RAMSSES - Realisation and Demonstration of Advanced Material Solutions for Sustainable and Efficient Ships

5th joint E-LASS/RAMSSES seminar
and 2nd workshop of the Maritime Advisory Group (MAG)
June 12th, 2018
Vigo, Spain

Matthias Krause
Center of Maritime Technologies

Agenda

E-Lass Seminar - June 11th-12th, 2019
Vigo region, Spain

June 11th	**Lightweight Products and Processes**				
	13:00	13:30	*Registration, reception, refreshments*		
	13:30	13:45	Welcome	Franz Evegren	RISE
	13:45	14:00	Short Introduction and Rules of the House	Elena Rodriguez Senin	AIMEN
	14:00	14:25	Introduction of the Sargasso platform	Andreas Bach	RISE
	14:25	14:50	Steel to Composites structural bonding (hybrid structures) measurement in Lightweight Marine transport applications	Gregoire Beauduin	Com&Sens
	14:50	15:20	*Coffee break*		
	15:20	15:45	the Nautilus project	Saul Balsa Barrros	NAVANTIA
	15:45	16:10	Repair and Reinforcement with Composites	Darko Frank	CompaRepairs
	16:10	16:35	the FIBRESHIP project - latest developments	Alfonso Jurado	FibreShips
	16:35	17:00	Structural Health Sensing and Monitoring	Raquel Travieso	AIMEN
	17:00	18:00	*Visit to AIMEN facilities*		
	18:00	18:30	Bus transfer to Vigo		
	20:00	22:30	*optional: E-LASS dinner (at own expenses)*		registration required
June 12th	**the RAMSSES project**				
	08:15	09:00	*Bus transfer from hotels*		
	09:00	09:15	Arrival, reception, coffee		
	09:15	09:40	RAMSSES - half time overview	Matthias Krause	CMT
	09:40	10:05	the Development of a lightweight rudder flap	Jörg Mehldau	Becker Marine Systems
	10:05	10:30	Steel and Repair in RAMSSES	Giovanni Risso	Cetena
	10:30	11:00	*Coffee break*		
	11:00	11:25	RAMSSES - Under construction: The fast track to approval	Stéphane Paboeuf	Bureau Veritas
	11:25	11:50	FRP composites and reaction to fire challenges	Anna Sandige	RISE
	11:50	12:00	Fire Restricting Material' composite	Diego Jezler	CFP Composites
	12:00	12:50	Discussion		
	12:50	13:00	Closure		
	Technical visits				
	13:00	14:00	Lunch and session for group picture		
	14:00	19:30	Industry tours incl. transfer		
	19:30	22:30	*optional: E-LASS dinner (at own expenses) - times may vary*		

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RAMSSES Half time overview
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Project OVERVIEW

01.06.2017
31.05.2021

Budget: €13.5 M
Funding: €10.8 M

36 partners
12 countries

www.ramsses-project.eu

Call Topic: MG-2.2-2016 Development and Use of High Performance and Lightweight Materials … (IA)

Coordinator: CETENA (Italy) – Financial and Administrative

CMT (Germany) – Technical and Dissemination

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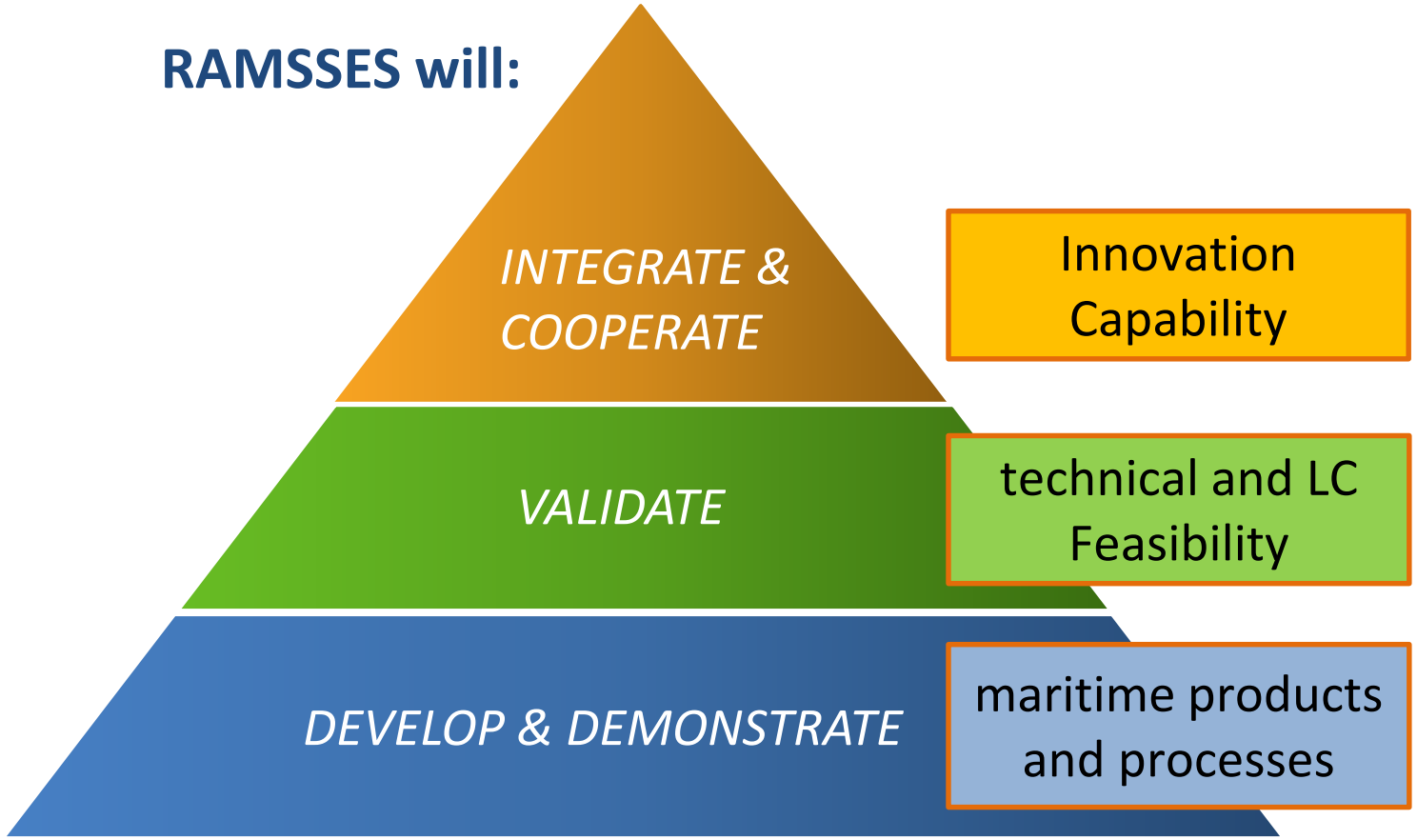
Innovative Materials for Ships:

- less fuel and emissions
- efficient and competitive
- safe and comfortable
- smart and functional

RAMSSES will:



