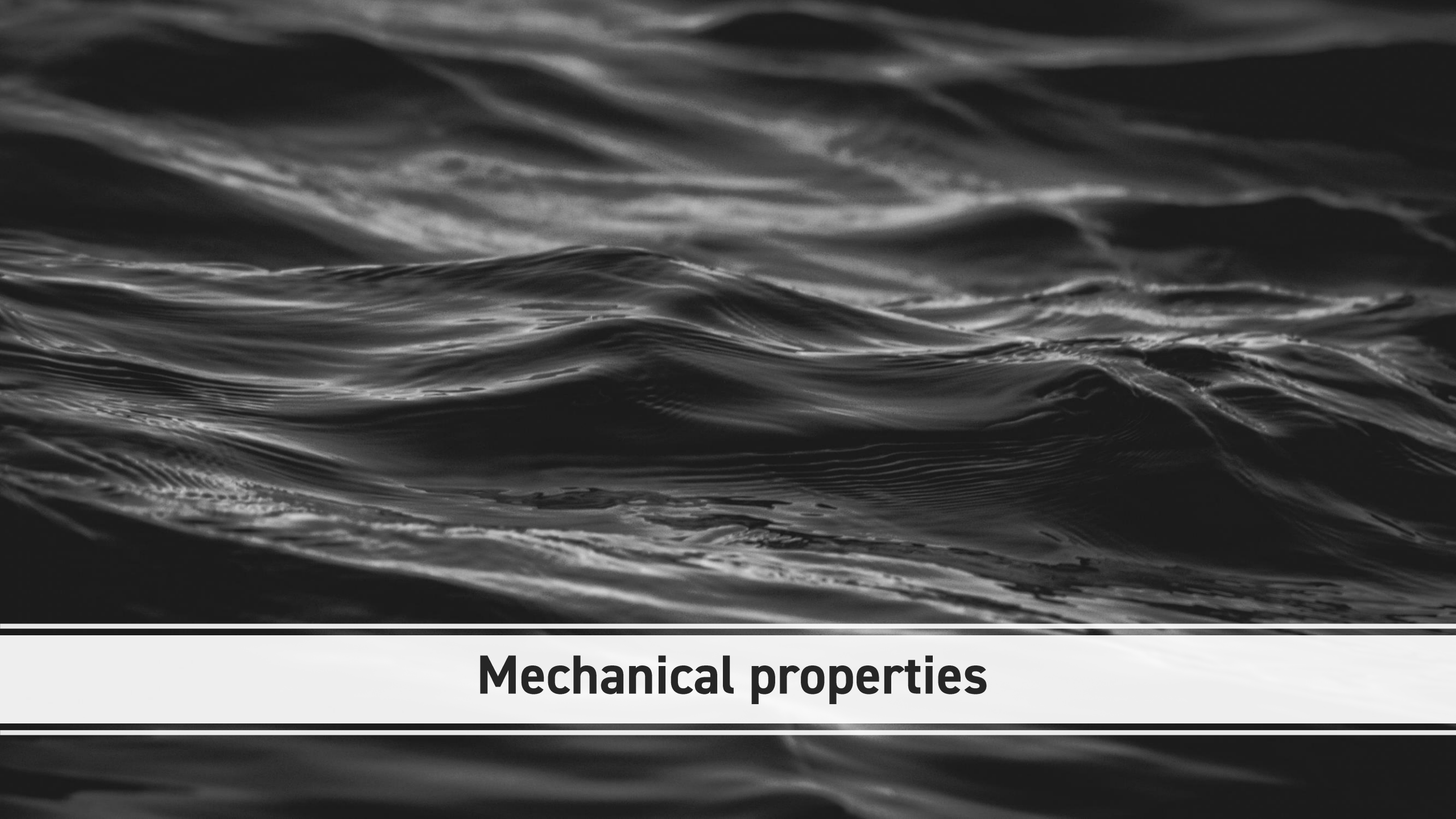


FRP welding

- Easy and fast welding. Here: 3 min / m with MAG .
- Low heat input – no impact for the composite.
- No rework before welding: high accuracy of composite -FAUSST panel.

