FIBRESHIP 3
INTEGRAL COMPOSITE SHIP

This project has recived funding from European Union's Horizon 2020 research and innovation programme under grant agreement Nº 723360

EUROPEAN NETWORK FOR LIGHTWEIGHT APPLICATIONS AT SEA
E-LASS SEMINAR
VIGO, SPAIN, 11TH JUNE 2019

FIBRESHIP PROJECT: ENGINEERING, PRODUCTION AND LIFE CYCLE MANAGEMENT FOR THE COMPLETE CONSTRUCTION OF LARGE LENGTH FIBRE-BASED SHIPS

LATEST DEVELOPMENTS

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3. RESULTS ACCORDING TO FIBRESHIP OBJECTIVES
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TSI INTRODUCTION

TÉCNICAS Y SERVICIOS DE INGENIERÍA, S. L. (**TSI**) is a Spanish SME established in 1983 specialised in Noise & Vibration Engineering solutions. Since its creation TSI has been continuously developing its specialised activities in the following fields:

- Marine, Power Generation, Nuclear, Wind, Defense, Oil & Gas, among others.

Since 2012, TSI is participating in several **R&D projects** related to marine industry. Through these projects, the company had increase its knowledge of noise and vibration, as well as developing solutions for new growing markets.

Main engineering services of TSI (more info on www.tsisl.es):

DESIGN OF SILENT SHIPS. N&V PREDICTION

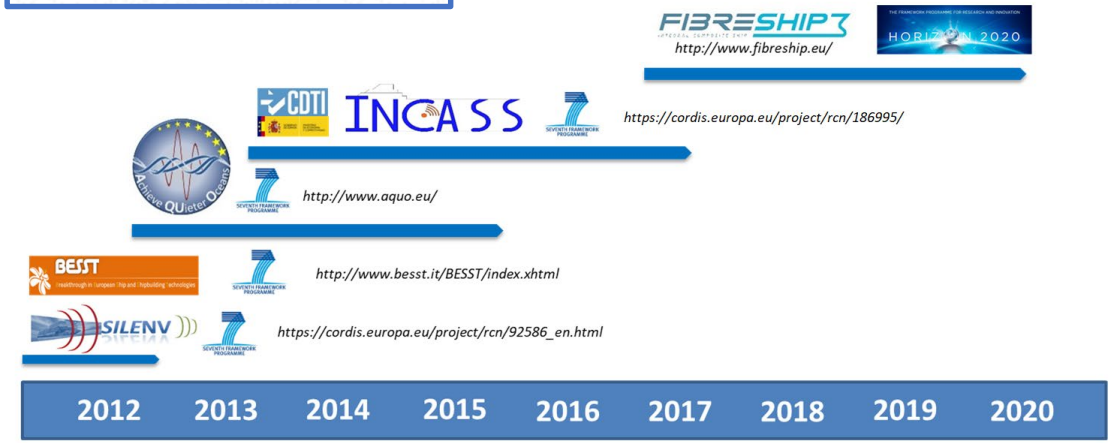
NOISE & VIBRATIONS AND URN MEASUREMENTS IN VESSELS

STATIC AND DYNAMIC STRUCTURAL ANALYSIS

CONDITION BASED AND PREDICTIVE MAINTENANCE ASSESSMENT

SENSOR & INSTRUMENTATION SUPPLIER

EUROPEAN R&D PROJECTS



FIBRESHIP PROJECT DESCRIPTION

FIBRESHIP Project

- FIBRESHIP project addresses the **feasibility of composites for large-length vessels**, trying to generate a regulatory framework that allows **designing, building and operation** of these vessels, and overcome the challenges identified. (technical and not technical)
- The project consists of:
  - ✓ **analyzing** the possible **impacts** in the **market of this technology**
  - ✓ **evaluating** innovative **composite materials** for marine applications
  - ✓ **developing numerical software tools** capable to assess the structural performance of the vessel and validated through experimental testing
  - ✓ **performing** new **design guidelines**
  - ✓ **generating production** and **monitoring methodologies**