RAMSSES – a „DYNASTY“ of success

continuity + cooperation + application = SUCCESS

advanced composite sandwich steel structures

SANDCORE

DE-LIGHT Transport

BESST

MOSAIC

ADAM4EVE

RAMSSES


Deck of a river cruiser


Bridge retrofit

Rail driver cab

Superstructure

Cruise ship balcony

DAMEN Waterbus

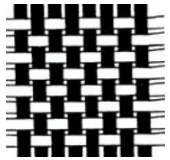
ULJANIK Car Carrier

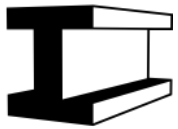
13 more innovative applications to come soon

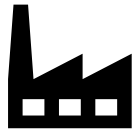
RAMSSES Demonstration – Approach

addressing complexity

All relevant materials and processes


composites


HS steel


Fabrication

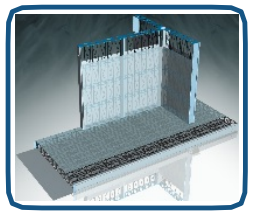

Assembly

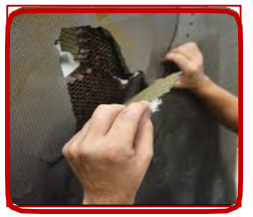

Outfitting


Approval

TRL (5) 6…7

Demonstrating process chain





Innovative materials

Pre-fab Components

Equip-ment

Ship and Process Integration

Modular LW System

Custom Specific

Steel

Repair

RAMSSES Assessment – approach

Properties relevant for approval and customer acceptance

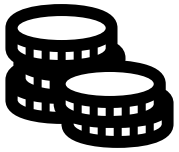
Mechanics

Fire

Corrosion

Noise, vibration

Comfort

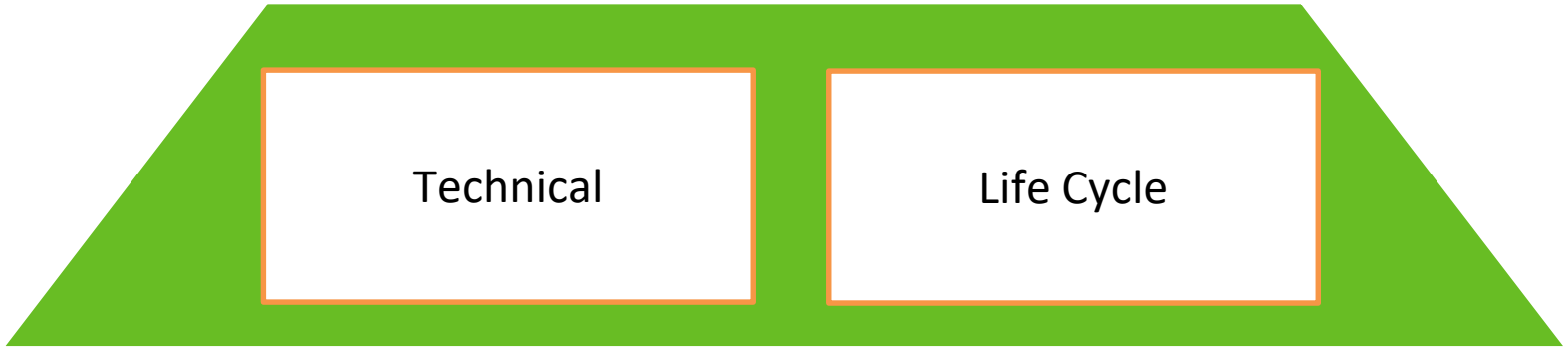


Costs

Emissions

LCPA

Sustainable assessment



Assessment process chain

Coupon tests, production trials (Demo Cases)

(Pre) approval tests (RISE et al)

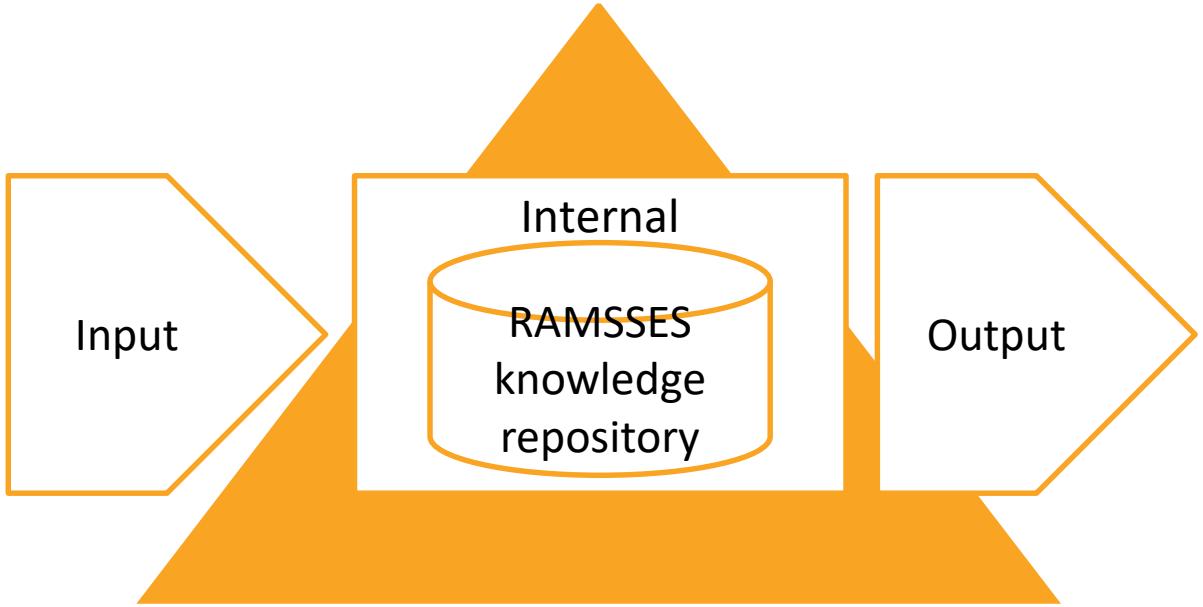
RAMSSES knowledge repository

Common LCPA approach and tool (BALance)

RAMSSES Integration, interaction – approach

Inter-sectoral exchange of ideas, experiences; future concepts

End users' requirements and feedback



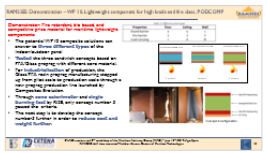
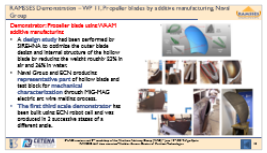
Enhance innovation capability

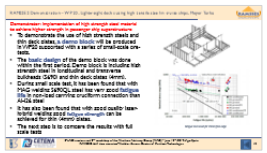
Dissemination, sustainable network

Easy to use standards and rules for new materials

Exploitation, definition of future research needs

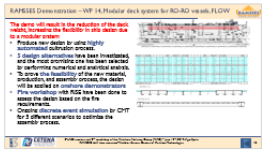
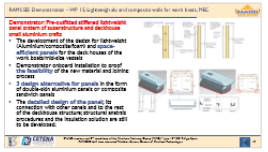
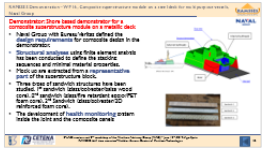
RAMSSES – Demo Cases

