RAMSSES

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

01.06.2017
30.11.2021

Budget: €13.5 M
Funding: €10.8 M

36 partners
12 countries

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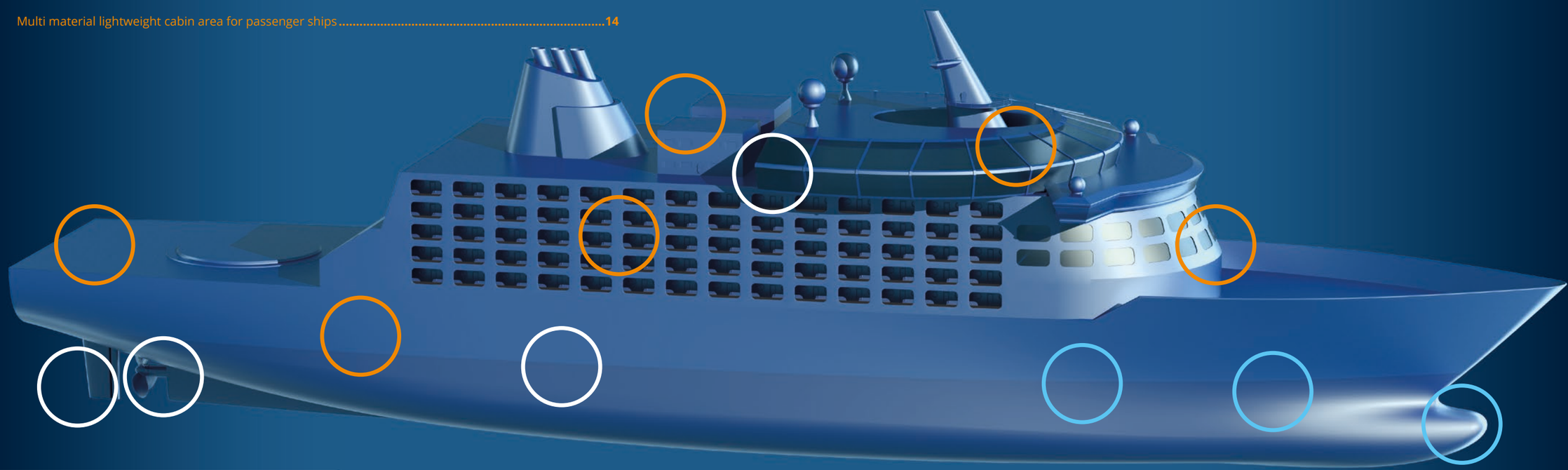


Equipment & Components

RAMSSES Assessment

RAMSSES Coordination & Organisation

Steel & Patch Repair

FROM THE COORDINATORS

Carlo Cau

RAMSSES Administrative & Financial Coordinator
CETENA S.p.A. Centro per gli Studi di Tecnica Navale

I am pleased to present the results achieved by the RAMSSES project during its 54 months of life. The project, developed by 36 partners coming from 12 different European countries, paved the way towards lighter and consequently more eco-friendly and more efficient ships.

As suggested by the acronym, RAMSSES is conceived as a pyramid whose base layer is made up by results of physical demonstrators ranging from innovative components, maritime equipment, the application of high-performance steels, and the integration of composite materials in various structures, as well as solutions for global repair. These results were analysed and validated from a technical and economic perspective in the second layer while the top of the pyramid has led to reusable test results, material data and experiences for future similar applications setting up a Materials Innovation Platform for information exchange and cooperation.

From the coordinator's perspective, this work was made even more difficult due to the pandemic situation that hit our project, as well as the rest of the world in 2020 and 2021. Despite this global disease, we ensure the continuity of the project making the communication smart, intensifying the use of virtual meetings up to the organization of virtual General Assemblies with wide participation of external stakeholders.

The success of the project confirms the strength of the partnership in overcoming these difficulties and the extraordinary capacity of the Project Management Team which was able to coordinate the development of the project in this unprecedented situation.

Matthias Krause

RAMSSES Technical Coordinator
Center of Maritme Technologies gGmbH

RAMSSES was accompanied by a strong increase in public awareness of the threat posed by climate change. Without doubt, the path to zero-emission shipping requires technical innovations. Highly complex vehicles, a wide variety of transport tasks and a high life expectancy of the vessels form a set of requirements that can only be met by a mix of different approaches which can be applied in the short term or in the next few years for new buildings or retrofitting existing ships.

The fact that the use of new, lighter materials and structures in shipbuilding is already technically possible, ecologically advantageous and economically viable for a wide range of areas is the good news that RAMSSES can convey today.

Standardisable panel systems from series production, large one-off structures produced by an advanced vacuum infusion process, fire-resistant and bio-based materials, innovative processing methods such as additive manufacturing technology and filament winding... the project has effectively made use of technologies to create and demonstrate solutions that can be applied in equipment or structures for all kind of vessels.

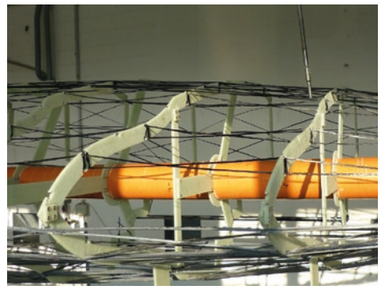
Now it is time to bring the new technologies afloat, but much more needs to be done. We are happy that many instruments are in place to enhance further maritime material innovation, such as the Smart Track to Approval concept, the lively E-LASS network and various funding programs. We are looking forward to discuss ideas and opportunities with you!

Modular lightweight system for less critical internal walls and superstructure

OBJECTIVE

Development of a lightweight modular system consisting of a truss core with connecting and outfitting elements. For the maritime industry, primary motivation for the application of new materials in commercial shipbuilding is weight saving and reduction of mounting time.

BaltiCo has developed a technique to produce lightweight panels, boats or similar structures: in an automated way carbon fibres are laid to form a load bearing inner structure – a truss-like structure, which will then be covered, e.g. with GFRP laminates. This strand laying process has been applied to design and build a lightweight catamaran with zero-emission, called 0e-N. It consists of four modules – two hulls, main and solar deck – which can be assembled and disassembled. The catamaran has solar modules which provide the energy for the electric propulsion unit, and has been designed and made by BaltiCo, too. Lightweight panels made using the strand laying process can be used for example as bulkheads, decks or to build cabins. Such a panel passed the FTP Code Part 11 regulation, that is it sustained 60 minutes of flame without failure in a test.