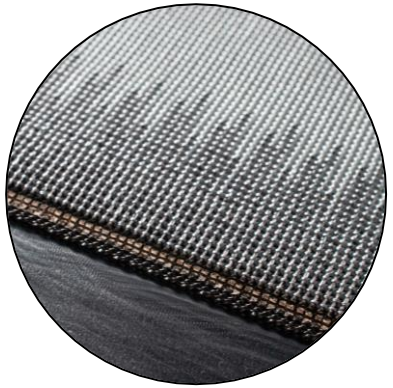
Comparison of joining metal to compsosites



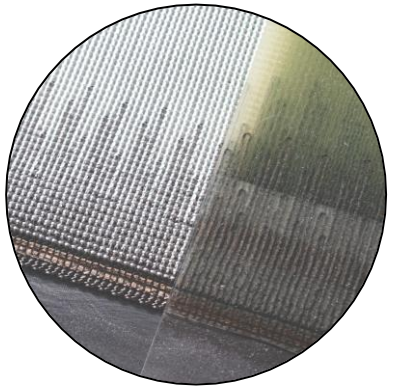


Mechanical properties

High performance joining



- Load transfer via interlocked fabric and weld from the pure reinforcement fibre to a solid profile.
- No seperation possible. All parts are mechanically or weld locked to each other.

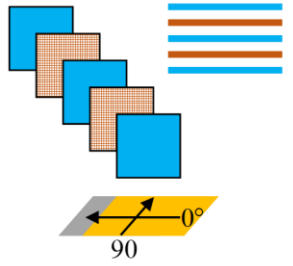


- FAUSST joining elements are overlapped by the reinforcement layers of the FRP part.
- High strength integration by this state-of-the-art method for FRP production.

Mechanical testing

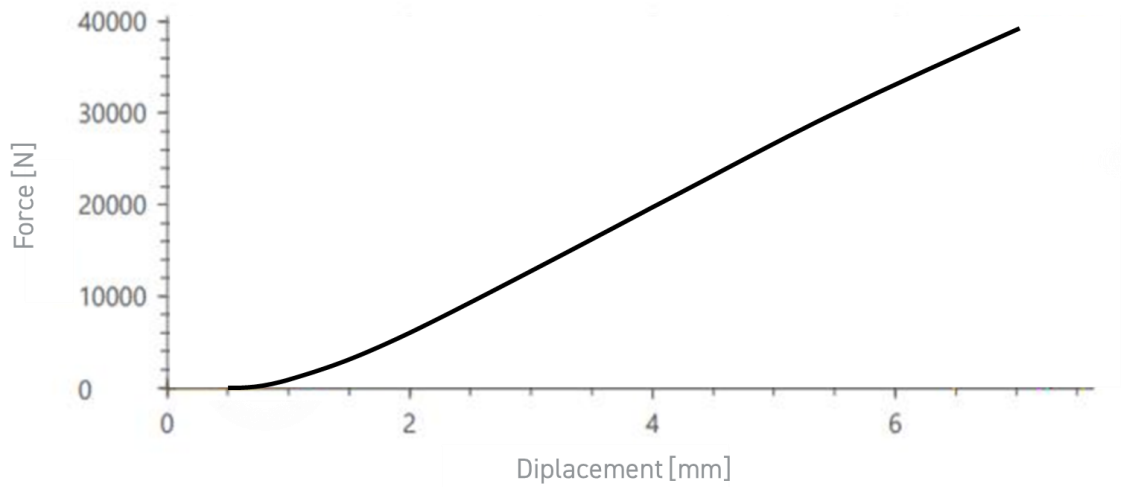
- Testing of an integrated FAUSST joining element with:
  - Two layers of FAUSST hybrid fabric
  - Flat profile (1.4301 stainless steel) with 3mm thickness
  - Edge preparation by milling

- Integration to a GFRP plate with epoxy resin system in vacuum infusion.

Joining design	Material and layers	Orientation
	1. U-E-640g/m² 2. FAUSST-fabric 3. U-E-640g/m² 4. U-E-640g/m² 5. U-E-640g/m² 6. U-E-640g/m² 7. FAUSST-fabric 8. U-E-640g/m²	

Tensile strength

- Quasi-static testing of coupons until total failure
- High tensile strength with low scatter
- The tensile strength is calculated to the nominal area of the steel profile: **264 Mpa**