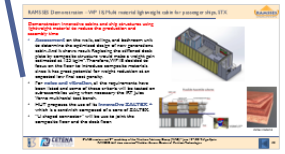





WP No	Cluster Title / WP Title	Lead	Focus Material	TRL Target	Validation
	Components & Equipment	**NetComp**			
WP09	Modular Light System for Less Critical Internal Walls and superstructure	BALTICO	various	6-7	(pre)approval*
WP10	Lightweight Components for High Loads and Fire Class	BLA	composite	6-7	(pre)approval*
WP11	Propeller blades by additive manufacturing	DCNS	metal	4-5	shore based
WP12	Lightweight Rudder Flap	BMS	composite	6-7	onboard
	Ship integration: Composite	**DSNS**			
WP13	Integration of System for Internal Walls and Superstructure of Cruise Ships into shipyard processes	MW	composite	7	onboard
WP14	Modular Decks for RoRo vessels	ULJ	composite	7	onboard
WP15	Lightweight aluminium and composite walls for Work Boats	MEC	various	6	onboard
WP16	Composite superstructure module on steel deck for multi purpose vessels	DCNS	composite	6	shore based
WP17	Custom Made Hull for Offshore vessel	DSNS	various	6	shore based
WP18	Multi material lightweight cabin for passenger ships	STX FR	various	6-7	shore based
	Ship integration: Steel&repair	**CET**			
WP19	Highly Loaded structural details from high tensile steel in passenger and research vessels	FC	steel	6	shore based
WP20	Lightweight Decks using High Tensile Steel in cruise ships	MT	steel	7	onboard
WP21	Composite Overlay to repair and improve metallic and non-metallic structures	CARDA	various	7	(pre)approval* onboard

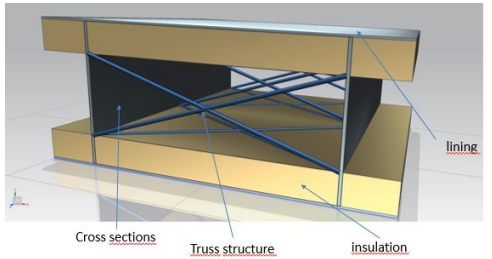
** commercial approval to be done outside the project based on data elaborated in RAMSSES*

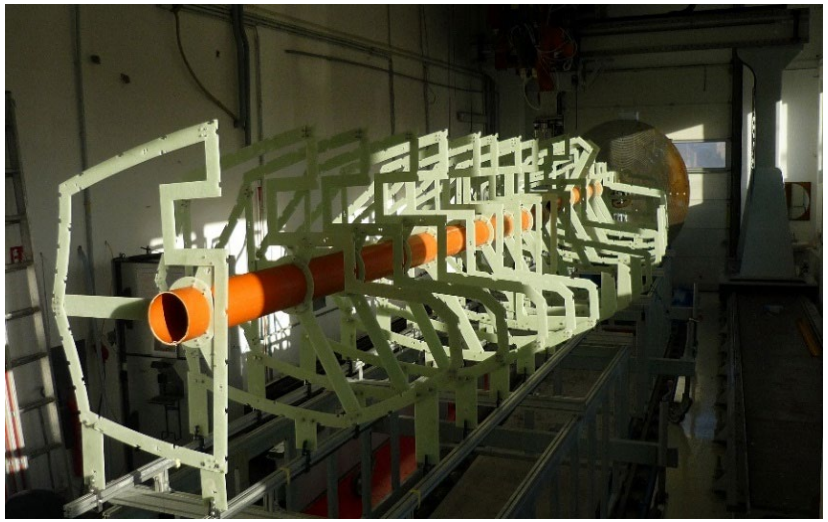







Demontrator: Ultra low weight modular system using a highly automatic winding manufacturing process

- Develop **ultra low weight** panel, with truss core and laminates
- **Demonstration** of module production and assembly integration in the lightweight **catamaran** (0e-n, non SOLAS ship), powered by solar energy
- **Self-supporting** modular system, 2 hulls and 2 decks modules.
- **Production process** of catamaran to be finished by mid of 2019
- Fire, sound and vibration screening test result will be done by RISE by the end of this year.



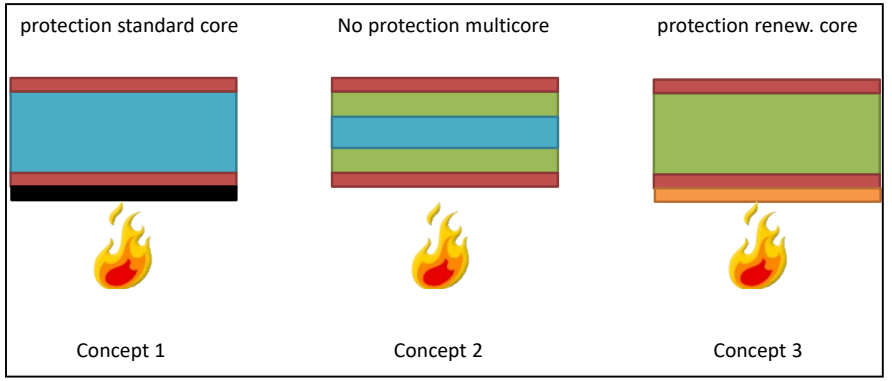


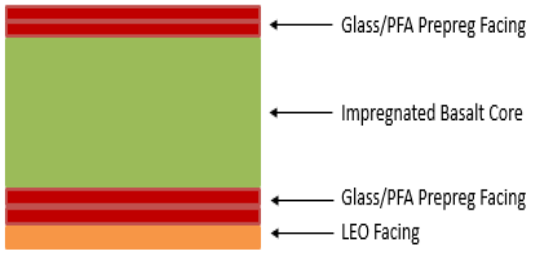
Demonstrator: Fire retardant, bio based, and competitive price material for maritime lightweight components

- The potential WP10 composite solutions can answer to **three different types** of the indoor/outdoor panel
- **Tested** the three sandwich concepts based on PFA/Glass prepreg with different core material.
- For **industrialisation** of production, the Glass/PFA resin prepreg manufacturing stepped up from pilot scale to production scale through a new prepreg production line launched by Composites Evolution.
- Through **cone calorimeter** and **single burning test** by RISE, only concept number 3 passed the criteria.
- The next step is to develop the concept number3 further in order to **reduce cost and weight further**.