Production of inner structure of hull in strand laying process

Test of the catamaran

Electrical propulsion unit

LIFE CYCLE PERFORMANCE ASSESSMENT

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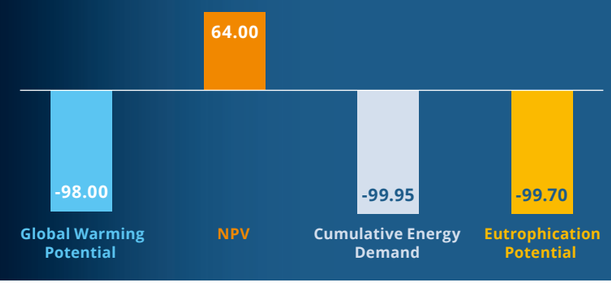

TECHNOLOGY HIGHLIGHTS

- **Lightweight modular system**
- **Zero emission during operation**
- **Increase revenue more than 50% and faster payback time**

WP LEADER

Dr. Dirk Büchler
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BaltiCo has shown that using the strand laying process very light panels and structures can be made. Moreover, this is done in an automated way ensuring a high quality while being cost efficient. Producing a catamaran consisting of modules proves to our customers the great flexibility and range of applications of this technique.

Lightweight Components for high loads and fire class

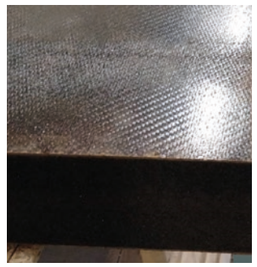
OBJECTIVE

Development of an integrated lightweight panel system for a competitive price with excellent fire, thermal and acoustic properties. This system will include weight saving and reduction of mounting time combining multiple options of interior outfitting applications using for external structural components.

PODCOMP led the development of renewable PFA resin/glass fibre prepreg composite sandwich panel concepts with good fire performance, tailored acoustic, and mechanical properties. Depending on the required properties, the skin layer is combined with one of three different cores, the renewable balsa, non-combustible silicate, or non-combustible FoamGlas from recycled glass. For Meyer Werft, the team developed fire-resistant walls with an easy mounting solution. Six wall segments were made. Two were installed onshore as demonstrators while four are saved for onboard installation. For Baltic Workboats, the team developed a fire-resistant sunroof. These panels are mounted on a test rig onshore, to evaluate resistance to outdoor conditions. For FLOW Ship Design, the team developed a car-deck panel with a low environmental footprint, using the PFA prepreg and balsa core. A ~7 m long panel was made and full-scale fire tested. In addition, several panels for acoustic insulation have been made and tested. To reach a competitive price, a semi-automated production line for such panels must be developed.

One panel as delivered and one with PVC-foil at Meyer Werft

Cardeck panel for Flow Ship Design, full scale fire test of cardeck panel at RISE



Acoustic panel from PFA/glass prepreg and FoamGlass core

LIFE CYCLE PERFORMANCE ASSESSMENT

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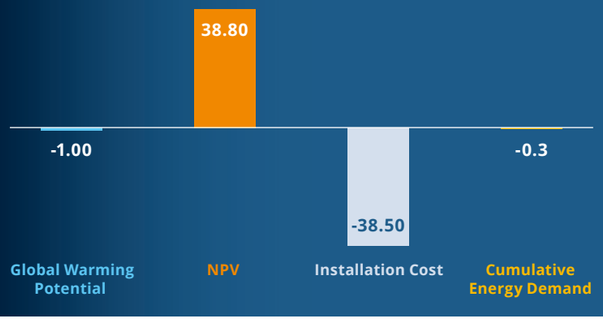

TECHNOLOGY HIGHLIGHTS

- **Produced non-combustible organic composite material**
- **Produced renewable and recyclable organic composite material**
- **Wide range of application area**

WP LEADER

Birgitha Nyström
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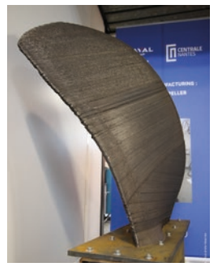
The project has been a great experience for our company and the team working together to achieve the goal to develop integrated fire, thermal, acoustic and lightweight composite panel system with a competitive price for marine applications. The different concepts meet requirements from shipyards for different applications. The projects opens the possibilities to increase production of prepreg at Composite Evolution and start new production lines at Podcomp.

Propeller blades made by additive manufacturing

OBJECTIVE

Development of a representative propeller blade demonstrator and identify fabrication risks to mitigate before introducing this solution on the market. Choosing Additive Manufacturing (AM) for production provides great benefits for the entire production value chain.

NAVAL GROUP, SIREHNA, Ecole Centrale de Nantes (ECN) and ENSTA Bretagne (ENSTA) designed, manufactured and tested a hollow blade demonstrator in order to assess the benefits of Wire Arc Additive Manufacturing (WAAM) for propellers. The size of the demonstrator (1,5 to 2 m blade) is sufficient to allow extrapolation of the use of the WAAM process to propellers of a larger size, allowing to address globally the propeller market. The demo-case addresses the challenge of new lightweight high-performance materials and related construction principles to provide a step change in vessel efficiency, both in terms of energy use and maintenance costs. The first in the world of simplified demonstrative blade produced and showed the capability of the WAAM process to manufacture a hollow blade in 3-axis.



Simplified demonstrator hollow propeller

LIFE CYCLE PERFORMANCE ASSESSMENT

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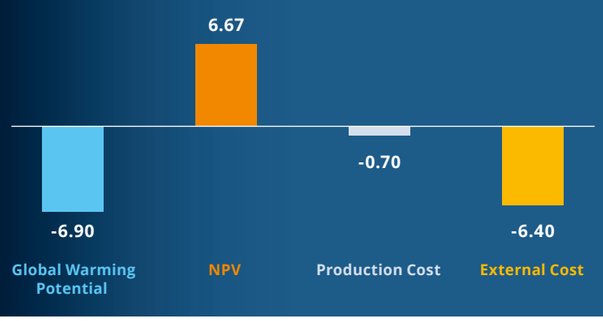

TECHNOLOGY HIGHLIGHTS

- **High freedom of design**
- **Low acoustic emission**
- **Improved hydrodynamic properties hence reducing the energy use and maintenance cost**

WP LEADER

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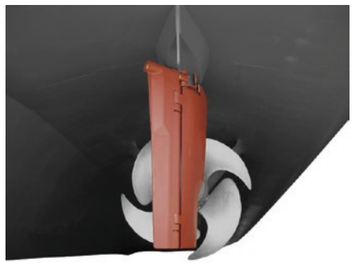
Naval Group

Lightweight Rudder flap

OBJECTIVE

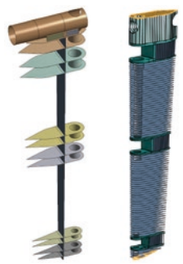
The WP 12 demo case addresses in combination the first load adapted as well as hydrodynamically optimized application on flap-rudders for merchant vessels. The combination and development of these techniques is straightforward in order to obtain recognition and an established role for fibre-composite materials in flap-rudder structures.