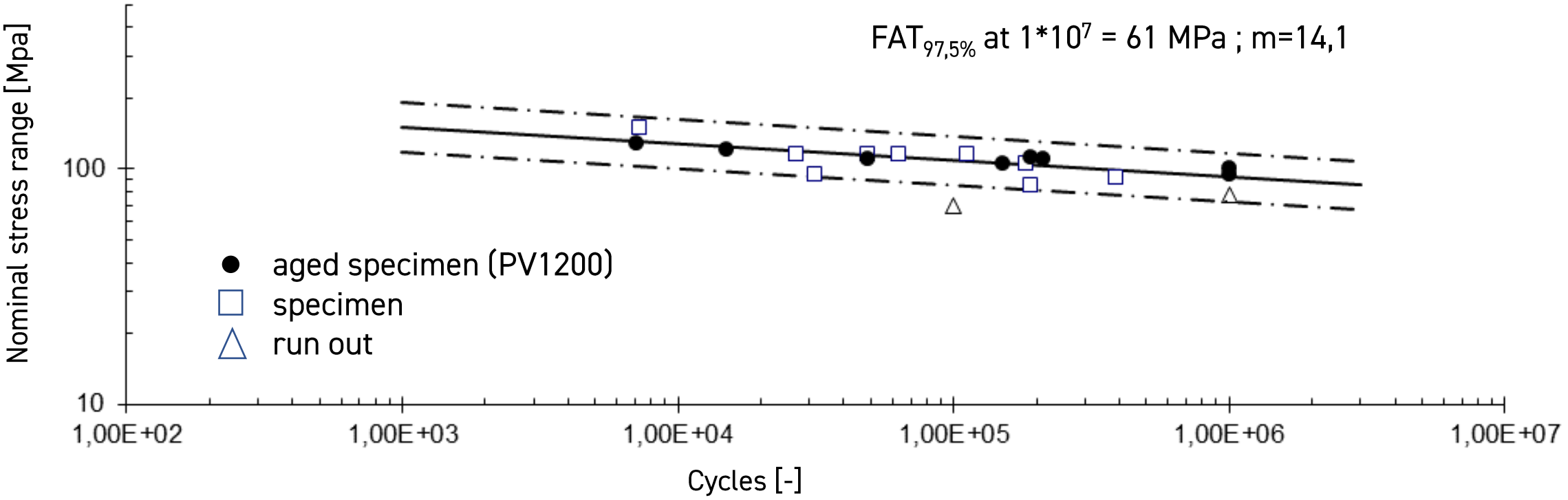


Curve represents average of eight coupons. Nominal area is 50mm widht x 3mm thickness.

Fatigue testing - Wöhlerkurve

- R-Ration: R>0.
- Test frequency: f<10Hz.
- Test according to ISO 13003.
- Parts of the specimen group removed according to PV1200 method.
- Evaluation according to IIW with k=2.7

Fatigue – Wöhlercurve



Specimen from 3mm thick and 25mm wide Steel-GFRP specimen. Stress calculated on nominal area of steel part.
R > 0 ; f=8Hz ; Aging by PV1200 procedure (-40°C - +80°C for 1200hours)

Certification

Certification

- Approval in Principle by Bureau Veritas of the FAUSST joining element in maritime and offshore use.

APPROVAL in PRINCIPLE

At the request of:

Hyconnect

BUREAU VERITAS MARINE & OFFSHORE SAS, acting within the scope of its general conditions[1], declares hereunder that the design of the:

FAUSST

is **Approved in Principle**, with respect to the aim of the Classification as defined in Part A, chapter I of the latest edition of Bureau Veritas Rules for the Classification of Steel Ships and the conditions stated in ANNEX 1. The present Approval in Principle is referring to the general options chosen by the designer and is based on the documents listed in ANNEX 2.

The validity of this approval may have to be reconsidered, in case of any major modification likely to invalidate the principles shown on these documents. The Approval in Principle would become null and void should Bureau Veritas Marine & Offshore not be kept informed of such modifications.

Prior to the classification and/or certification of a Unit, all relevant drawings, calculation notes, test reports and other documents required by the applicable Rules or necessary to address the technical requirements listed in ANNEX 3 are to be submitted for review, with the aim of issuing a Design Approval certificate.

Issued at Paris La Defense, on 23rd December 2021

Olivier CARTIER

Vice President, Technical Director

[1]: see overleaf

- Non combustible material according IMO MSC.307 FTP-Code 2010 and DIN EN 13501-1 [A1].

MPA Dresden

Klassifizierungsbericht

Classification Report

Klassifizierung des Brandverhaltens nach DIN EN 13501-1:2019-05
fire classification acc. to DIN EN 13501-1:2019-05