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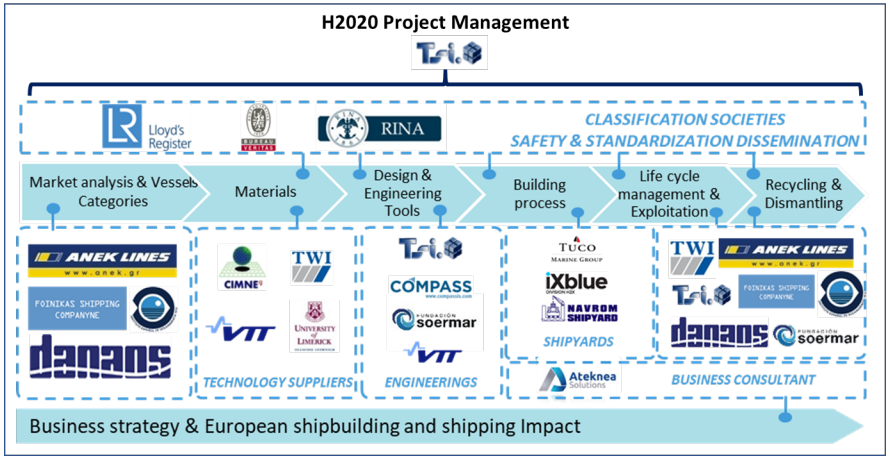
Main particulars of FIBRESHIP Project

- Grant Number: 723360
- Duration: 36 months (2 periods of 18 months)
  - ✓ Start Date: 1st June 2017
  - ✓ End Date: 31st May 2020
- 18 partners with broad skills and knowledge in different complementary disciplines
- Estimated Project Budget: 11,041,212.50 €
- Requested EU Contribution: 8,866,322.75 €
- TRL: 7-9



RESULTS ACCORDING TO FIBRESHIP OBJECTIVES (1/3)

- Objective 1: EVALUATION AND SELECTION OF INNOVATIVE FIBRE-REINFORCED POLYMERS (FRP) FOR MARINE APPLICATIONS
  - Several **experimental tests** have been performed, consisting of mechanical, fatigue and fire performance assessment of composite materials.
  - A **composite material selection methodology** for large vessels has been carried out as well as a set of joining techniques eligible to composite structures.
  - A **composite materials constitutive numerical model** has been developed and validated through experimental tests.

- Objective 2: ELABORATION OF NEW DESIGN GUIDELINES AND PROCEDURES
  - An analysis on the **current marine regulatory framework** focused on the use of composite materials has been conducted.
  - The **structural design** of 3 different vessel in composites has started and is progressing well: containership, ROPAX and fishing research vessel.
  - A set of **new design guidelines** is being developed based on structure performance criteria and fire resistance.

RESULTS ACCORDING TO FIBRESHIP OBJECTIVES (2/3)

- Objective 3: GENERATION OF EFFICIENT PRODUCTION, LIFE CYCLE MANAGEMENT AND INSPECTION METHODOLOGIES
  - It has been carried out a definition of **production methodologies** to reach a cost-efficient balance between design and production strategies for large-length composite vessels, considering **modular subdivision** and **production sequencing recommendations**.
  - A **structural health monitoring strategy** has been developed according to the hydro-structural behavior of the vessel.
  - Different strategies regarding **inspection** and **waste treatment** are being analysed.

- Objective 4: DEVELOPMENT OF VALIDATED SOFTWARE ANALYSIS TOOLS
  - It has been developed a **software suite** made up of different coupled numerical models able to simulate the structural behavior:
    - ✓ FRP mechanical and thermo-mechanical response in terms of constitutive elements, hull-girder long term hydro-structural behavior, local structural health monitoring assessment.
  - **Calibration** and **validation** process of all developed numerical models is ongoing.

RESULTS ACCORDING TO FIBRESHIP OBJECTIVES (3/3)

- Objective 5: VALIDATION AND DEMONSTRATION OF THE TECHNOLOGIES GENERATED IN FIBRESHIP
  - **Vibro-acoustics tests** were performed in a small length vessel of composite material to:
    - ✓ (1) validate numerical models of URN
    - ✓ (2) assess potential benefits of using composite materials regarding on board vibration & noise.
  - A **full-scale testing campaign** in a 260m container ship has been performed in harsh sea states obtaining useful data to validate the coupled hydro-structural numerical model.
  - A ship block of a Fishing Research Vessel (FRV) has been selected as a full-scale **demonstration** of the **design** and **production solutions** proposed in FIBRESHIP project.