Becker Marine Systems (BMS), in conjunction with its project partner InfraCore Company, have developed an innovative composite-based rudder flap for high-lift rudder application. By replacing the traditional steel-based flap construction with a composite approach, numerous advantages such as improvement on the hydrodynamic design, reduction of the maintenance, increased safety, eliminated corrosion, lower transportation and handling cost, and weight reduction are gained. Flap rudders are very highly loaded and operate in a hostile marine environment. Consequently, composite construction for rudder flaps is a new approach and has required extensive effort to adapt the steel-based flap design for application of composites. For this project, a 1:6 scale model of a flap fitted to a 100m² fast container ship flap rudder has been used as a design basis. InfraCore have applied their expertise in glass-fibre construction techniques using a rib and spar combined with one-shot infusion approach. Comprehensive static break-load testing that simulates hydrodynamic loading with a safety factor of 2 has been successfully performed on the structure.



The Becker Marine Systems flap rudder.

Measured deflections on composite rudder flap under load.



Flap Internal structure

LIFE CYCLE PERFORMANCE ASSESSMENT

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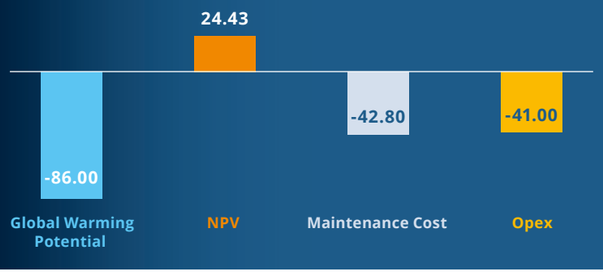

TECHNOLOGY HIGHLIGHTS

- **One-shot resin infusion process hence reduced production cost**
- **Better hydrodynamic performance and significantly reduced weight**
- **Longer life time**
- **Lower maintenance, transportation and handling cost**

WP LEADER

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IBMV

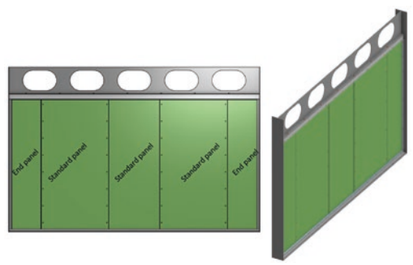
RAMSSES has allowed us to develop new lightweight composite design and construction technology for application to high-lift ship rudders for the first time. This will allow better, more efficient flap rudders to be designed in the future, with easier installation, significantly reduced maintenance requirements and reduced weight.

Integration of systems for internal walls and superstructure of cruise ships into shipyard processes

OBJECTIVE

Introduction of fibre reinforced polymers (FRP) into the yard production process for usage in cruise ships, passenger ferries and gas carriers with the aim to reduce weight (up to 30%).

The ambition of WP13 is to complete the design of the composite wall panels according all technical and process requirements, perform the tests necessary for approval of the material and start with the demonstration of a globaly non-load bearing internal bulkhead. The general design of the composite panel was completed in close cooperation with the WP-partner InfraCore Company, taking into account a huge variety of requirements, such as mechanical, noise & vibration, process and fire behaviour in compliance with SOLAS, which was the most difficult hurdle and led to continuous iterative material changes and design work continuing until the end of the project and beyond.
The general design regarding the efficiency of the installation and the bonding techniques of composite and steel materials for different joining types was completed by realization of the onshore demonstrator. The necessary tests for the approval process of an on board demonstrator have been performed and still need round of iteration of the material development until all criteria are compliant to the SOLAS requirements.



Infracore multi-panel walls

Steel construction of the onshore demonstrator

Full-Scale fire testing (IMO FTP Code Part 3)

LIFE CYCLE PERFORMANCE ASSESSMENT

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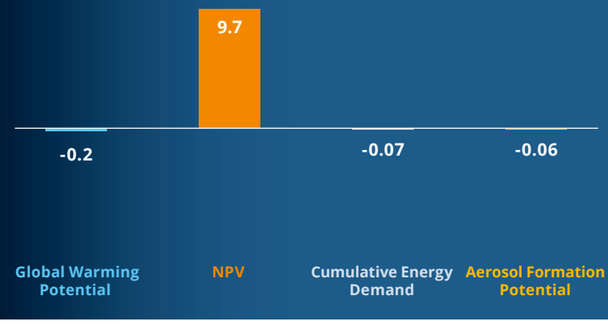

TECHNOLOGY HIGHLIGHTS

- **Lightweight panel reduced fuel consumption, emission, less draught, better stability and added more payload**
- **Standardized & easily to be modified modular panel to react on the late stage change process to customer wishes**

WP LEADER

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Meyer Werft

We developed a modular lightweight panel capable to be implemented in the yard production process and passed fire resistance requirements FTP code part 5 & 3. We made a big step forward to the application of composites onboard a cruise vessel and the remaining open issues of fire safety are clear and defined. The progress we made within RAMSSES pushed us to provide our customers solutions for a better, lighter, cost-efficient and environmentally friendly cruise vessel

Modular Decks for RoRo vessels

OBJECTIVE

Reduction of the weight of the strength decks with increased flexibility in the ship design due to modular system. Optimising the deck structure design using innovative materials and geometry results in more efficient production as well (shorter lead times, improved reliability and quality).

Internal strength decks on ro-ro vessels introducing FRP pultruded profiles have been developed at RAMSSES project. The overall objective to develop an optimised cargo deck structure using RAMSSES defined deck modules with respect to production optimisation as main objective followed by weight reduction, joint development, fuel oil consumption and CO_2 emission reduction. Several design alternatives assessed with respect to structural arrangement as well as production and assembly process. Assessment on the integration of the RAMSSES design alternative into shipyard process was performed considering several scenarios and considering the data collected from the full scale demonstrator production process. The novel structural design was further evaluated through laboratory tests results (mechanical tests, fire tests), site tests on the full scale demonstrator as well as demonstrator production process and assembly. It was shown that the design concept is applicable for production and assembly procedure at steel shipyard conditions.