Nr./*No.* 20211004/01

MPA Dresden

Prüfbericht

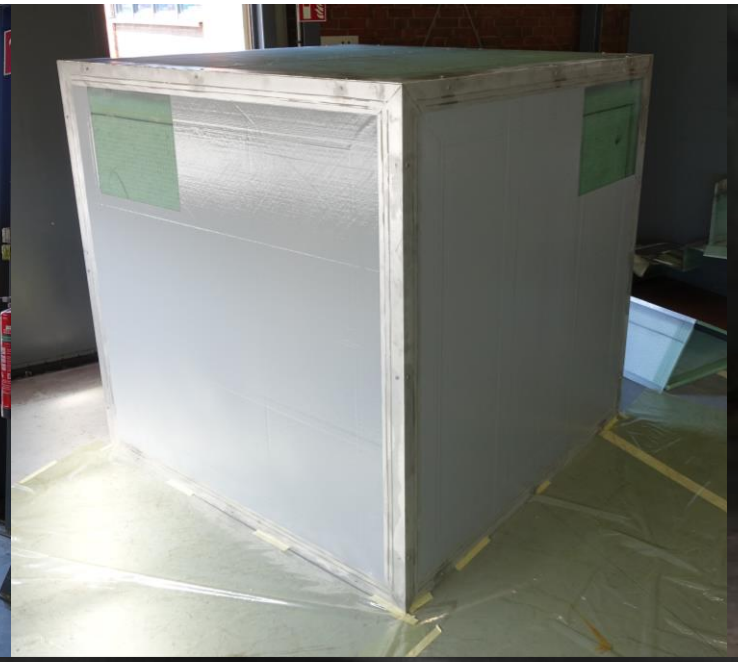
Test report

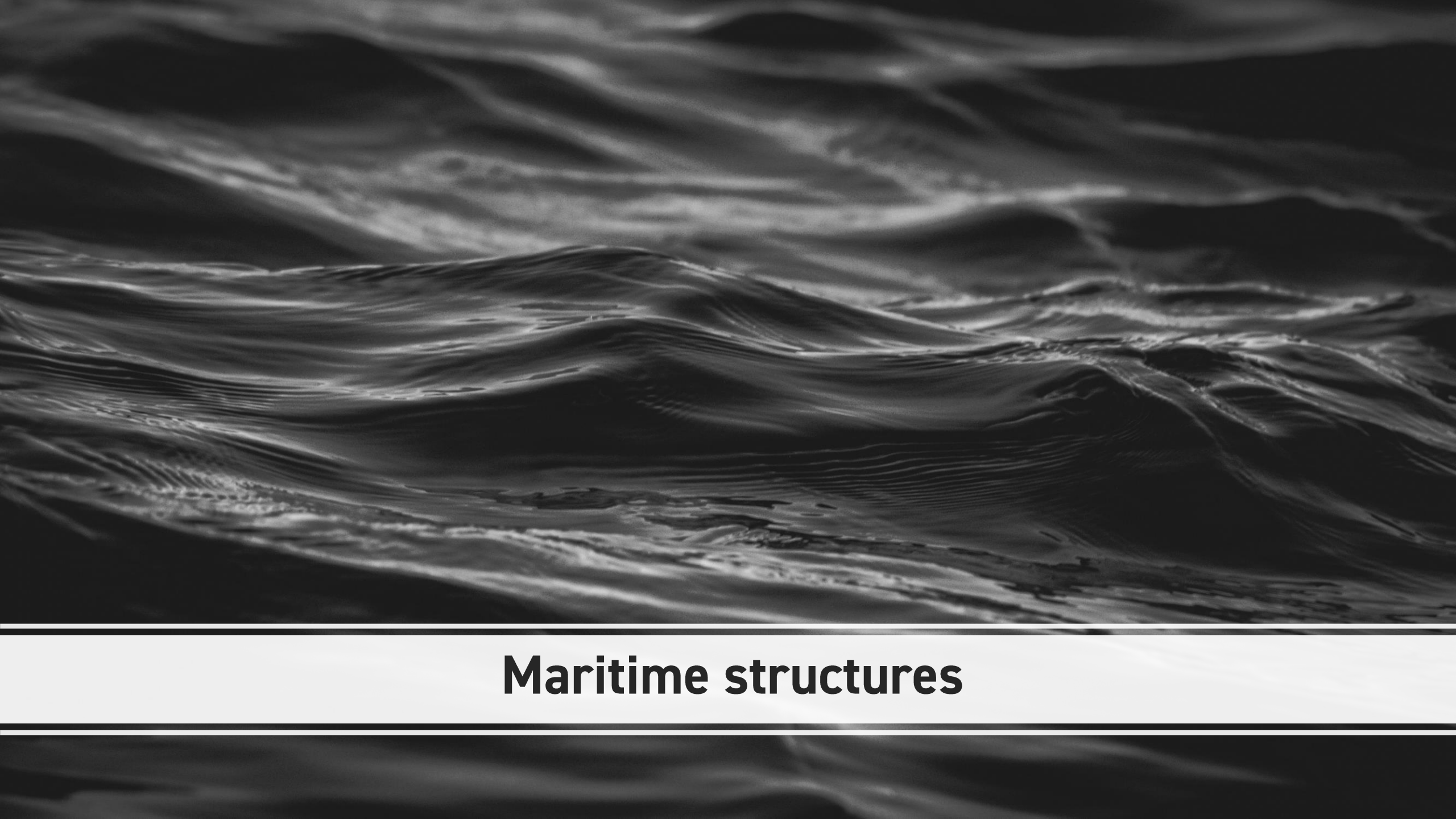
Nr./*No.* 20211004/04

Fire testing of container: GFRP versus aluminium

Short summary: fire resistance

Container built from metal framework and FAUSST-GFRP panels.
One side extruded aluminium profile. Firetesting 10 minutes with 1000°C.
Aluminum failed after 3 minutes. GFRP lasts 15 minutes plus.
Insulated FAUSST-GFRP panels 30% lighter compared to aluminium profiles.

