FLARE
FLOODING ACCIDENT RESPONSE

NEWS-LETTER

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Flooding Accident Response

This second edition of the newsletter for the FLARE project provides an overview of the progress achieved since February 2020.

In line with the EU 2011 Transport White Paper and the Horizon 2020 transport programme's aim to "reduce accident rates, fatalities and casualties", as well as with the Strategic Research Agenda of the Waterborne TP aiming for zero-loss of life and zero-pollution to the environment, FLARE contributes to ongoing efforts to increase the safety of shipping by reducing the risk of flooding incidents post-collision and grounding incidents, which is of paramount importance for passenger ships. Taking into consideration the IMO specific procedures for risk assessment and existing instruments (such as the Formal Safety Assessment), the main overriding objective of FLARE is to develop a Novel Risk-Based methodology beyond the existing state-of-the-art of 'live' flooding risk assessment and containment in line with IMO high-level goals

Over the past months, FLARE has achieved significant breakthrough: the initial data collection, collation, analysis and management is about to be finalised; damage accident modelling procedures have been developed; flooding tests have been performed; a first description of the framework for life-cycle flooding risk assessment and management has been delivered, together with an initial FLARE Framework Report and Users' Guide-lines; and methods have been developed as part of vulnerability analyses with the aim to improve mitigation of flood risks.

WORKSPACES

FLARE works on eight areas of attention throughout the lifetime of the project to achieve its goals. A more detailed summary of the activities executed within these workspaces since the publication of the last Newsletter in February 2020 is reported below.

1 Initial data collection, collation, analysis and management

The provision of sample ships, the analysis of operational data, the assessment of real traffic data and the review of the risk model form the basis for the results to be achieved in FLARE. As it stands, all these tasks have been finalised and the outcomes feed into the subsequent workspaces:

The project has received funding from the European's Horizon 2020 research and innovation programme (Contract No.: 814753)

- A number of sample ships of large cruise vessels and RoPax ferries were provided to reflect typical designs of current passenger ships. These sample ships are used in the project as the basis for the impact of any risk control options;

- Operational data of passenger ships were collected, reviewed and assessed, with particular attention paid to stability and actual loading conditions. Proposals were made on how to use real operational patterns in the assessment of flooding risk;

- Considering that the amount of floodwater has a significant impact on survivability after flooding, permeabilities were assessed, both by measurement and detailed calculation. The collected data was compared with the assumptions in SOLAS, which promotes the use of standard values for permeability. As a result, recommendations were made as to which permeabilities should be used in the assessment of flooding events for different categories of spaces;

- An analysis of operational patterns of cruise ships and RoPax ferries was carried out, with the assumption that the area of operation may have a significant impact on the probability of flooding accidents as well as on the survivability and consequences post-flooding. In particular, wave statistics, routing information and traffic density were considered as potential factors. This assessment allowed for the identification of the potential for collision, contact and grounding for different operational areas;

- A review of existing risk models was undertaken in order to remove any inconsistencies and allow for the replacement of historical accident data with results from this project.

As a last step, an open accident database is currently being established, to facilitate future use. This task is significant as it entails not only the gathering of already available information from existing accident databases, but also the expansion of data collection with information about near misses, which will be provided by operators. As such, the outcomes of this workspace represent an innovation and will significantly improve accident statistics for collision and grounding.

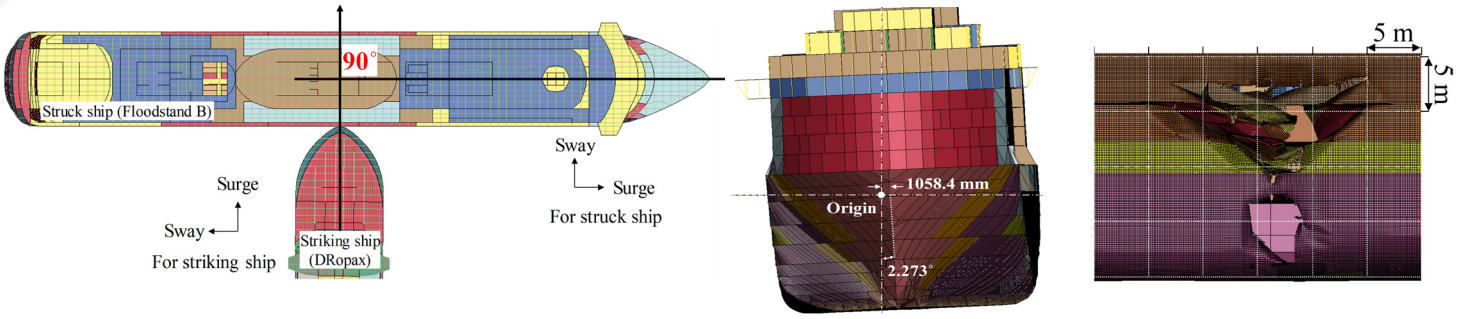
The public deliverables of this workspace are available here.