Demonstrator during assembly

Demonstrator lashning test

dFRP pultruded profile

LIFE CYCLE PERFORMANCE ASSESSMENT

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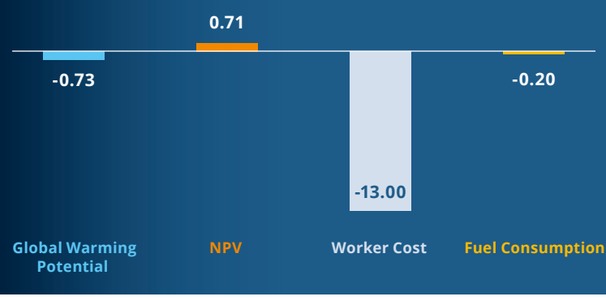

TECHNOLOGY HIGHLIGHTS

- **Reduced the weight and fuel consumption**
- **Modular lightweight panel design can reduce the assembly time in the shipyard**
- **Reduce the emission and increase the net present value up to 1%**

WP LEADER

Vito Radolovic
FLOW SHIP DESIGN d.o.o.
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The developed RAMSSES design using FRP pultruded profiles can not only be used for ro-ro cargo decks structural application, but also for several structural and outfitting applications on various types of vessels. The considered pultruded technology provides flexibility in both the design, production and cost, which is a great opportunity introducing of the technology to shipyards and shipowners.

Lightweight alu and composite walls for work boats

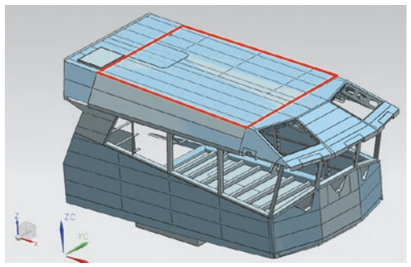
OBJECTIVE

The development of the design for lightweight and space-efficient extruded sandwich panels for the deck houses of the small crafts/workboats which include the integration of the new panel system concept into the design and production environment and the development of procedures of joining.

The research and development in this Work Package address a solution of double skin extruded aluminum panels and composite sandwich panels for deckhouses and superstructures of small to medium-size workboats (up to 50 m). The R&D work contributes to the overall aim of the WP to reduce the production lead time and to decrease the weight of the deckhouses of a workboat. The design case and the corresponding requirements have been defined. The shortcomings of the conventional solution have been identified. New possibilities provided by sandwich panel design have been analysed together with potential shortcomings and production-related issues. The requirements such as strength, fire and comfort have been identified and Podcomp delivered the sandwich panels. Actual demonstrator built in a smaller representation of the sunroof of a riverboat to prove the design and quality of the novel panel design and its production. The sandwich design resulting in comparable structural properties when compared to conventional single skin design using extruded aluminum panels have been developed and proofed.

A river boat with a sunroof

Sunroof demonstrator



Developed deck house design

LIFE CYCLE PERFORMANCE ASSESSMENT

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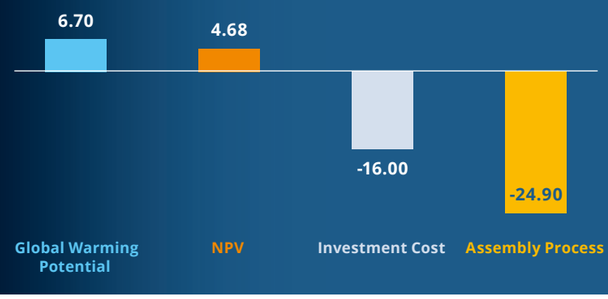

TECHNOLOGY HIGHLIGHTS

- **Composite sandwich panel with a fire class for sunroof of riverboat**
- **Reduced production lead time and costs as well as decreased weight of riverboat**

WP LEADER

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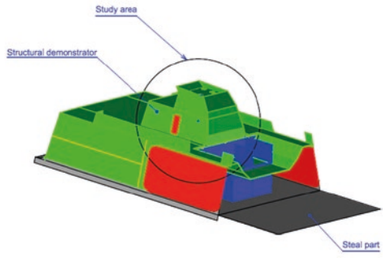
Composite superstructure module on a steel deck for multi-purpose vessels

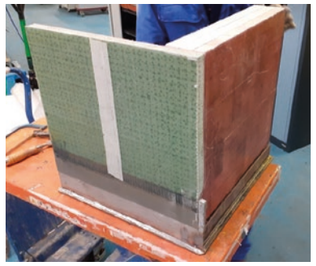
OBJECTIVE

Conception, production, testing and validation of a demonstrator for composite superstructure meeting multi-criteria made up of a module on metallic deck.

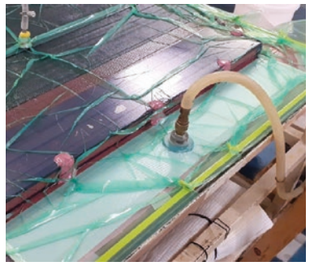
The main challenges of the WP16 are to: reduce the weight of vessel superstructures, reduce ownership and acquisition costs, improve the fire behavior of composites materials, develop functionalized composite structures (integration of fire insulation and sensors in bulkheads) or even design, develop and qualify multi-material assemblies. This project made it possible to go through a number of stages leading to the design and choice of materials for the selected application case. The concept of a composite superstructure block and the associated construction principles have been defined. Demonstrators of the joints were produced by Naval Group and tested at ENSTA Bretagne in order to guarantee the resistance of the joints against regulatory loads. In addition to the mechanical campaign, reaction and fire resistance tests were carried out to select the most efficient configurations so as to guarantee a level of fire safety that meets IMO SOLAS criteria. Following this experimental work, a regulatory process has been conducted by Naval Group and Bureau Veritas in order to approve this structure with respect to the rules and regulations (structural and fire assessment).



Localization of the usecase on the OPV super-structure



Multimaterial coupons



Infusion on the mlti material joint

LIFE CYCLE PERFORMANCE ASSESSMENT

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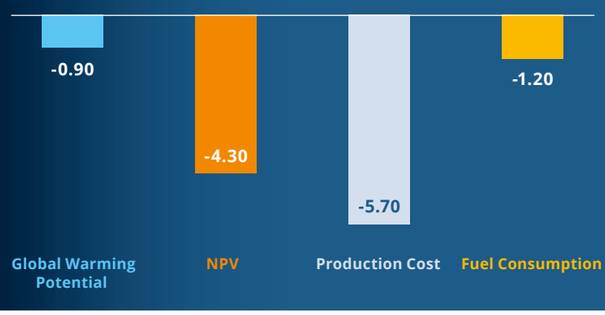

TECHNOLOGY HIGHLIGHTS

- **Multimaterial superstructures block and deck joint**
- **Two different configurations of lightweight bulkhead design passed the FTP code part 11**
- **Application of removable adhesive bonding to remove composite panels and to comply with the modularity purpose**

WP LEADER

Emilien Billaudeau
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Naval Group

The project has been a great experience and outcome for our company. We were able to develop not only a modular lightweight module system but also a lightweight system that passed the fire resistance requirements in FTP code part 11. It allows us to provide our customers a better, lighter, cost-efficient, and environmentally friendly vessel solutions

Custom made hull for offshore vessel

OBJECTIVE

Acquire the capability to design, produce and market complete composite vessels approx. 85 m length that complies with SOLAS and class regulations. By validating the production process of large composite structures with economic and cost improvement, key performance indicators on fire resistance, impact resistance and structural robustness.