Table 1: Different panel types

Properties	Floor	Ceiling	Wall
Sound barrier	x	y	z
Fire barrier	1	2	3
Load carrying	I	II	III

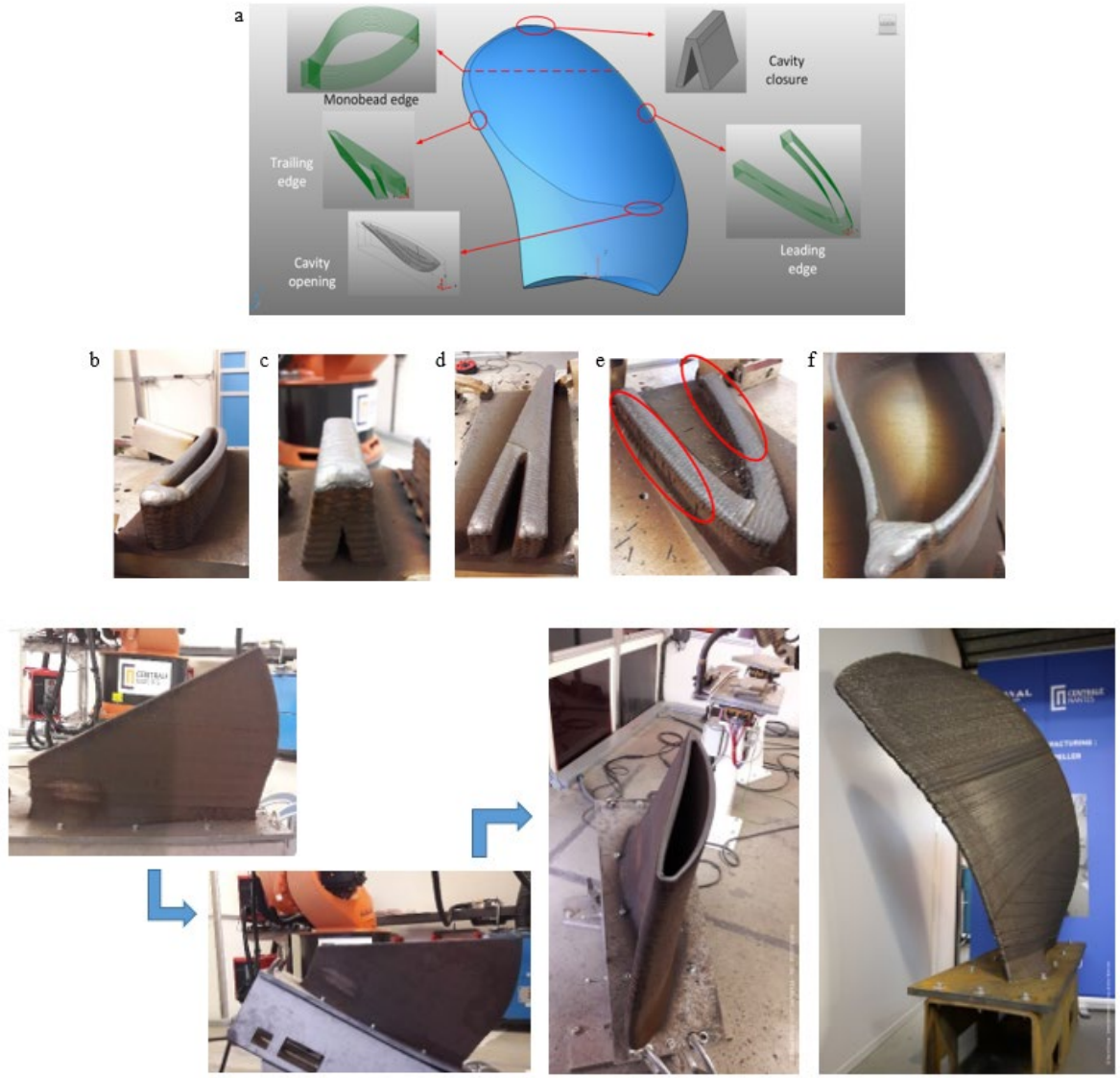




Concept 3 configuration

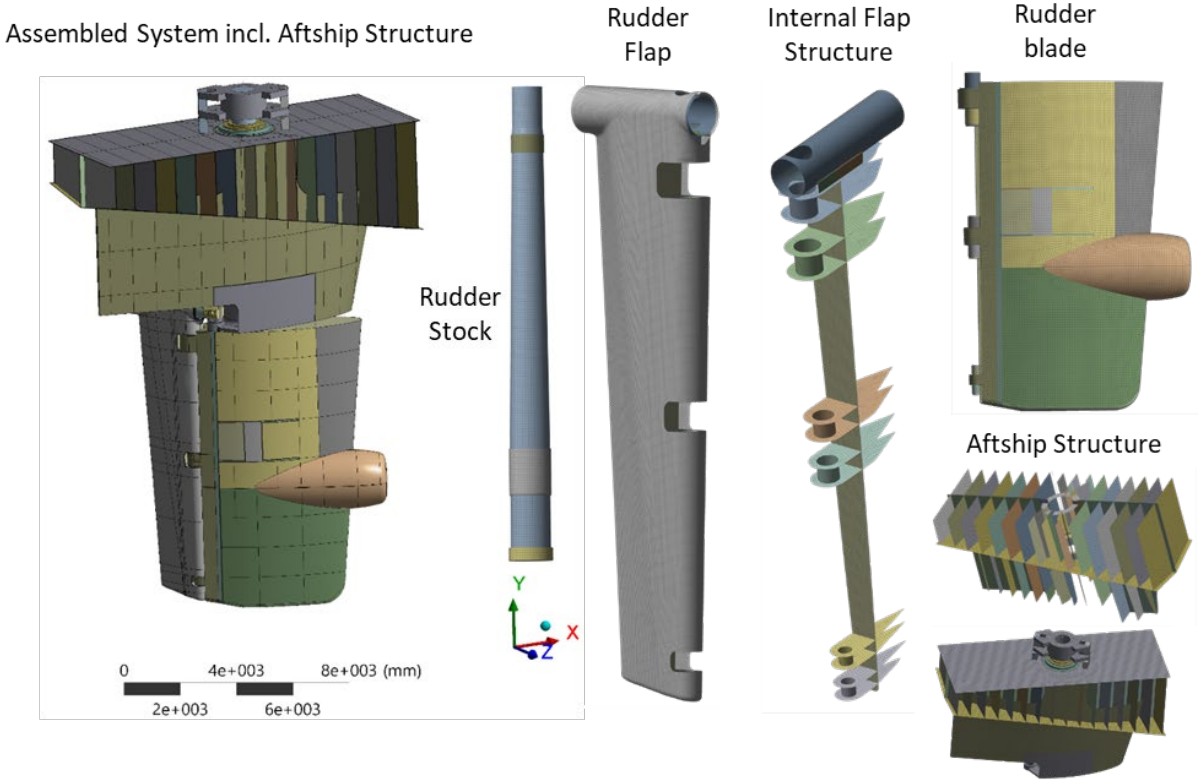
Demonstrator: Propeller blade using WAAM additive manufacturing

- A **design study** had been performed by SIREHNA to optimize the outer blade design and internal structure of the hollow blade by reducing the weight roughly 23% in air and 36% in water.
- Naval Group and ECN producing **representative part** of hollow blade and test block for **mechanical characterization** through MIG-MAG electric arc wire melting process.
- **The first third scale demonstrator** has been built using ECN robot cell and was produced in 3 successive stages of a different angle.