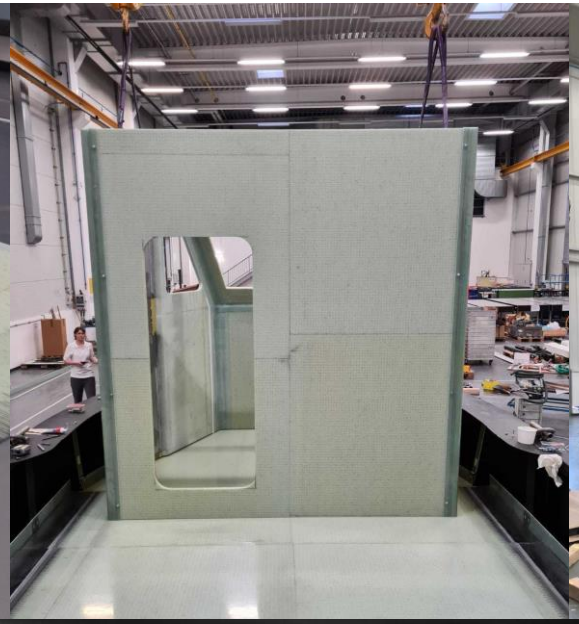


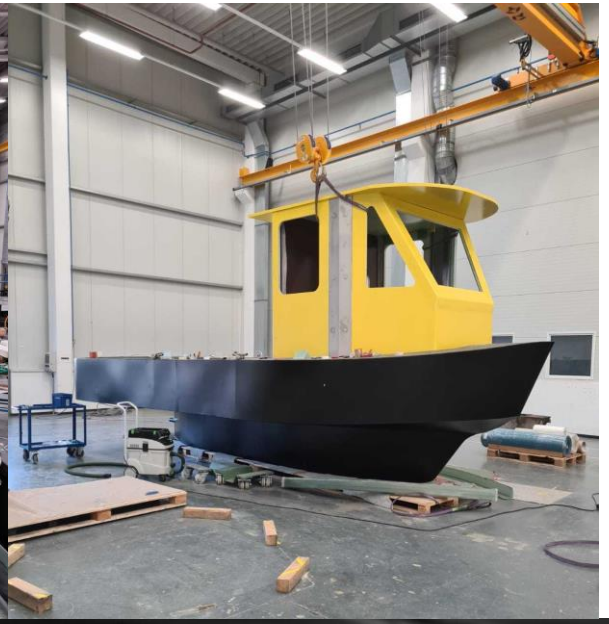


Maritime structures

Working floor and deckshouse

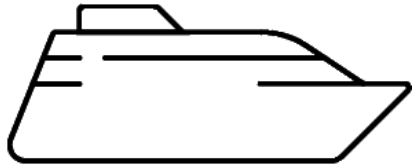
- Base plates steel-GFRP with low weight (-50% compared to steel).
- GFRP structure with corner connectors for quick assembly.





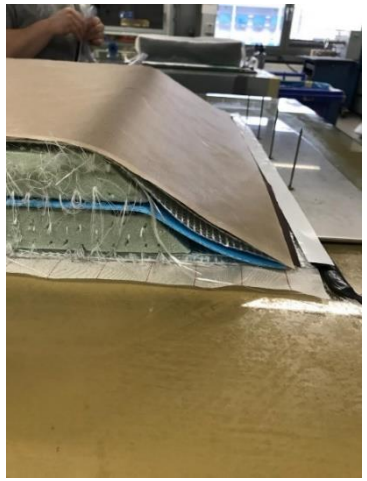
FAUSST boosts the production process.*

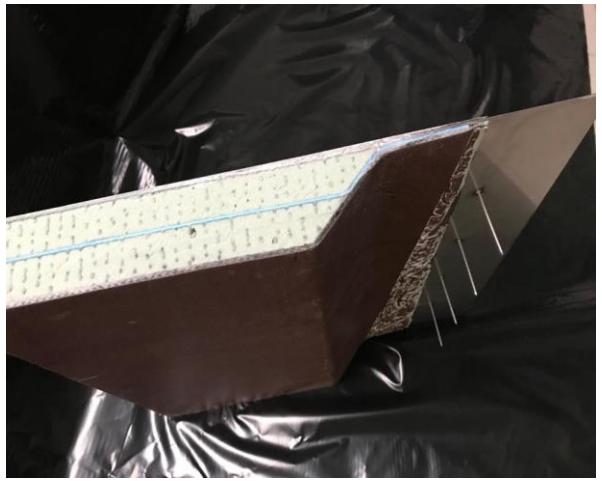
Measuring	4 hours	4 hours
Adjustments	4 hours	8 hours
Preparations	1 hour	12 hours
Joining	5 hours	12 hours
Waiting time before further work	-	>12 hours
	14 hours	**36 hours**
	FAUSST	**Bonding**



*Basis is a 235 m^2 GFRP superstruture joint to a steel deck of a ferry.