The team led by Damen answers the challenges to design and scaling up the composites technology production include pioneering the capability to infuse thick laminates up to 6 meters in height that represent full ship hull structures. Damen shipyard (DSGo) prepared the baseline design comparing traditional steel scantlings, sandwich panels, and monolithic structures under the auspices of the classification society Bureau Veritas (BV). Both AEL and ICC have demonstrated they can infuse hull sections for six-meter-high hulls with their technology of traditional sandwich structures and oblique layers structure by using novel resin developed by EVONIK. To validate the demonstrator structure, a complete package of testing was performed by TNO and RISE and witnessed by BV, involving coupon scale testing, components testing, full-scale joints testing, severe impact testing, full-scale testing on global ship bending moments up to full-scale fire testing representative for a helicopter deck fire after impact with damaged helideck.

Full-scale hull section for a large offshore vessel

Demonstrator

Production process

LIFE CYCLE PERFORMANCE ASSESSMENT

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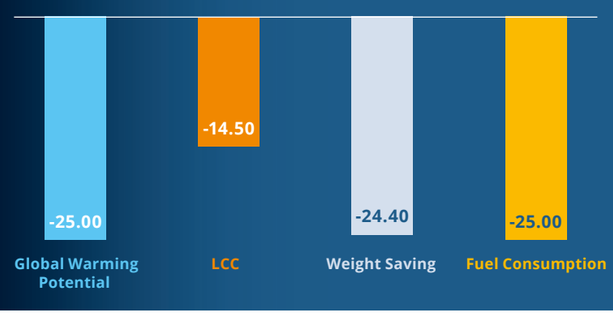

TECHNOLOGY HIGHLIGHTS

- **Vacuum infusion process of thick laminates up to 6 meters in height**
- **Enabling assembly of large composites decks and bulkheads relying on the adhesive bonding technology**

WP LEADER

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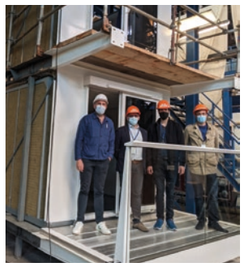
The project has been a great success for all partners. Together the results surpass the targets set at the beginning of the project. The complete development cycle for large composite ships structures was challenged. Each of us can disseminate results towards large composite marine assemblies. For Damen, the results will be used for extending the use of composite in for larger composite ships.

Multi material lightweight cabin for passenger ships

OBJECTIVE

Design innovative cabins and ship structure interfaces to generate a novel ship structure architecture, reducing weight, size, costs, production times, maintenance and refurbishment effort. This includes the design of a six-side cabin module for full functional modularity, the use of innovative hybrid or composite lightweight components and modified network integration into the cabin modules.

The percentage of prefabricated cabins has increased up to about 85%. The state of the art consists of a module including ceiling and walls (except bay window or window) and bathroom. The bay window and the balcony are not part of the prefabricated cabin as well as the floor for main cases (a very few have floor part of cabin module). The goal inside RAMSSES is to modify this outfitting sequence in order to install cabins that are as much as possible finished and ready for final inspection by the customers without needing any work inside. This needs to add to the existing prefabricated cabin on the floor, the bay window and the balcony. Cabin floor was designed in composite material, but unfortunately, none of the material selected passed FTP Code Part 11 regulation even with additional insulation. RAMSSES concept is showing a real benefit with 500 kilograms less per cabin system, and new material with higher fire properties have to be monitored for the future.



Picture 1: demonstrator with 2 cabines

Picture 2: cabin on top of the demonstrator

Picture 3: FRD test in RISE testing facility

LIFE CYCLE PERFORMANCE ASSESSMENT

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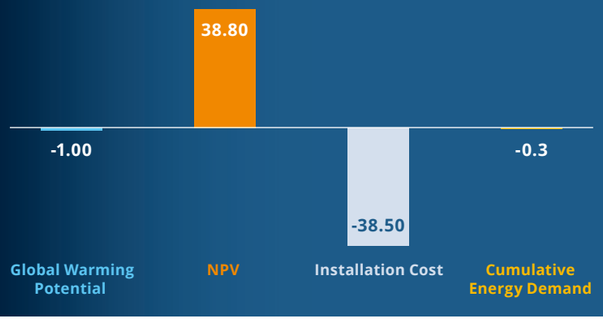

TECHNOLOGY HIGHLIGHTS

- **Weight reduction on the prefabricated cabins due to composite floor can add 7% to 9% additional cabins on the small cruise ship with 500 cabins**

WP LEADER

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The project has been a great experience and outcome for our company. We were able to design a new ship architecture for 6 faces cabin with high benefit in term of weight reduction and prefabrication with cabin fully finished in workshop. Unfortunately, composite materials we investigated for cabin floor are not suitable in term of fire resistance. We will still monitor new materials in the future.

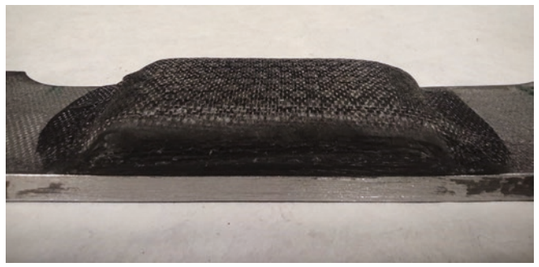
Highly Loaded structural details from high tensile steel in passenger and research vessels

OBJECTIVE

Demonstration of the effectiveness of High Strength Low Alloy (HSLA) steel for improving the mechanical performance (static and fatigue) of the marine structures (incl. welded joints) by means of test campaign and using appropriate design tools (e.g. development numerical simulation and statistical methods).

Highly loaded parts in the structure of large ships are currently strengthened with thick sections of conventional steel, or the design needs to be modified. High tensile steels can offer significant weight saving (5-20%, case-dependant), improved strength and more design freedom. While the feasibility of HTS in shipbuilding has been shown in previous projects; joining processes and joint properties are currently weakening HTS structures and decreasing practical use. Fincantieri, supported by Cetena, Aimen, NTUA and CMT, demonstrated how HSLA could be properly welded in shipyard conditions without pre and post heating, guaranteeing adequate performances in respect of the current regulatory framework over-performing from the point of view of corrosion and fatigue behaviour. Process parameters and post-treatment methods developed in the demo are applicable for a wide variety of large structures in ships and offshore structures, including renewable energy devices. Further application is possible in land-based steel structures, like bridges or buildings.