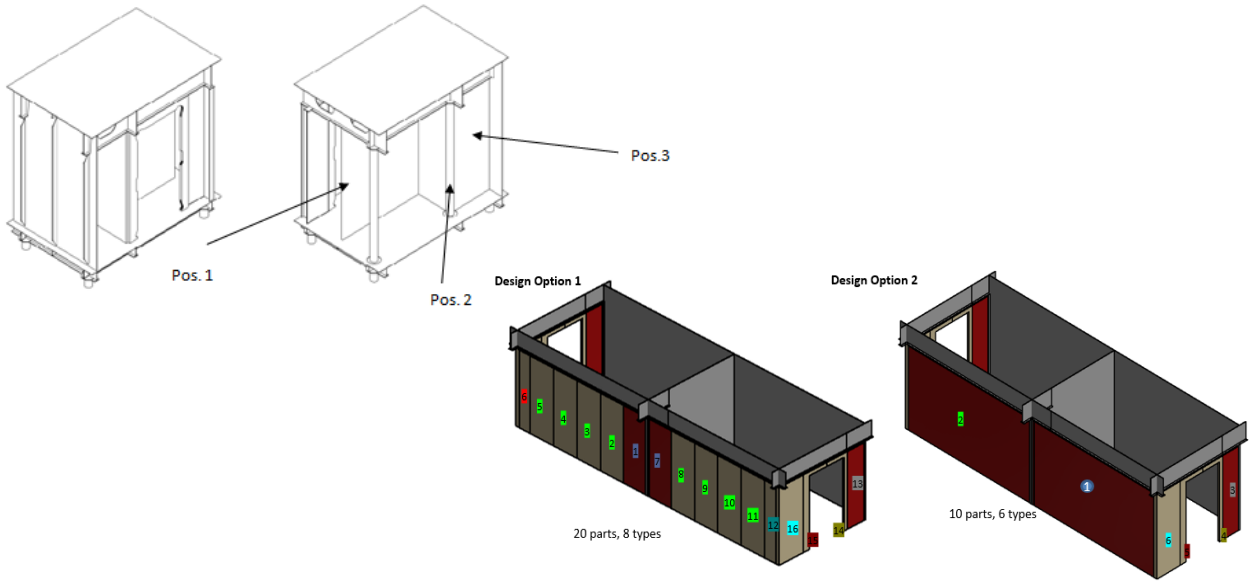
Demonstrator: Flap rudder using lightweight and high performance material for container ship

- Produce **real scale** rudder flap demonstrator for onboard application
- Hydrodynamics **investigation** as an input for preliminary design development
- Development of a **design catalog** including several design options for the shell, vertical & horizontal stiffeners, and joining methods of different structures
- **Practical** process development for manufacturing, handling, assembly, and repair
- The **comparison and assessment** of requirements for different manufacturing principles (contact moulding, and one shot infusion) are still under execution



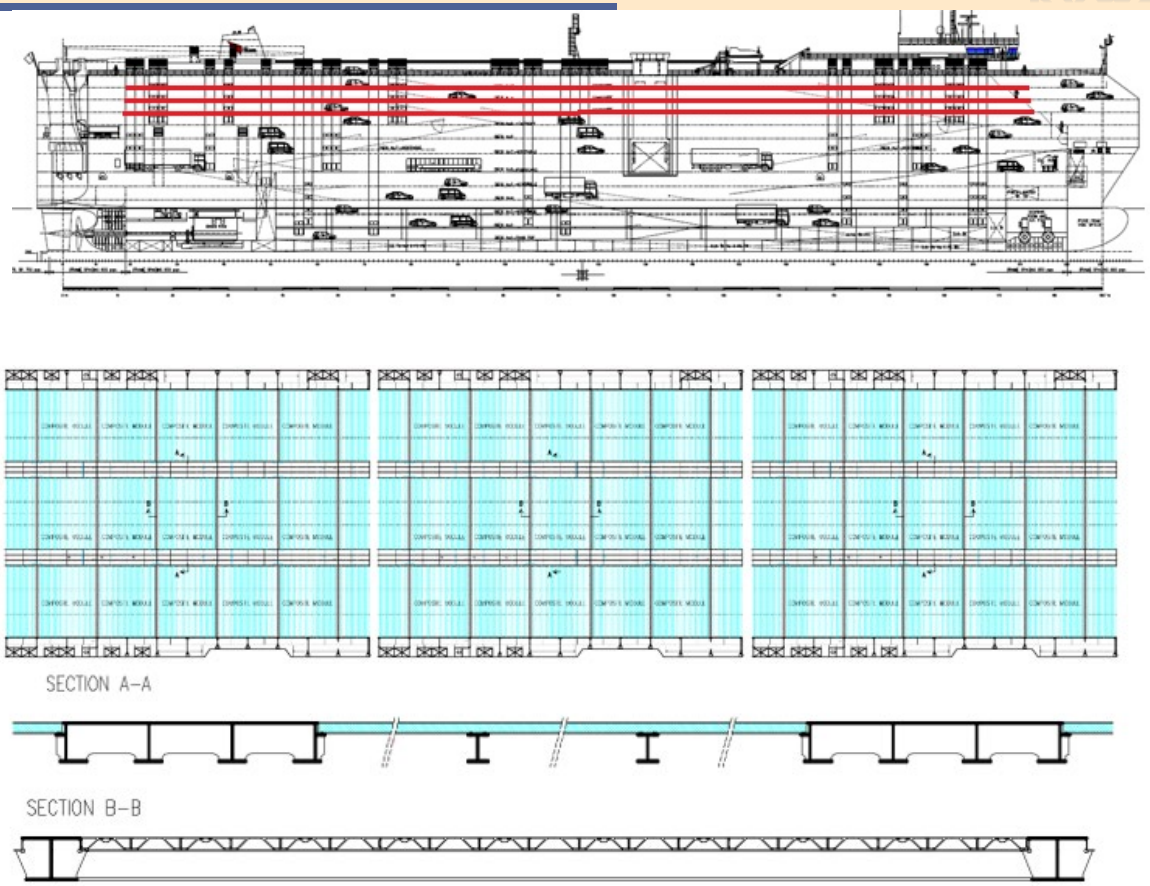
Demonstrator: Introduction of FRP material into yard production for cruise ships, passengers ferries and gas carrier

- **Developing** highly efficient shipyard process for adaptation, assembly and outfitting of a modular system.
- **Numerical and analytical analysis** to pass the requirement on the heat insulation, eigenfrequency, deformation, maximum width and weight of the composites wall have been performed by Infracore
- Development of design catalogue for **quick assembly** and joining technology between steel and composite component for series production.
- **Two demonstrators** (onboard, onshore) to be built
- The steel structure for **onshore demonstrator** has been built. The next step is to install the composite wall.
- **80 mechanical tests** are planned in total. The delivery of all samples are latest 01.12.2019