- Objective 6: SHIPPING MARKET AND BUSINESS ANALYSIS
  - It has been performed an **evaluation** of **impacts** and **potential benefits** of composites in large-length vessels.
  - A **SWOT analysis** (Strengths, Weaknesses, Opportunities, Threats) focused on all involved marine stakeholders (shipyards, suppliers, shipping principals) was carried out, including a possible roadmap of composite adoption in EU Shipping Market.
  - A **Cost-Benefit calculator tool** for composites large ships and an **economic support plan** for technical decision making is ongoing.

SOME SPECIFIC RESULTS OF THE PROJECT

Example of

OBTAINED RESULTS

Example Case I:

ZIM LUANDA testing campaign

Example Case II:

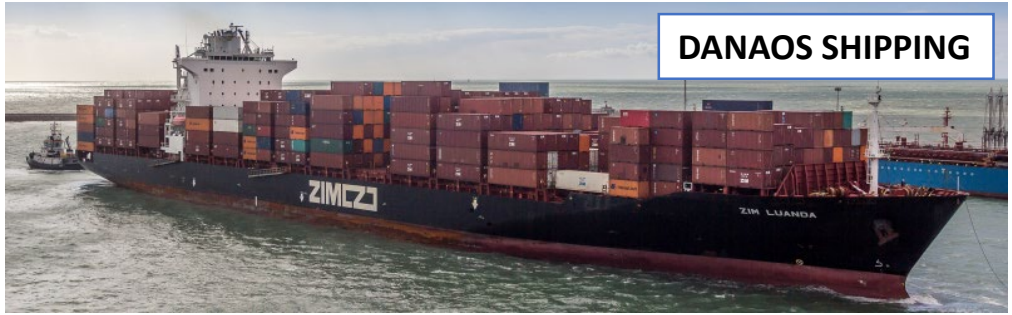
DEMONSTRATOR

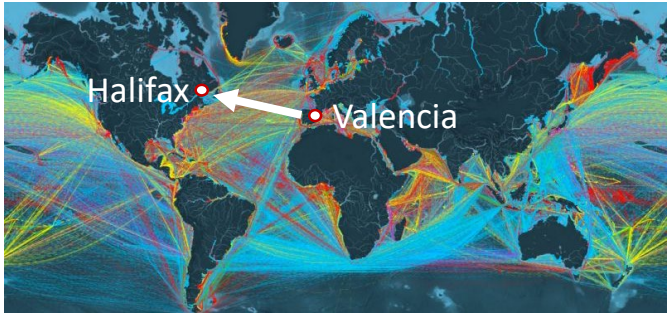
SOME SPECIFIC RESULTS OF THE PROJECT - Example Case I: ZIM LUANDA (1/6)

ZIM LUANDA testing campaign was carried out considering two aims:

1. Validate the developed hydro-structural numerical model
2. Assess the proposed Structural Health Monitoring strategy

ZIM LUANDA containership was monitored during navigation through a commercial route between Valencia (Spain) and Halifax (Canada).





Vessel main particulars:

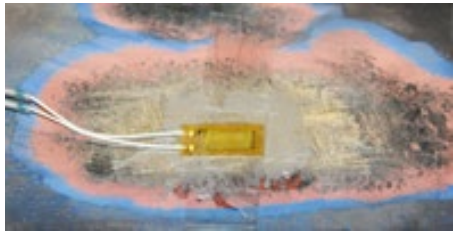
Length = 260 m Beam = 32 m
Draft = 11 m Depth = 19 m

SOME SPECIFIC RESULTS OF THE PROJECT - Example Case I: ZIM LUANDA (2/6)

The proposed Structural Health Monitoring approach of the vessel during navigation is based on three steps:

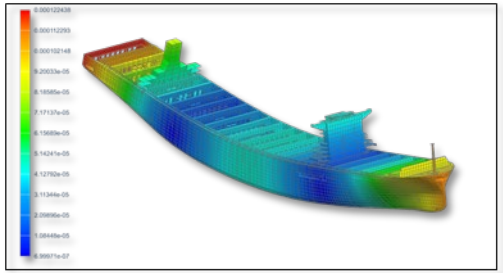
Measuring

Measure local and global deformations of the ship during navigation



Analysing

Analyse the tensional state and possible “hot spots” of the ship during navigation

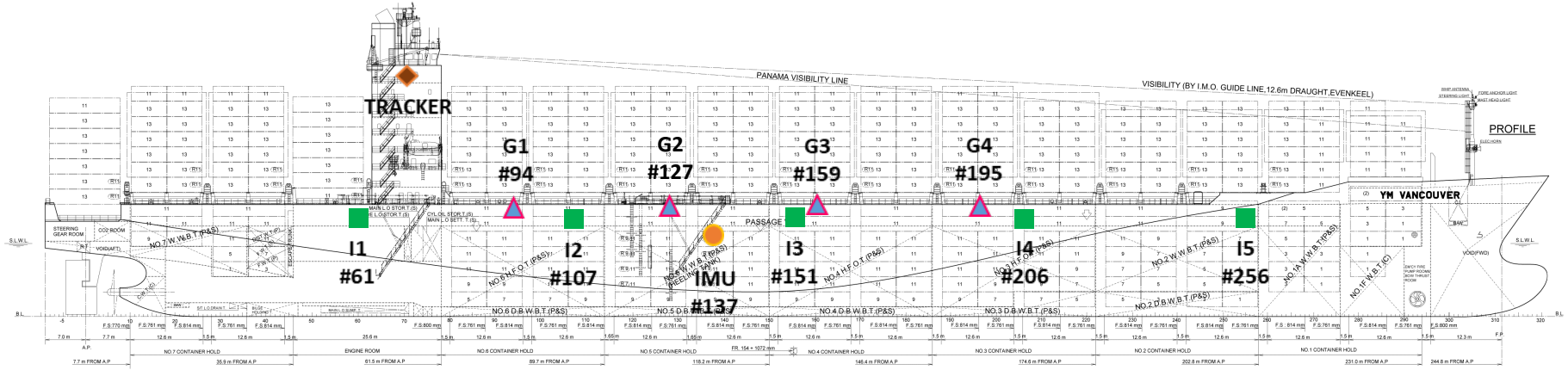


Diagnosis

Diagnose vessel structural integrity using maximum deformations theory (ULS / FLS)

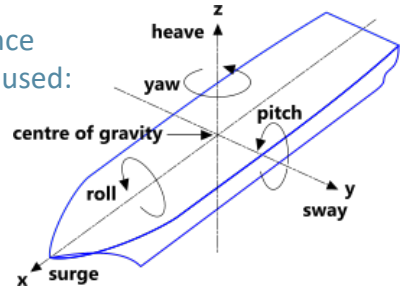
SOME SPECIFIC RESULTS OF THE PROJECT - Example Case I: ZIM LUANDA (3/6)

Measuring: The local and global deformations of the containership as well as their motions and the environmental conditions were monitored in real time.



- Environmental tracker
- Inclinometers
- Strain gauges
- Inertial Measurement Unit (IMU)

Reference system used:



SOME SPECIFIC RESULTS OF THE PROJECT - Example Case I: ZIM LUANDA (4/6)