Fire resistant structural panels





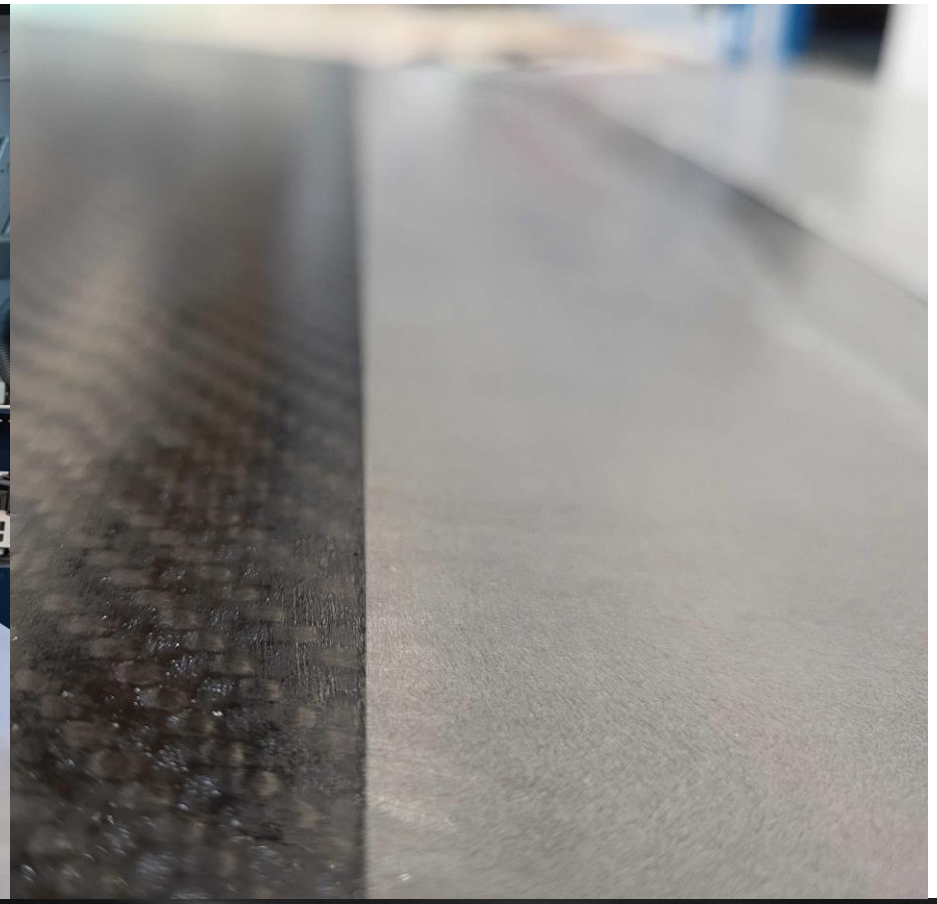
- A30 plus wall system with composite structure, FAUSST and composite fire protection system.
- Low heat increase (only 20°K) after 30 minutes on the back of the composite.
- 60% of ultimate strength remains in the panel after 45 minutes of fire testing.

Cable penetrations for composites

- standard products can easily be used with FAUSST system to integrate calbe and pipe penetrations in fire resistant walls.
- Both, penetration in the metal profile or in the composite part are possible.
- Based on the applications, the svt products can be adapted to fit also for composite solutions.

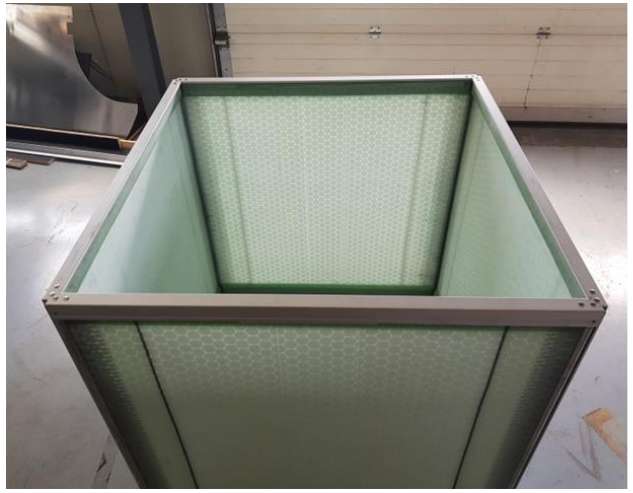
Examples for interior / outfitting / safety hatches

Joining surfaces - 1



- Smooth transition.
- FAUSST joining for curved, sandwich structures, etc. possible.
- Also local inserts or tube joining possible.
- No drilling in composite: long lasting joint with metal-to-metal.