2 Damage accident modelling beyond current statistics

In order to better understand the cause and effect of accidents on crashworthiness, and hence widen the scope of flooding risk management, this workspace focuses on the simulation of grounding and collision events by state-of-the-art Multiphysics methods. At this stage of the project, modelling procedures have been developed and the influence of fluid structure interaction modelling on hull breaches of passenger ships for typical accident scenarios has been idealised.

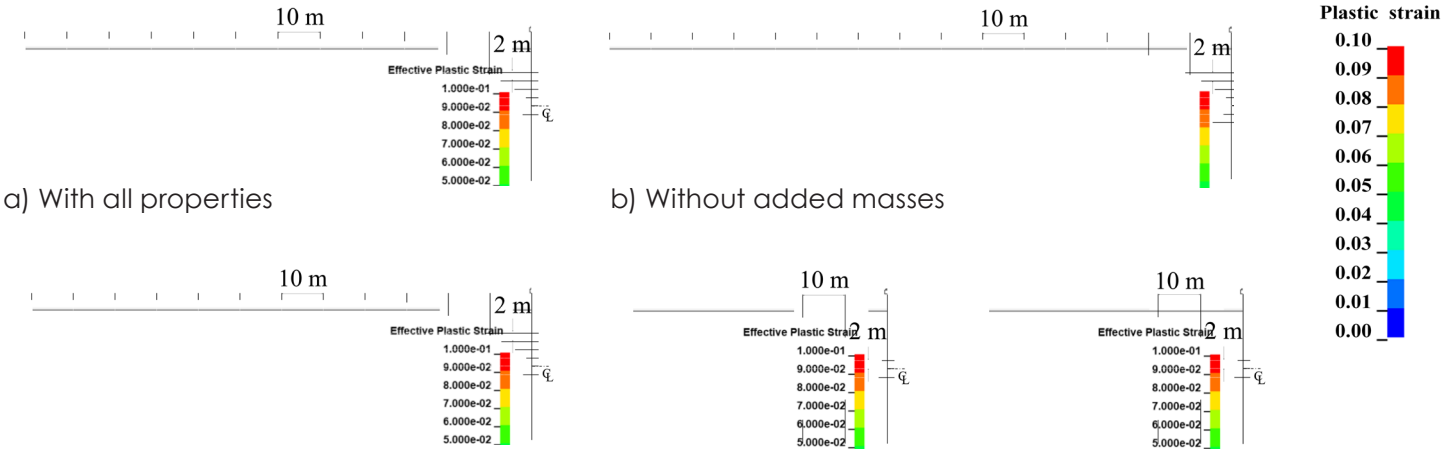
The new method brings together structural dynamics with marine hydrodynamics accounting for wave radiation/diffraction, ship evasiveness and viscous ship resistance. The simulations confirmed that realistic Multiphysics modelling is key when simulating either collision or grounding events. This is primarily because of the influence of hydrodynamic restoring forces on ship dynamic response. Detailed results from this work will be presented in ISOPE 2020 conference in October 2020 and will also appear in Ocean Engineering and Marine Structures Journals over the next period.

The lessons learnt are now being collected in a rapid assessment tool based on the super element method. It is believed that such approach will be much faster than existing general-purpose commercial solvers, accurate in comparison to simplified analytical formulations, and user friendly. It could therefore help to link crashworthiness with future damage ship stability SOLAS regulations.