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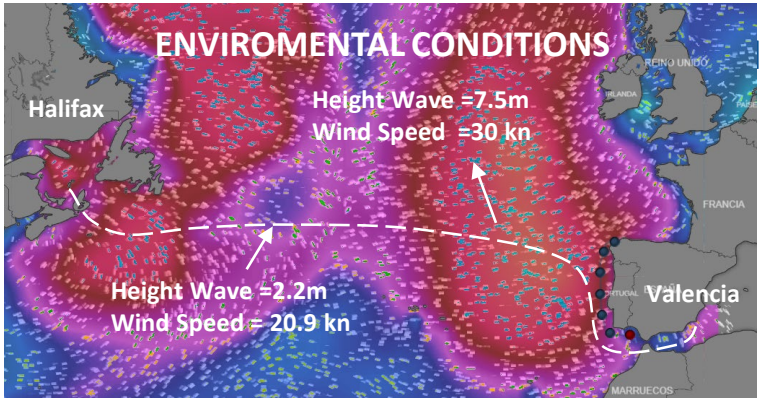
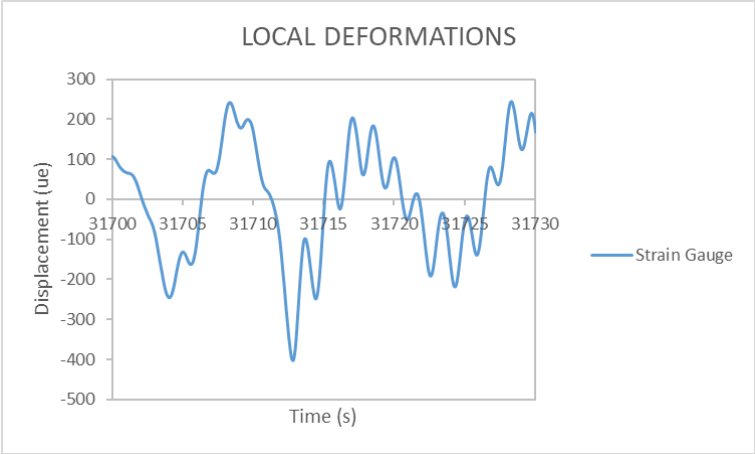
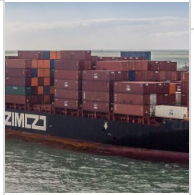
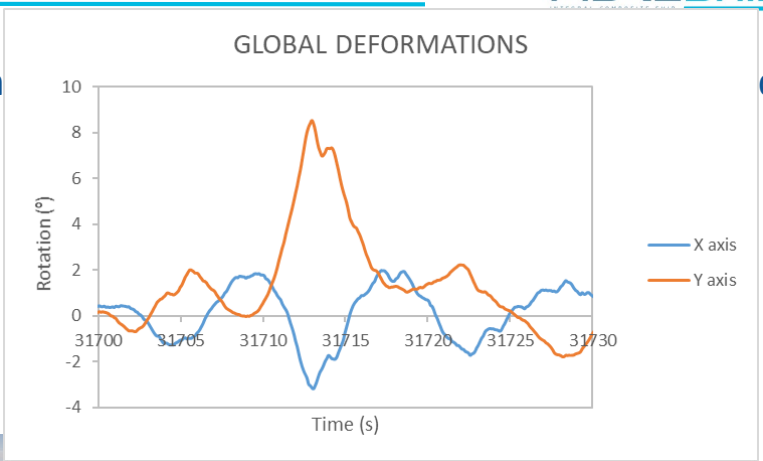
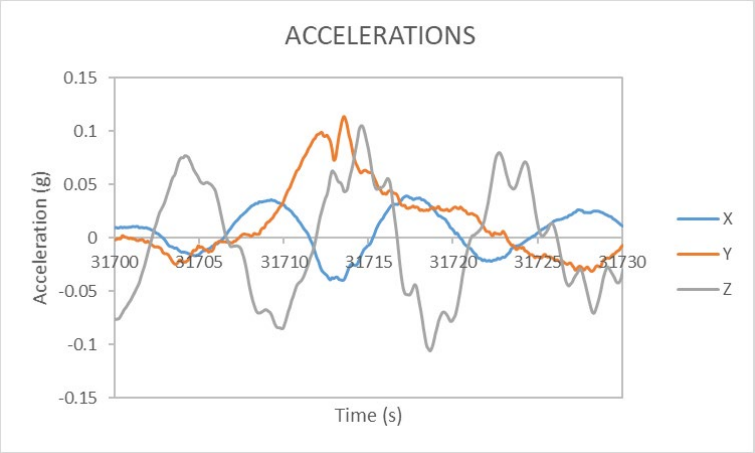