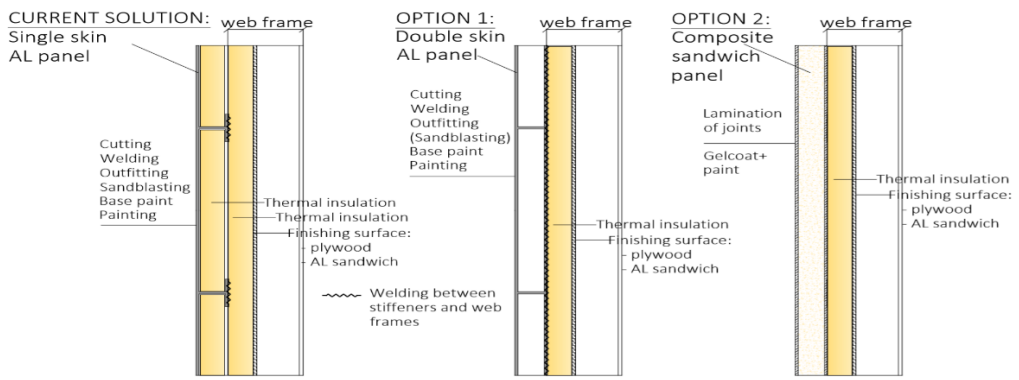
The demo will result in the reduction of the deck weight, increasing the flexibility in ship design due to a modular system

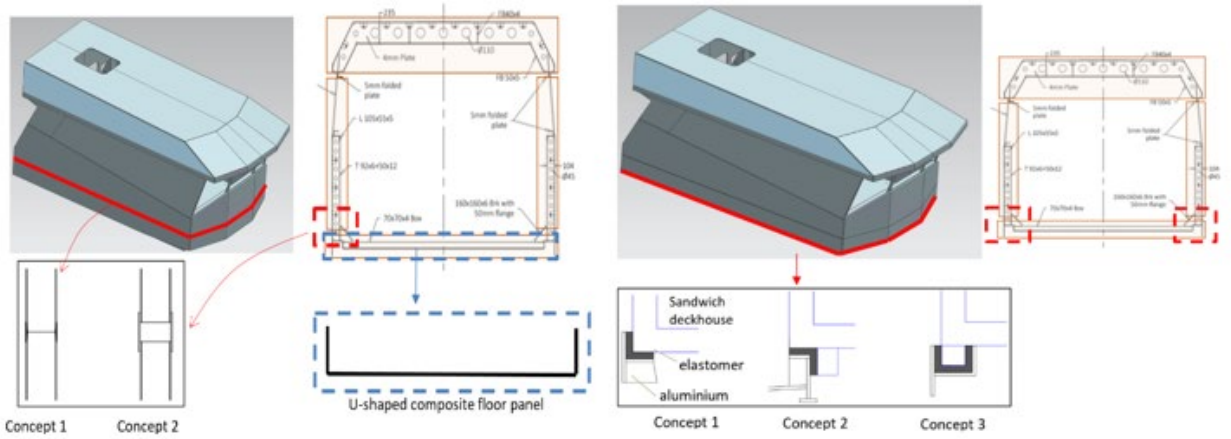
- Produce new design by using **highly automated** pultrusion process.
- **5 design alternatives** have been investigated, and the most promising one has been selected by performing numerical and analytical analysis.
- To prove **the feasibility** of the new material, production, and assembly process, the design will be applied on **onshore demonstrators**
- **Fire workshop** with RISE have been done to assess the design based on the fire requirements.
- Ongoing **discrete event simulation** by CMT for 5 different scenarios to optimize the assembly process.



Demonstrator: Pre-outfitted stiffened lightweight panel system of superstructure and deckhouse small aluminium crafts

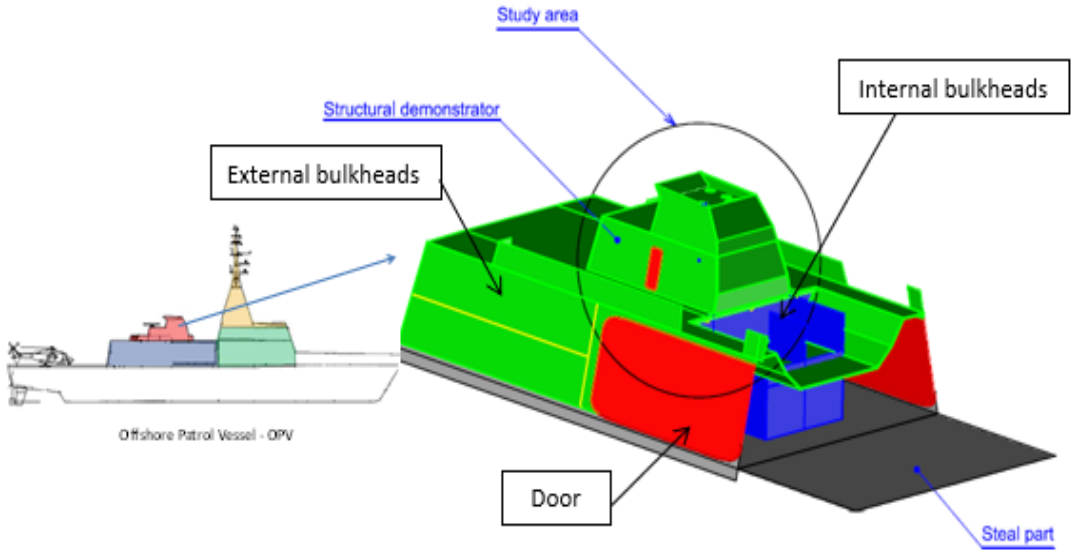
- The development of the design for lightweight (Aluminium/composite/foam) and **space-efficient panels** for the deck houses of the work boats/mid-size vessels
- Demonstrator onboard installation to proof **the feasibility** of the new material and joining process
- **3 design alternative for panels** in the form of double-skin aluminium panels or composite sandwich panels
- The **detailed design of the panel;** its connection with other panels and to the rest of the deckhouse structure; structural analysis procedures and the insulation solution are still to be developed.

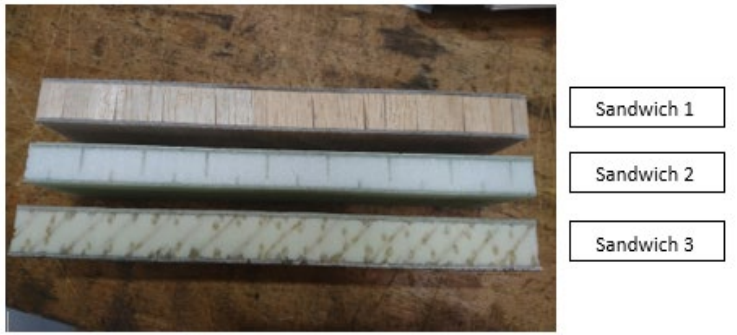




Demonstrator: Shore based demonstrator for a composite superstructure module on a metallic deck