Joining surfaces - 2



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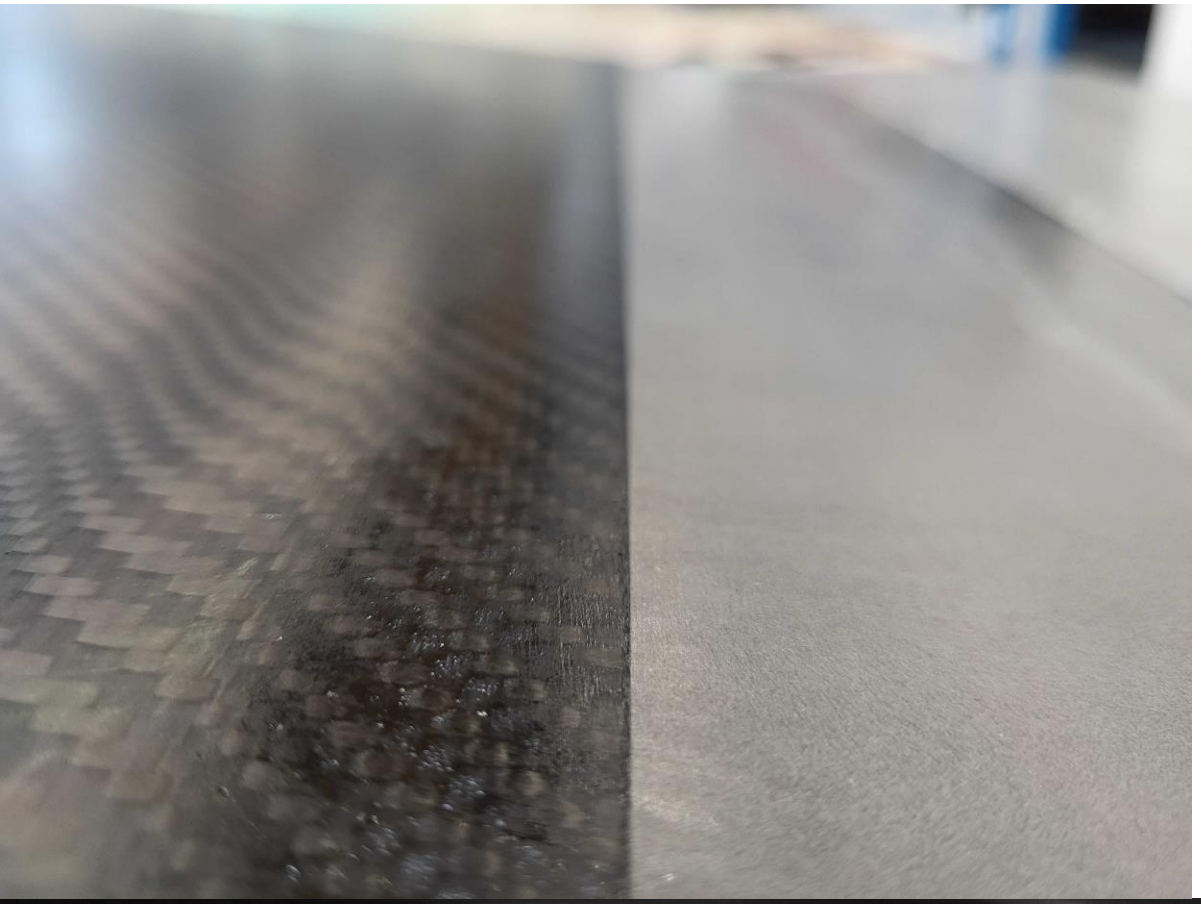
Coverings and design elements Carbon