FSP performed in AIMEN,

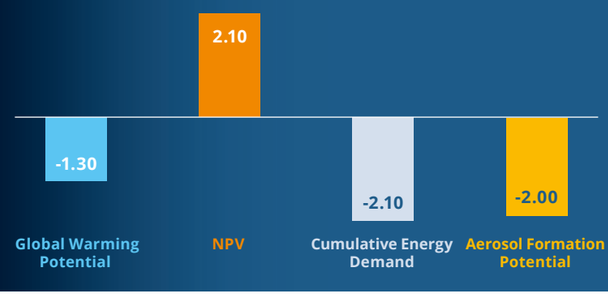


Composite overlamination specimens

Welded joint

LIFE CYCLE PERFORMANCE ASSESSMENT

% DIFFERENCE TO REFERENCE SHIP



TECHNOLOGY HIGHLIGHTS

- **HSLA can be welded in shipyard condition fulfilling rules requirements adopting proper procedures**
- **HSLA corrosion performances comparable to the conventional steels**

WP LEADER

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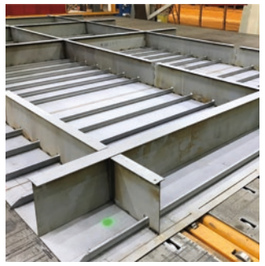
The project has been a great experience for all partners. We are a step closer to the extensive application of HSLA for marine application, enabling safer, lighter and more sustainable new-building in future. Research centres and academia, gained relevant know-how in the HSLA field. The RAMSSES project is giving us the possibility to consolidate our leadership on the specific topics

Lightweight high tensile steel in cruise ships

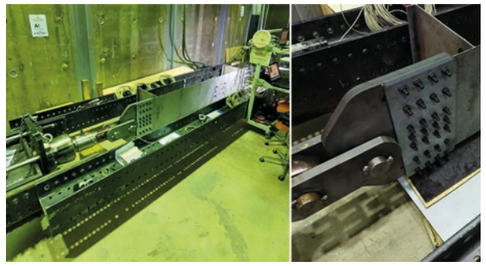
OBJECTIVE

Implementation of high-strength steel materials and advanced manufacturing technology together so that high-quality production and resulted in higher strength can be used in a final product. To obtain this, the work-package exploits a full-scale demonstrator: a block of passenger ship superstructure, in which the selected strength critical structural elements (e.g. joints) are made from high strength steel including both thin and thick plates.

Weight of the cruise ship can be reduced using thinner and higher strength steels compared to the use of conventional steel. The demonstrates that 4 mm thick deck plate and HSS bulkheads are possible to be used in building cruise ships using state of art production technologies. This was done within demonstrator, a block of a cruise ship superstructure produced with real shipyard conditions using state of art production technologies. Tests from the demonstrator show that with high quality production i.e. laser-hybrid welding, the use of 4 mm thick deck plate is possible in terms of deck flatness and weld misalignment. Fatigue strength of the critical laser-hybrid welded butt-joint was found to be similiar to what is given for thicker plates in the design codes. For plasma-cut 4 mm base material fatigue strength was very good. Use of HSS steel was also shown a high potential as very good fatigue strength was observed for plasma-cut and grinded base material. A good fatigue strength was also observed for A36-S690QL welded butt-joint in the demonstrator.



Welding thin deck panels

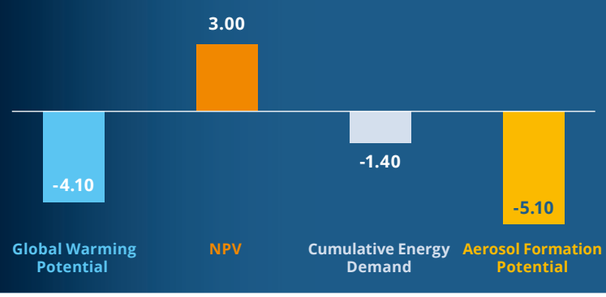


Thin deck panel fatigue test

Finished demonsrator, a block of cruise ship

LIFE CYCLE PERFORMANCE ASSESSMENT

% DIFFERENCE TO REFERENCE SHIP



TECHNOLOGY HIGHLIGHTS

- **HSLA and thin deck application can reduce the weight in the cruise ship**
- **HSLA and thin deck panels can be used in the cruise shipbuilding process using state of art production technologies**
- **High quality production can reduce the ship deck thickness up to 4mm hence reduce the ship weight**

WP LEADER

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Composite Overlay to repair and improve metallic and non-metallic structures

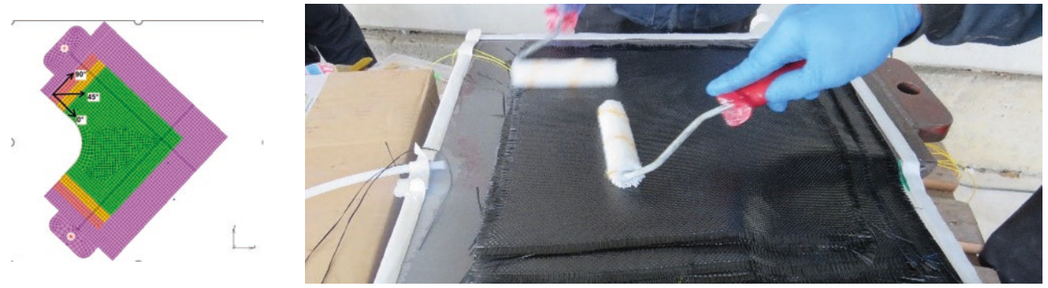
OBJECTIVE

Demonstrate that composite overlaminate is suitable both as repair technology for damaged structures in a marine environment to improve the pristine properties of welded joints.

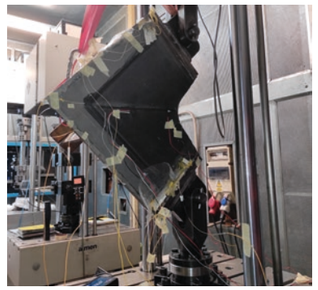
The team develop an innovative repairing solutions. Reinforcement composite solutions have been developed to be applied over steel welds and composite structures, to improve their in-service behaviour, preventing fatigue damage. Materials and configuration selection for patch design, laminate manufacturing for composite characterization, an exhaustive characterizartion and numerical modelling have been done to select the right material for the right application. Three different demonstrator cases have been developed:

- Repairing of steel structures by overlamination of composite patches acting as crack arrestors: a structural detail of a cruise vessel has been studied.
- Repairing of non-metal structures by composites: the use of composite patches for crack repairing a composite structure of a cruise ship.
- Composite overlamination techniques have been studied and applied as a reinforcement of welded HSLA steel joints without and with corrosion treated.

