Towards Safety of Composite Ships

Date: Monday 3 February, lunchtime
Duration: 30 minutes
Presenters: Alfonso Jurado, Matthias Krause, Stéphane Paboeuf
• Motivations for both projects
• FIBRESHIP
• RAMSSES
• Joint conclusions
• Q&A
Very little number of FRP ships registered at IMO

SOLAS Ch.II-2 Regulation 2:
“The hull, superstructures, structural bulkheads, decks and deckhouses shall be constructed of steel or other equivalent material.” = barrier

SOLAS Ch.II-2 Regulation 17:
“Alternative design and arrangements” On basis of Equivalent Safety = opportunity

Main issue to be addressed: fire safety
Motivations
Current regulatory regime

Guidance available

- MSC.1/Circ.1455 Guidelines for the approval of alternatives and equivalents as provided for in various IMO instruments
  - Uncertainty of getting approval in contract phase

- MSC/Circ. 1002 Guidelines on alternative design and arrangement for fire safety

- MSC.1/Circ.1574 Interim guidelines for use of fibre reinforced plastic (FRP) elements within ship structures: Fire safety issues.
  - Adopted June 2017, 4 years evaluation period

Figure 2: Design and Approval Process
Developed Approaches

Short term approach

• Based on existing rules and a **Smart Track to Approval**
  • Database of pre-approved solutions and materials test results
  • Fire risk scenarios
  • Analysis and modelling tools, including numerical or statistical models

Long term approach

• Development of **new prescriptive rules** in:
  • Structure
  • Fire
  • Production

• Validation by simulations, tests and full-scale demonstrator
FIBRESHIP PROJECT DESCRIPTION

FIBRESHIP Project

- FIBRESHIP addresses the feasibility of using FRP technology for large-length vessels, trying to overcome the identified technical challenges and promote a change in the regulatory framework that enables their design, building, and operation.

Main particulars of FIBRESHIP:

- Grant Number: 723360
- Duration: 36 months (June 2017-May 2020)
- Project Budget / EU Contribution: €11M / €8,7M
- TRL: 7-9
- Collaboration between 18 partners of 11 countries
Benefits for shipowners due to the reduction of structural weight:
- Reduction of Powering Needs & Wet Surface implying
  - Bunkering Consumption Reduction
  - Lower Greenhouse Gas Emissions
- Increasing of Payload Capacity

Other potential benefits identified in the FIBRESHIP project:
- Continuous Structural Health Monitoring
- Possibility of Using Wireless Sensors
- Underwater Radiated Noise Reduction

Other potential benefits for shipowners:
- Better Fairing Solutions for the Constructed Hull
- Aesthetic Improvements
- Corrosion Immunity
- Life Cycle Costs Reduction

Structural Weight reduction due to the use of composites up to 70% (including insulation)
MAIN OUTCOMES (1/5) – SUMMARY OF RESULTS

FRP adoption roadmap in EU shipping market considering end-users satisfaction

Cost-Benefit calculator and Global Business Plan

FRP methodology selection

Coupled software capable to assess the vessel structural and fire performance

Definition of vessel inspection and SHM strategy

Decision Support Tool on life-cycle assessment (LCA)

Results verification with experimental tests:
- Material mechanical properties and bondings.
- Small- & medium scale fire tests of FRP panels with and without insulation.
- Influence of environmental conditions on FRP panels.
- Onboard N&B tests and URN measurements.
- Structural full-scale vessel test.
- Modal analysis and NDT of FRP panels for detection of delamination failures.
- Engineering solutions for aesthetic improvements.

Guidance notes and recommendations:
- Applicable materials and joining techniques.
- Structural design based on structural and fire criteria.
- Adoption of new production strategies and building techniques.

Building a FRV block fully in composites as a demonstrator

Designing of three fibre-based vessel structural:
- Containership 250m LOA
- ROPAX 204m LOA
- FRV 85m LOA

Sub-task 4.1.1: CATEGORY I
Light Commercial Vessels
CONTAINER VESSEL

Sub-task 4.1.2: CATEGORY II
Passenger Transportation & Leisure Vessels
ROPAX

Sub-task 4.1.3: CATEGORY III
Special Services Vessels
FISHING RESEARCH VESSEL
MAIN OUTCOMES (2/5) – FRV Structural design process

STANDARD SCANTLING FOR STRUCTURAL DESIGN
- Classification Society Rules
- Structural configuration definition
- Materials and laminates definition

3D MODELLING
- Midship and Web-frame Scantling
- From Midship to a full 3D ship structure

2nd stage

Demonstrator design for construction
- FEM Analysis
- Optimization stage

1st stage

3D FEM model
- Decks & Bulkheads
- Reinforcements & Spaces
- Beams
MAIN OUTCOMES (3/5) – Structural and Fire Performance Criteria