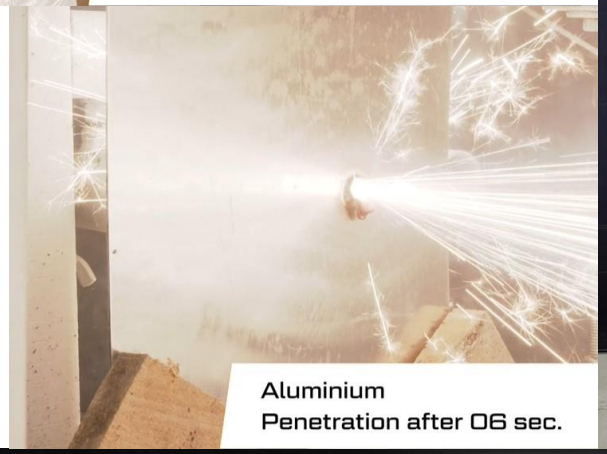


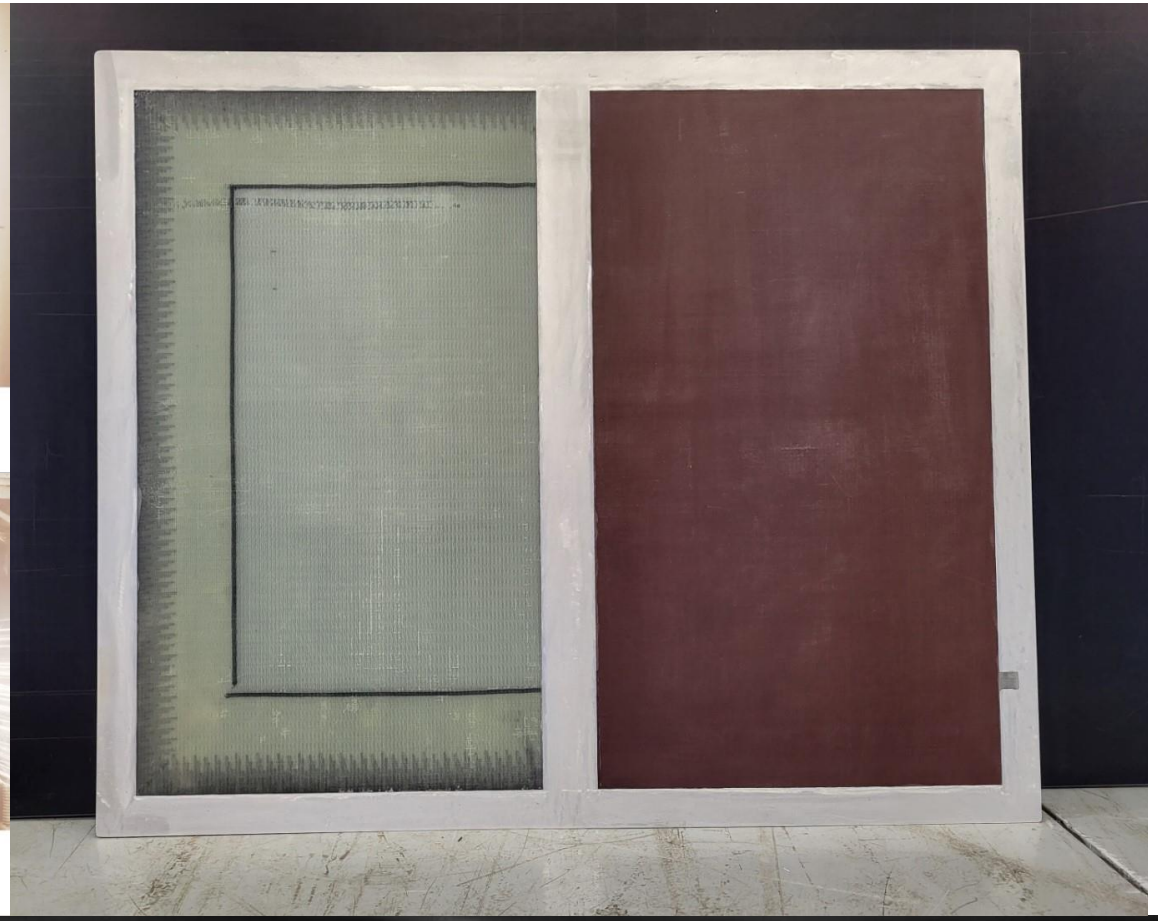
- CFRP-steel connection for better assembly of add-on parts to primary structure
- High resistance to impact loads and vibration.
- Very smooth transitions. Optical zero gap.

Coverings and design elements GFRP

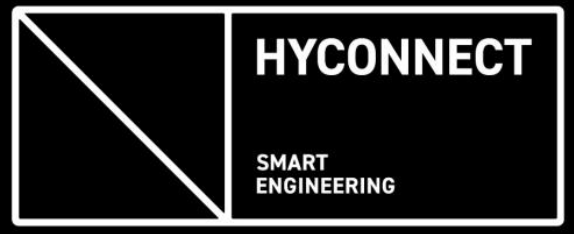
- Embedded to curved sandwich GFRP structure for easy assembly and maintenance (railway cap)
- Suitable for thermoset and thermoplastic processes.
- Extruded aluminum profiles available for extreme lightweight structures.

Battery case safety hatch





- Aluminum support frame - GFRP panel with fire protection.
- Low weight, increased protection against particle impact.
- Simple and durable connection through aluminum frame to the housing.



info@hyconnect.de