Decrease crack growth rate and increase the lifespan of the patched steel and patched composite structures, also, the improvement of their fatigue life of the patched specimens have been obtained.



Composite Patch design by FEA analyses (left). Patch Manufacturing process (HLU+VB) with optical fibers embedded among layer (right)



Set up of the fatigue test caryy out in AIMEN facilities

Manufaturing Patch Process to repair the composite structure

Fatigue test developed Patched and UnPatched composite structure

WP LEADER

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CARDA - Francisco Cardama S.A.

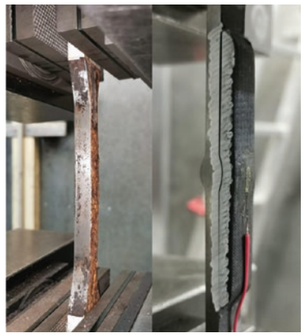
The project has been a really great experience and outcome for CARDAMA Shipyard. We have been able to increase our knowledge about repair and reinforcement composite systems in shipbuilding. Also, we're able to develop three demonstrators using composite patches to achieve longer lifespan vessels. As a result, it allows us to provide our customers with an improved repair system

Technical Assessment

OBJECTIVE

Proving the functional feasibility of the product and the processes is an important objective in RAMSSES. Along with numerical calculations and design work, testing is an important means to prove functional feasibility. Either tests are carried out as required by prescriptive rules, or based on a risk assessment carried out for the cases with the aim to prove equivalent safety of alternative designs.

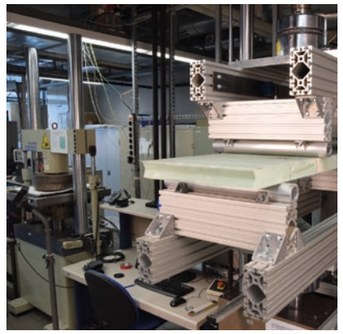
Within the RAMSSES project, a large number of lightweight FRP (Fibre Reinforced Polymer) composite and metal structures as well as equipment, components and methods for steel and patch repair was addressed in 13 different demonstrator cases. To reach approval for theses products, a technical assessment of each demonstrator was conducted within the technical assessment. Test requirements applicable to each demonstrator was defined from the perspective fire safety, mechanical safety, comfort and ageing. As a result, a comprehensive evaluation of material and construction performance was made in close collaboration between the testing partners and the demonstrator WPs. It included risk assessments as well as testing of fire, mechanical, and acoustic properties. Successful solutions were identified and the results are used as basis for approval of onboard application of the developed products.



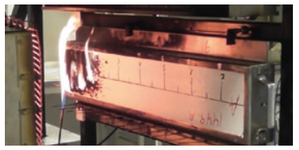
Fatigue tests at AIMEN.

Large scale fire testing of a ro-ro deck structure at RISE

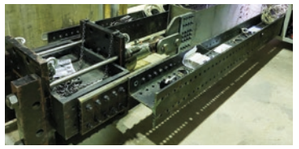
Successful test on the composite box at TNO



Four-point bending test of sandwich panel at Fraunhofer



Spread of flame test at RISE.



Full-scale fatigue testing at Aalto University

WP LEADER

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The RAMSSES project has successfully deveopled several lightweight solutions, ready to be installed on-board. During the project, lightweight materials and constructions have been tested and knowledge has been shared between partners to reach the goal to develop solutions which have good mechanical, acoustic and fire safety properties.

Life Cycle Performance Assessment

OBJECTIVE

LCPA will provide valuable guidance during the development process of potential lightweight component / system and examines the value proposition of the final RAMSSES products for potential end-users. Combining LCPA results with the elaboration of appropriate business models for each application will foster the chance of a successful market introduction after the project.

The economic viability and the potential to reduce the environmental footprint are key factors to assess the potential market uptake of the RAMSSES Innovative solutions. Therefore life cycle performance assessments are calculated for each demo-case to analyse key performance indicators like Global warming potential (GWP) or Net-present value (NPV) in a comparative approach with state of the art vessels. The LCPA-process in close collaboration with the technical development of the demo-cases comprised the identification of the value proposition, a jointly creation of potential future scenarios, data input for the LCPA and the transfer into the BAL.LCPA software-tool to perform the analysis. The LCPA-results underline the positive impact of RAMSSES Innovative solutions on energy consumption reduction and therewith an improved environmental footprint. At the same time, the economic assessment proofed life cycle cost savings thanks to new production process of innovative lightweight materials and operational energy savings throughout the lifecycle. Based on the LCPA-result, we developed tailored business models for the component clusters.

LCPA-process

WP LEADER

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BALance Technology Consulting GmbH

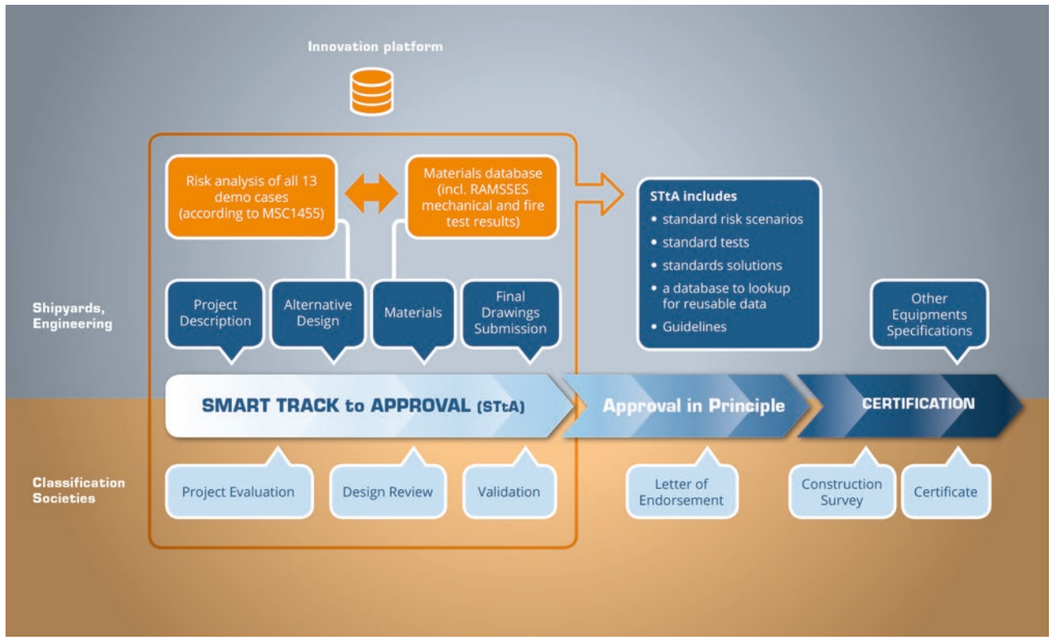
Life cycle performance assessments support design decisions and help quantify the value proposition of each RAMSSES demo-case and thereby encourage our project partners to foster the market uptake of sustainable and efficient innovations. Moreover, the RAMSSES project enables us to validate our life cycle performance assessment approach and enhance the functionalities of our life cycle software BAL.LCPA.