a) collision event b) sway / roll response c) damage extends

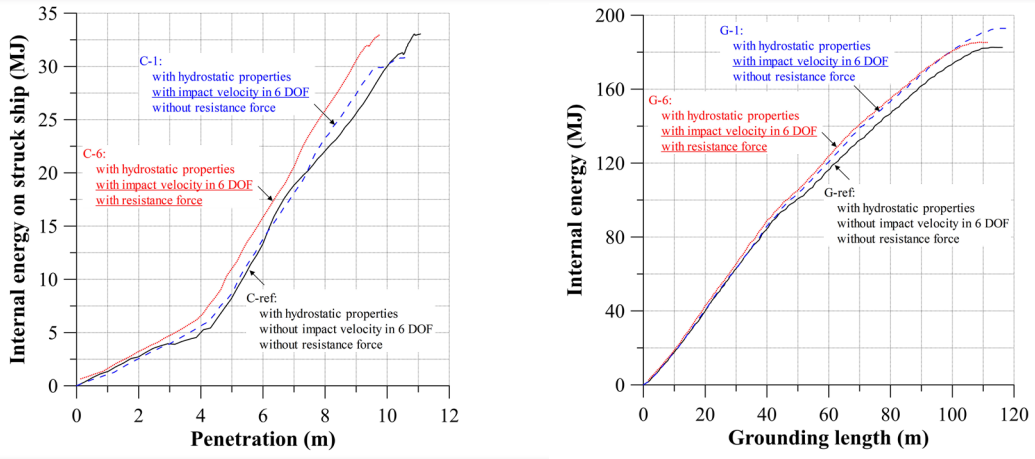
Figure 1: Visual of the influence of hydrodynamic properties on collision response and damage extends 12 sec after a typical collision event.



a) With all properties b) Without added masses

c) Without damping forces d) Without restoring forces e) Without all properties

Figure 2: The influence of hydrodynamic properties on damage extents at the end of a grounding event.

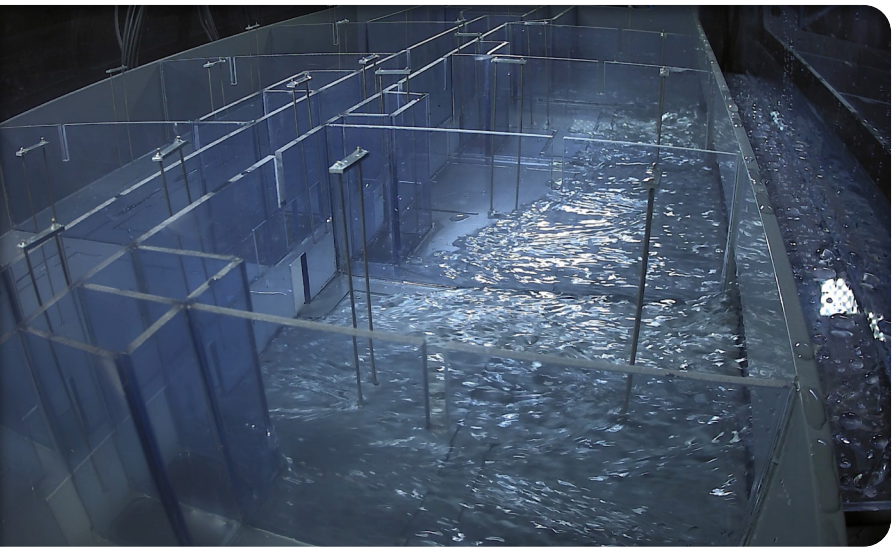


a) In collision

b) In grounding

Figure 3: The influence of hydrodynamic simulations on the crashworthiness of ship structures.

3 Numerical simulations and verification



Over the last few months, numerous activities have taken place in the model basins at HSVA and MARIN, with the aim of delivering benchmarking data for the validation of the existing numerical flooding simulation tools in realistic large-scale flooding scenarios. Fundamental flooding tests with simplified geometries are considered as an essential stepping stone in the validation process of numerical flooding models: such data is very scarcely present in the literature, and the experimental data collected in FLARE will be a new milestone in this aspect. One example of such a fundamental test was the flooding of a compartment deck arrangement on a single cruise ship deck in various degree of complexity. It was tested in isolation of the real ship.

The tests were successfully conducted and are now ready for further use in the numerical benchmarking task within the project, which aims at delivering the results by the end of this year. A unique group of participants consisting of FLARE partners and outside-project contributors will join this open-benchmark task; a truly cross-industry effort involving all those concerned with ship damage stability.

To better understand the damaged ship hydrodynamics, a series of roll motion tests has also been conducted in towing tanks using a damaged RoPAX vessel in various configurations. These tests will provide unique and essential data for the numerical models since the roll damping properties in those models need to be correct to obtain trustworthy simulation results in irregular waves. Over summertime, the model test campaigns will be completed with dedicated tests in irregular waves for a cruise ship and a RoPax vessel respectively. In those tests, all hydrodynamics and flooding fundamentals come together, allowing for deterministic and stochastic validation and verification.

4 Flooding risk model

The overarching objective of FLARE is to develop and institutionalise a framework for life-cycle risk estimation, monitoring and control for ship design and operation, with a particular focus on emergencies. This workspace is the "engine" of this estimation and, hence, the core of the project. This is depicted in the figure below.