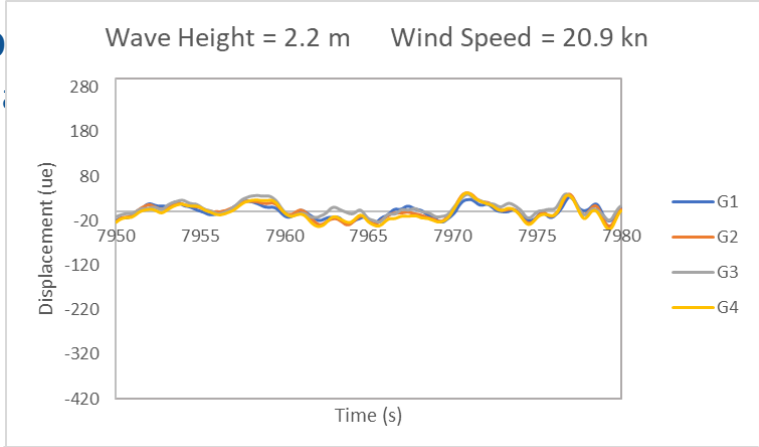


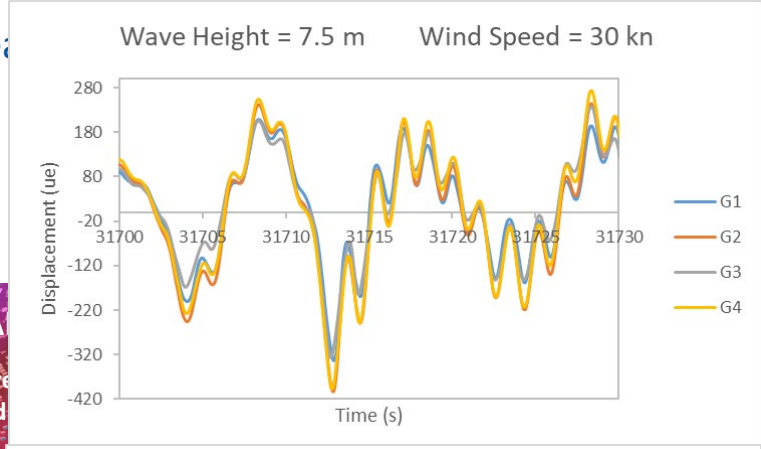


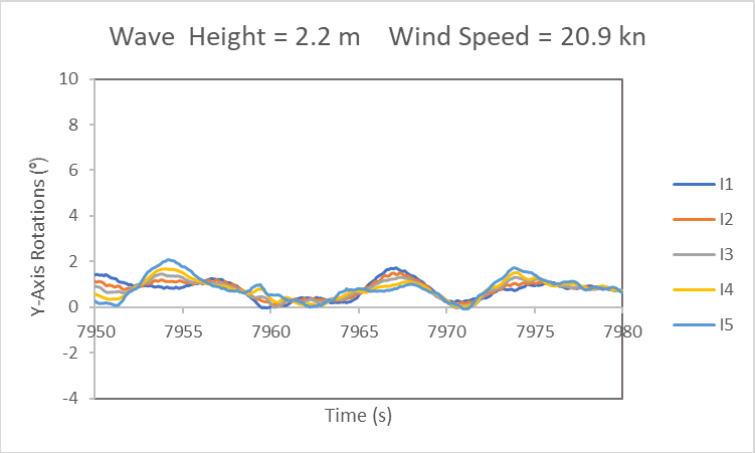


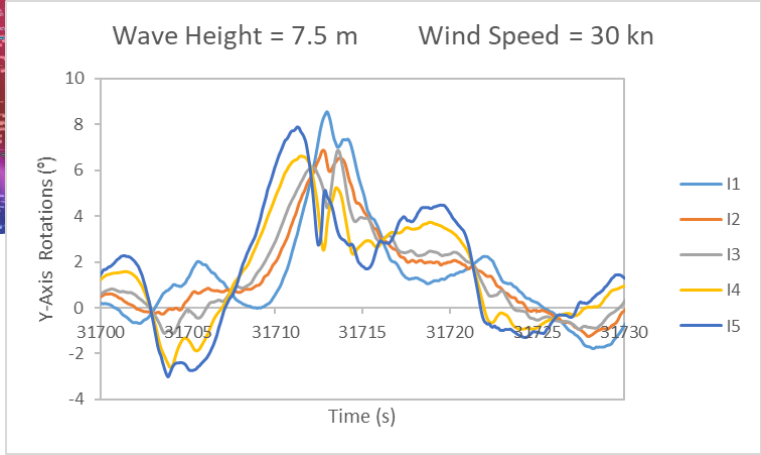


SOME SPECIFIC RESULTS OF THE PROJECT - Example Case I: ZIM LUANDA (5/6)