STtA (Smart Track to Approval)

OBJECTIVE

The mission is to provide inputs to pertinent regulatory regimes in order to help eliminate existing barriers and facilitate market take-up of lightweight and advanced materials, in particular composites, in the maritime sector.

The team developed a methodology called Smart Track to Approval (STtA), which is aiming for accelerating the market uptake of advanced innovative materials in the maritime sector by shortening the two main elements of the risk-based design process, which are the risk assessment and testing process. For risk assessment, currently carried out case-by-case, the project aims to introduce “standard risk scenarios” covering a range of similar applications. These can be referred to in the future without the need to carry out extensive quantitative risk assessments. For testing, the database of test results and pre-approved solutions, to be developed in RAMSSES, will avoid the necessity of repetitive tests if a simple qualitative risk analysis shows that relevant results and solutions are already available. The other objective of the team is to evolving the maritime regulatory regime toward the STtA approach. Therefore, together with FIBRESHIP project, the RAMSSES STtA was presented at the IMO during the Ship Design and Construction Sub-Committee (SDC7) in February 2020. Several Members (Japan, India, Spain, Denmark, Germany, Netherlands and CESA) expressed their interest in the project results and The Sub-Committee agreed to invite the interested Member States and international organizations to consider the need to review MSC.1/Circ.1574 and to submit any proposals to that effect to SDC 8. The RAMSSES project invites them to consider the guidelines developed as part of the STtA as a basis for proposals.



Process diagram of Smart Track to Approval

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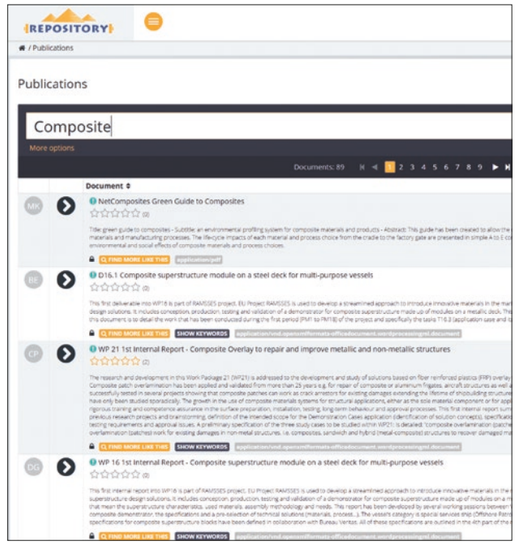
Innovation platform

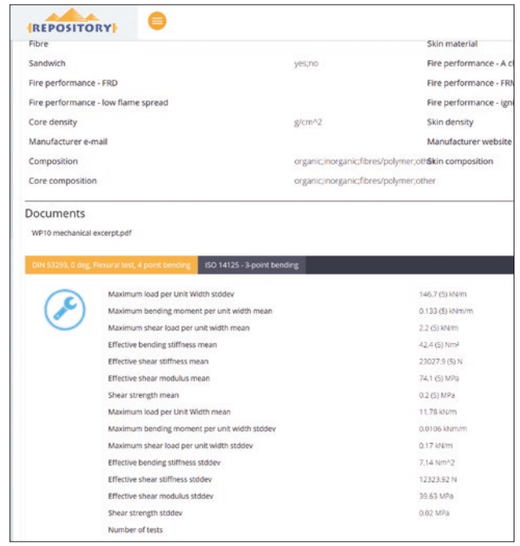
OBJECTIVE

The RAMSSES project pursues the objective to create a sustainable network for material innovation in the maritime industry. An important measure towards this goal is to provide an innovation platform based on the knowledge repository.

RAMSSES has developed an Innovation Platform, a database to store project results, background information and especially material data such as material properties and results of fire, mechanical, and acoustic tests. The database content has been reviewed by a group of experts to ensure a high quality of the data. In addition, users may provide comments to the items, enabling them to discuss and futher enhance the information. Furthermore, the platform will establish interfaces with other collaboration platforms, e.g. the SARGASSO network run by RISE. It is envisaged to make the platform available to an interested public and to further populate it with information about lightweight materials beyond the of end of the RAMSSES project. Since the platform is browser-based and platform independent, it can be accessed without the installation of any additional software as long as an Internet connection is available. Use of the platform will be free of charge. However, a registration will be needed to ensure that the users of the system will be known and may be contacted for further discussion.



Result list of the document repository



Result of a material database search

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The Innovation Platform provides a great opportunity to make the RAMSSES results available to material experts and potential customers. By providing an easy-to-use interface, information can be retrieved for initial investigations whether a material is suitable for a specific application. Further communication can then be established by directly contacting suppliers and test institutes.

Sustainable Network

In addition to the realisation, demonstration and assessment of new products, members of the RAMSSES consortium will be given plenty of opportunities to convene, collaborate and exchange information on material innovation through a sustainable network. For the RAMSSES project, the existing European network for lightweight applications at sea (E-LASS) network was identified as the backbone of the sustainable network. E-LASS (e-lass.eu) was established in 2013 and gathers stakeholders interested in lightweight design for the maritime industry. The aim is to create an organization where exchange of information and knowledge becomes easy and natural. RAMSSES's main aspect in creating a sustainable network is to strengthen E-LASS. E-LASS is bringing experts (ship owners, shipyards, OEM, material suppliers, etc.) from the maritime materials sector together by organising technical visits and seminars in which success stories, challenges (e.g. rule-making) and lessons learnt are presented and discussed. Another important aspect to ensure the sustainability of the network is the strong cooperation with research projects, also beyond the RAMSSES network. E-LASS will continue to contribute, also in the long run, to research projects as a channel for result dissemination and collaboration, to rule-making as a strong alliance towards legislation, and to innovation, not least through an open maritime innovation platform called SARGASSO. SARGASSO connects companies and organizations looking for solution providers to technical challenges or services or new partners to project consortia.

Technical visit

E-lass event

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Composites Evolution
Coventive Composites
DAMEN Damen Schelde Naval Shipbuilding
Centrale Nantes
ENSTA Bretagne
EVONIK Power to Create
FINCANTIERI
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TNO innovation for life
Naval Group
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