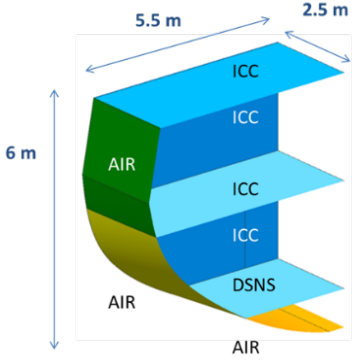
- Naval Group with Bureau Veritas defined the **design requirements** for composite design in the demonstrator.
- **Structural analyses** using finite element analysis has been conducted to define the stacking sequences and minimal material properties.
- Mock up are extracted from a **representative part** of the superstructure block.
- Three types of sandwich structures have been studied. 1st sandwich (glass/polyester/balsa wood core). 2nd sandwich (glass/fire retardant epoxy/PET foam core). 3rd Sandwich (glass/polyester/3D reinforced foam core).
- The development of **health monitoring** system inside the joint and the composite panels

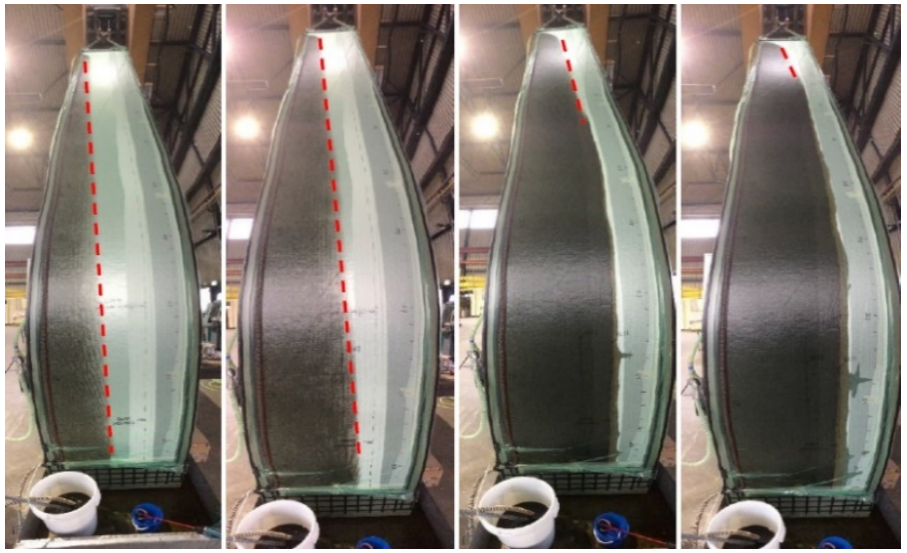




Demonstrator: First approved (complete) fibre-reinforced plastic (FRP) SOLAS ship

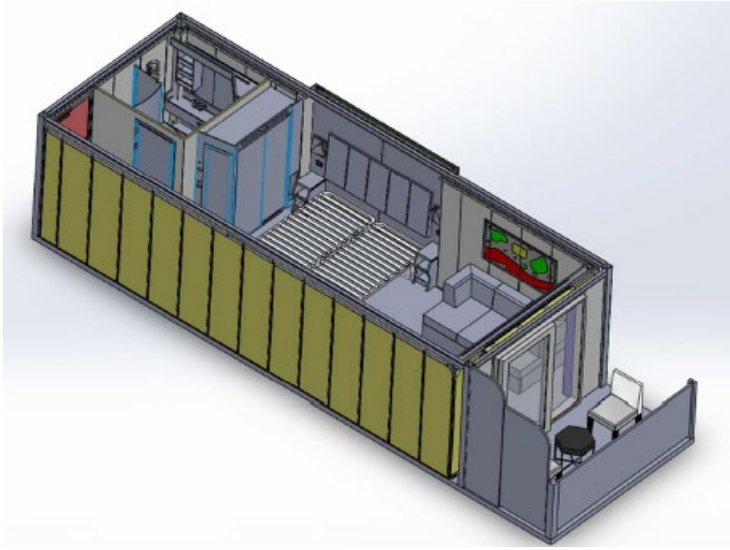
- Damen Shipyard Gorinchem prepared **the baseline design**. An analytical approach, as well as FEA approach was performed and documented
- The **novel resin** has been developed by EVONIK in various iterations on the different infusion temperature and mechanical properties in close collaboration with the production partners.
- The strategy for the **vertical infusion** is ongoing by both production partners AEL as well as ICC. Initial trials have been performed on small scale as well as larger scale for which a 6-meter-high tooling has been developed.
- For site testing, TNO will perform tests in relation to **quality management and structural performance**.
- Damen with close cooperation with BV, RISE, and NMTF has defined a **first draft of the approval process** to be considered within RAMSSES project.

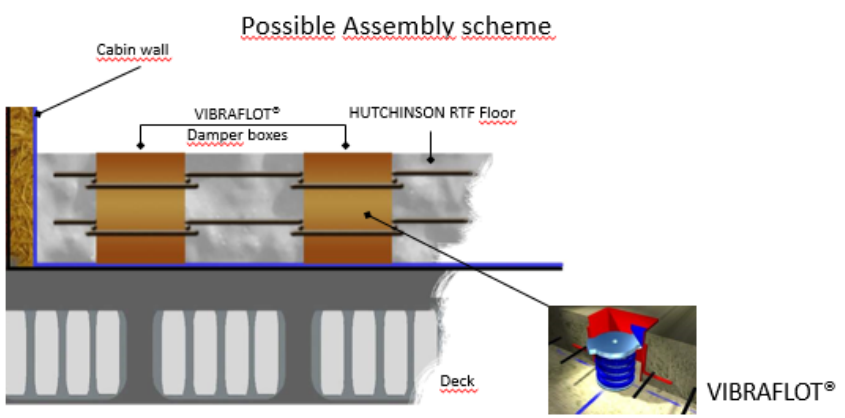


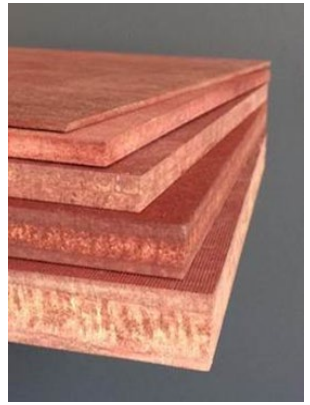


Demonstrator: Innovative cabins and ship structures using lightweight material to reduce the production and assembly time

- **Assessment** on the walls, ceilings, and bathroom unit to determine the optimized design of new generations cabin. And it shows result Replacing the stiffened deck plate by composite structure would make a weight gain estimated at 125 kg/m². Therefore, WP18 decided to focus on the floor to introduce composite materials since it has great potential for weight reduction at an expected low final cost penalty.
- For **noise and vibration**, all the requirements have been listed and some of those criteria will be tested on sub-assemblies using when necessary the IRT Jules Verne multi-axial test bench.
- HUT proposes the use of its **innovative ZALTEX +** which is a sandwich composed of a core of ZALTEX.
- "U shaped connector" will be use to joint the composite floor and the deck floor.