SOME SPECIFIC RESULTS OF THE PROJECT - Example Case I: ZIM LUANDA (6/6)

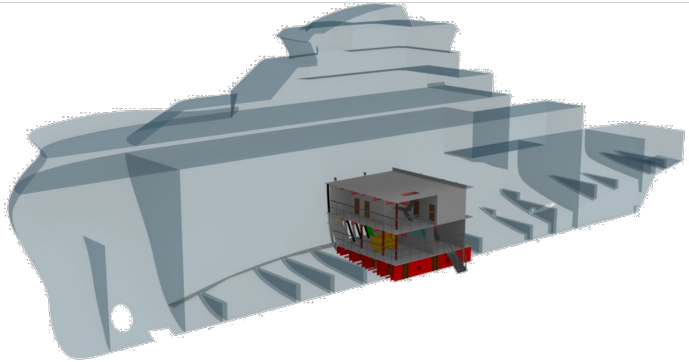
FIBRESHIP
INTEGRAL COMPOSITE SHIP

The main conclusions of this experimental campaign are the following ones:

- The system allowed to monitor the tensional state and motions of ZIM LUANDA during navigation.
- Local and global deformations of ZIM LUANDA were successfully measured during the navigation route.
- Detection of “hot spots” is possible through local and global deformations of the vessel.
- The existence of damage can be predicted using the maximum deformations theory.
- The environmental conditions (e.g. wave heights, wind speed, ….) can be predicted by means of GPS and reanalysis (NOAA database), making possible the correlation with vessel deformation.
- Data to validate the developed software has been obtained, which will allow to verify the finite element models of the designed vessels of the project.

SOME SPECIFIC RESULTS OF THE PROJECT - Example Case II: DEMONSTRATOR

Real-scale demonstrator of a Fishing Research Vessel (FRV) module is being built at iXblue facilities in La Ciotat (France).



Fishing Research Vessel (FRV)
of 85m of length

Demonstrator: Engine room and other above accommodation spaces. 11m x 11m x 8.6m

2ND PUBLIC WORKSHOP

Engineering, production and life-cycle management for the complete construction of large-length FIBRE-based SHIPs

2ND FIBRESHIP PUBLIC WORKSHOP – LA CIOTAT (FRANCE), 25TH JUNE 2019

Date & Time:	**Tuesday, 25th June 2019, 09:00 – 17:00 Hrs**
Venue:	**BEST WESTERN PREMIER Hôtel Vieux Port, 252 Quai François Mitterrand, 13600 La Ciotat, France**

2nd Public Workshop

About the event

This 2nd workshop is to engage with shipowners, ship operators, shipyards, regulatory bodies, transport policy-makers at EU and members states including research organizations/academia, ship design and engineering firms and transport organizations involved in different EU projects to not only raise awareness of the issues that the project is dealing with, but also to discuss ways to overcome the current market challenges and technology gaps to make feasible the building of large commercial vessels in FRP materials.

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Any question?

THANK YOU

www.fibreship.eu

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BACK-UP SLIDES

FIBRESHIP PROJECT (2/3) – Vessels considered for the project

CATEGORY I
Light Commercial Vessels

Vessel selected:
Container Vessel

Other options:
- RORO vessel
- Car Carrier vessel
- Multi-purpose vessel
- Freezer vessel
- LNG vessel
- …..

CATEGORY II
Passengers Transportation & Leisure Vessels

Vessel selected:
ROPAX

Other options:
- Ferry
- Passenger vessel
- Megayacht
- …..