• Structure Performance Criteria
  ✓ **Calculation Approach:** Loads - Rules Based / Numerical (FE) approach
  ✓ **Loads combination:** Local / Global
  ✓ **Fatigue assessment:** S-N Curves, cumulative damage
  ✓ **Joining:** Adhesive bonding of composites and hybrid materials
  ✓ **Structural continuity:** Between primary hull girder and structure / primary and secondary stiffener

• Fire Performance Criteria: two complementary approaches
  ✓ **Local equivalence approach for composites:**
    o Based on SOLAS expectations for steel structures and deck/bulkheads fire ratings.
    o Proposal of new fire division rating and spaces: REI
      a. Resistance (R), Integrity (E), Insulation (I) (to avoid misunderstanding with A & B class fire divisions)
    o Proposal of new fire tests and performance criteria for FRP structures
  ✓ **Global equivalence approach for composites:**
    o Based on generic risk models to be developed.
    o Considers fire risk in a global approach and all possible fire safety systems
    o Identification of specific nodes (from local equivalence approach) to reach an equivalent safety level
MAIN OUTCOMES (4/5) – FIBRESHIP Market Readiness

ACHIEVABLE IMPACTS FOR SHIPOWNERS

- O&M cost savings
- Emissions reduction
- Economies of scale achievement by increasing cargo capacity

Vessel segments closest to market:
Inland Waterway Vessels / Superyachts / Small Feeders
Research Vessels / Small Offshore Supply Vessels

Good starting point for fully fibre-based vessels

Larger ships in FRP looks as a good idea to owners!

FACTORS OF MARKET READINESS

- Incentives to Short Sea Shipping market
- Construction Readiness
- Positive ROI

Smooth Scale Increasing
MAIN OUTCOMES (5/5) – FIBRESHIP Demonstrator

Full-scale demonstrator of a Fishing Research Vessel (FRV) module was built at iXblue facilities in La Ciotat (France):

- Bottom deck with a part of an engine room.
- Upper deck with a set of accommodation spaces.

Ship block that considers two different spaces on board.

Approx.: 11m x 11m x 8.6m; 20 tons
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

The project RAMSSES has received funding under the European Union’s Horizon 2020 research and innovation programme under the grant agreement No 723246. The information contained herein reflects the views only of the author(s), and the European Union cannot be held responsible for any use which may be made of the information contained herein.
Innovative Materials for Ships:

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

RAMSSES will:

1. DEVELOP & DEMONSTRATE
2. VALIDATE
3. INTEGRATE & COOPERATE

- Innovation Capability
- technical and LC Feasibility
- maritime products and processes
RAMSSES – Demo Cases

Ship & Process Integration

Target TRL: 5…7
Smart Track to Approval

RAMSSES Demo case analysis

Risk Analysis
- Including Model Tests: FEM, CFD, Thermo-mechanic, ...
- And Demo Case Tests

Innovation platform

Materials Database:
- Mechanical properties
- Thermal properties
- Insulation

Validation

SMART TRACK to APPROVAL

A.I.P.

Certification

STtA will propose:
- standard risk scenarios
- standard tests
- standard solutions
- a database to lookup for re-usable data...
- Guidelines

Classification Societies

Shipyards,
Suppliers,
Engineering

List of documents to be submitted

Project Description:
- Drawings, GA...

Alternative Design:
- MSC.1/Circ.1455

Materials:
- Certificates, tests...

Final Drawings Submission

Summary of the design review process

Rules:
- BV NS546, NR600, NR467...

Design Review:
- Structure, Safety, Stability...

Validation

Letter of endorsement

Construction Survey

Certificate

Others Equipment Specifications

Material/Process validation

Incl. Preliminary Design Approval
- MSC.1/Circ.1455

RAMSSES presentation to IMO SDC7
SMART TRACK to APPROVAL

Project Description:
- Drawings, GA...

Alternative Design:
- MSC.1/Circ.1455

Materials:
- Certificates, tests...

Final Drawings Submission

Project Evaluation

Design Review:
- Structure, Safety, Stability...

Validation

Fire

- A and B Class Division
- Resistance Class Definition
  - REI or EI
- Insulation / No insulation
  - Fire-Restricting Materials
  - Low Flame-Spread
  - Restricting ignitability

In accordance with FTP Code
RAMSSES Innovation Platform

SMART TRACK to APPROVAL

Project Description: Drawings, GA...
Alternative Design: MSC.1/Circ.1455
Materials: Certificates, tests...
Final Drawings Submission

Project Evaluation

Design Review: Structure, Safety, Stability...

Validation

Materials information

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Finding pre-approved solutions

• Suggestion to use selection tables to find existing solutions

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- Quickly known what is already possible, and what is not
- More time available to assess safety of new elements
Conclusion

FIBRESHIP & RAMSSES:

- Demonstrate **advantages** of composite materials in shipbuilding,
- Prove the **ability** to build large structure in composite,
- Propose **new approach** for fire division rating,
- Ask Member States to:
  - support using our results in evaluation of MSC.1/Circ.1574 and,
  - encourage them to submit their own experiences to IMO
Q&A