Zaltex material

Demonstration of mechanical performance improvement and effectiveness of welded joint by using low HSLA thickness in marine structure

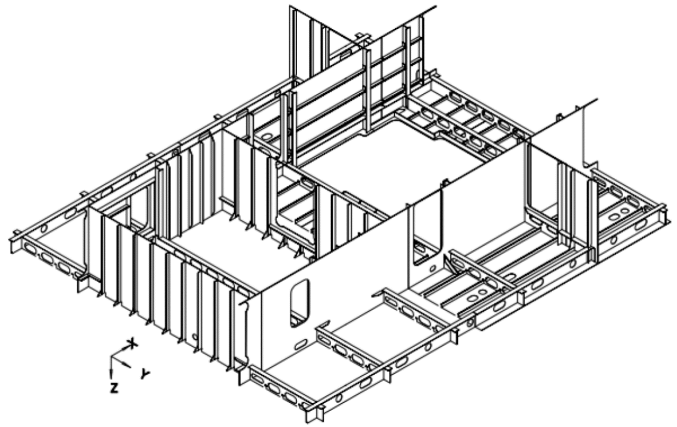
- **The test matrix** based on the welding techniques, welding parameters, and two post processing methods and DoE (Design of Experiment) have been developed.
- The **welded coupon** for laboratory test were cut in Ficantieri Shipyard. The steel plate were cutted using plasma cutting system and welded using the FCAW (Flux cored arc welding) process.
- In this period, the first phase, the study of **corrosion properties** for the parent metals, including the microstructure characterization has already started by NTUA
- AIMEN has performed the non destructive test, macro and hardness test, tensile test, impact test, and fatigue test for all material combinations (AH36-AH36, X65-X65, AH36-X65, AH36-S690)
- The next step is to conclude all the result and choose the best combination for post processing methods application.

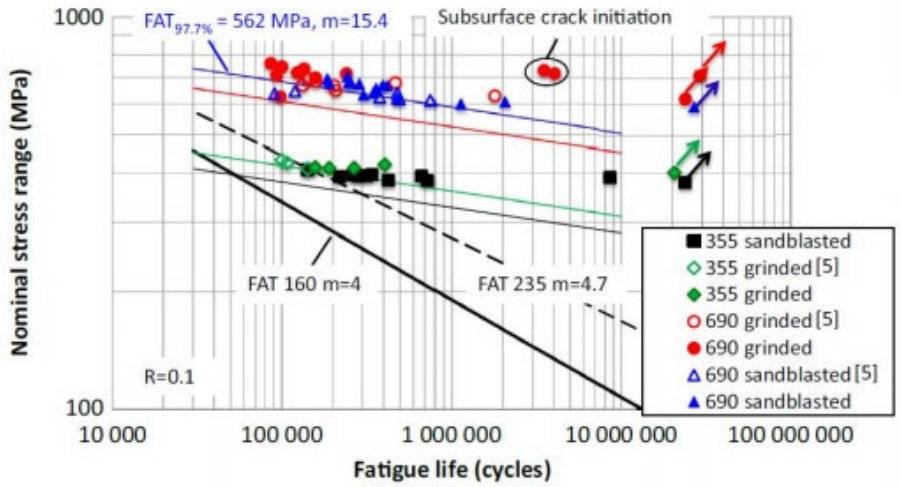
Preparation of welded coupons

FSP preliminary trials performed in AIMEN on homogeneous sample S690 material

Demonstrator: Implementation of high strength steel material to achieve higher strength in passenger ship superstructure

- To demonstrate the use of high strength steels and thin deck plates, **a demo block** will be produced in WP20 supported with a series of small-scale pre-tests.
- The **basic design** of the demo block was done within the first period. Demo block is including high strength steel in longitudinal and transverse bulkheads (S690) and thin deck plates (4mm).
- During small scale test, it has been found that with MAG welding S690QL steel has very good **fatigue life** in non-load carrying cruciform connection than AH36 steel
- It has also been found that with good quality laser-hybrid welding good **fatigue strength** can be achieved for thin (4mm) plates.
- The next step is to compare the results with full scale tests

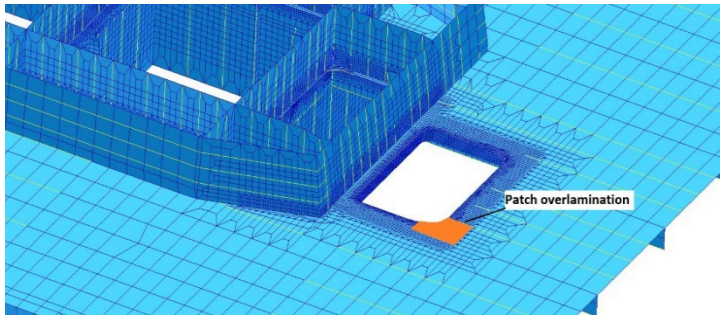




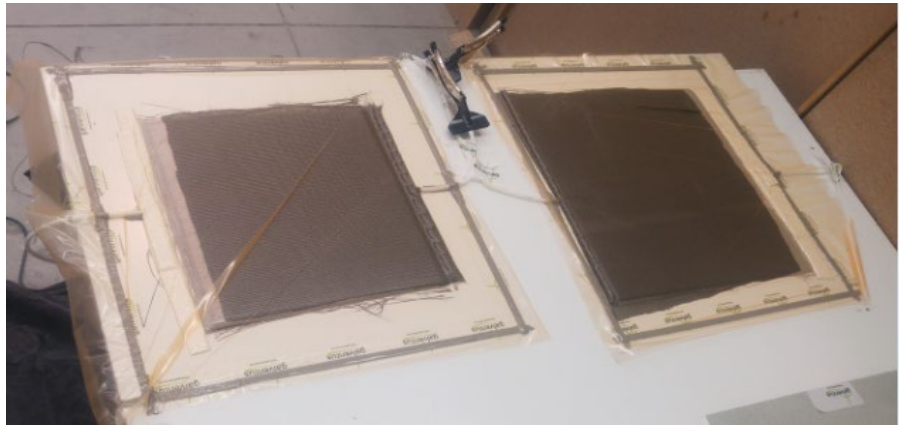
Fatigue test result for 15mm free edge

Demonstrate solutions of composite overlamination for repair and improve the pristine properties of welded joint in marine environment

- **Systematic design** and **processing guideline** for application of composite patches in maritime application
- The **product design** for 3 demo cases (composite for crack arresting, joint repair by composite overlamination, and improving fatigue behavior of welded HSLA by composite overlamination) were done.
- **Steel surface optimization** by analysing the surface roughness and surface energy obtained by three different surface conditions was done, with the objective to improve composite to metal adhesion.
- The SLJ (single-lap joints) combining AH36 and both composite systems studied (Epoxi and Vinylester) were manufactured and sent to Frounhofer IFAM to be tested.
- **Composite characterizations** tests were performed (tensile tests, compression and shear tests, as well as fibre fraction within the composite calculation). Results obtained from this tests were included as inputs into the numerical modelling developed to design the composite patch for the demo.



Example of opening corner on exposed deck with composite patch (FEM model)



Composite laminates manufactured by GALVENT using Vacuum Resin Infusionn (VRI)

Grit blasted HSLA steel and Pull-off tests