CATEGORY III
Special Services Vessels

Vessel selected:
Fishing Research Vessel

Other options:
- Fishing vessel
- Seismic Vessel
- Offshore Supply vessel
- Rescue vessel
- ……

THE CHALLENGES OF FIBRESHIP (2/2) – Potential benefits

A

B

Structural Weight reduction (30%-70%)

- Fuel Consumption Reduction
- Increase Payload Capacity
- Underwater Radiated Noise (URN) Reduction
- Lower Greenhouse Gas Emissions
- Higher Recycling Rate

+

- Reduced Maintenance & Life Cycle Costs
- Immune to Corrosion
- Continuous Structural Health Monitoring
- Possibility of Using Wireless Sensors
- Aesthetic Improvements

MAIN OUTCOMES (1/4) – Expected Results

FIBRESHIP

Engineering

- Design report for each vessel category.
- Project guidelines for design and certification of large-length vessels in FRP materials based on fire and structure performance criteria.

- Vessel Specifications.
- End-users assessment and roadmap of composite adoption in EU shipping market.

- Guidelines on inspection, monitoring and maintenance applicable to FIBRESHIP approach.
- Guidelines on waste management in the implementation of FIBRESHIP approach.
- Structural health monitoring & long-term damage control (as part of the Engineering Guidelines)
- Decision Support Tool on life-cycle performance of FIBRESHIP approach.

- European and global business trends analysis.
- Cost-Benefit calculator and global business plan.

Shipping Market Analysis

Cost-benefit analysis & business plan

WP1 WP8

Engineering

WP3 WP4

Fibre-based Materials

WP2

Production & Life Cycle/Dismantling

WP5 WP6

Coordination

WP10

- Development of numerical tools for FRP vessels design (structure and fire).
- Numerical tools validation.

FIBRESHIP Dissemination

- Dissemination & Exploitation.
- Infodays & Open-door industrial days organisation (2 workshops).
- Regulatory and Standardization of the results.

Small & Full-Scale Validations

Mechanical & Fire-Resistance Tests

Manufacturing & Recycling Processes

Validation and demonstration

- Experimental test campaigns for validation:
  - ✓ Noise and vibration on board tests and URN measurement.
  - ✓ Full-scale vessel test for hydro-structural coupled numerical model validation.
  - ✓ Small-scale fire tests of FRP panels with and without insulation.
  - ✓ Modal tests of FRP panels for detection of changes in natural frequencies.
- Engineering solutions for aesthetic improvements.
- Demonstrator Building & Production Process Assessment.

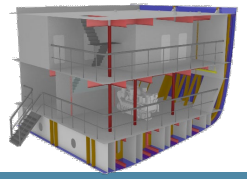
WP7 WP9

- Optimum building strategy & production techniques.
- Modular subdivision and production sequencing recommendations.
- Analysis of existing shipyard facilities adaptation.

- Selection methodology of FRP materials.
- Catalogue of applicable materials & joining techniques.

Materials

Production



MAIN OUTCOMES (3/4)

Example: photos of the demonstrator construction process at the shipyard iXblue in La Ciotat (France)

MAIN OUTCOMES (4/4)

Example: photos of the demonstrator construction process at the shipyard iXblue in La Ciotat (France)

"2nd Public Workshop" → **25th of June 2019**

MAIN OUTCOMES (2/5) – Expected Results

- **Short Term (0 Years)**
- **Medium Term (1/3 Years)**
- **Medium/Long Term (3/5 Years)**

- Classification Societies: Standards and Rules
- Owners: specifications & orders
- Shipyards: facilities adaptation
- Designers: design process

Business Opportunity

- Massive application of FRP-materials
- Enhance competitiveness of the European Operators
- Enhance competitiveness of European shipbuilding industry

Relevant advance over the traditional methods, allowing the exploitation of the new solutions and procedures in the existing market

POLICIES

ENVIRONMENTAL

- Fuel safety / Gas Emissions
  Directive 2012/33/EU
- Life cycle performance & reduced maintenance costs
  Directive 2013/1257/EU
- Underwater Noise impact
  Directive 2008/56/EU

Safety SOLAS / IMO / EMSA

- Structural resistance criteria
- Fire safety
- Stability
- etc…