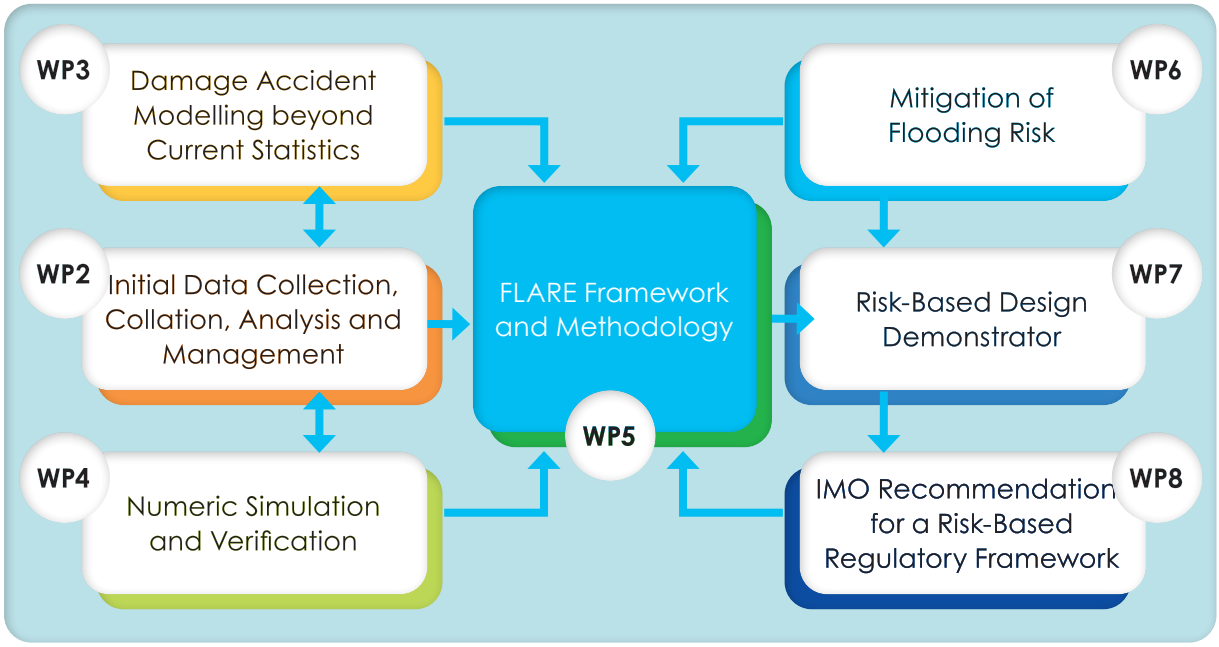


Figure 4: The FLARE Project – Engine and Components

Since February 2020, significant progress has been made on working out a detailed arrangement for the FLARE Framework application (software).

The use of a Novel Risk-Based methodology to assess 'live' flooding risk and understand the vessel survivability was highlighted in the analysis of static damage stability, dynamic damage stability and evacuation. Innovative solutions and techniques were applied within the software in various ways. For example, to facilitate time and resource efficiency within the Framework, several intelligent filtering and sorting tools were adopted. This makes it possible to assist the user in identifying the marginal-to-severe damage cases, wherever higher fidelity tools are needed.

More specifically, the FLARE Framework consists of numerous individual calculation stages, which fulfil the life-cycle concept of a vessel's safe return to port. Within this Framework, users are allowed to use the database from mature platforms (such as NAPA) in a creative way, while simulation/ calculation results by four different methods provided by FLARE partners become exchangeable and comparable for the first time.

As a result, the Framework offers, at the designing stage, flexibility for the user to compare different designs. It also helps in the identification and verification of appropriate Risk Control Options in the operation stage. Finally, it can work as a crucial Decision Support System (DSS), composed of breach estimation model, flooding progression and passenger evacuation models, which help prepare and guide the crew to minimise casualties when it comes to abandoning the vessel.

A demo software has been produced and the initial version of the users' guide is now available. This is the first step in the institutionalisation process, enabling the end-users to better understand and comment upon the process of Life-cycle Flooding Risk Estimation and therefore facilitate the iterative process being adopted.

5 Mitigation of Flood Risk

The activities in this workspace focus on the operational aspects of life-cycle vulnerability of an intact ship as well as flooding survivability assessment and on the study of different risk control options.

Over the past months, a new method has been developed to more accurately assess the effect that open watertight doors have on the damage stability and survivability in the event of flooding. The new method properly considers each individual door location and how much it contributes to the vulnerability. Moreover, the proposed method is robust and responsive enough to be applicable to rapidly changing situations onboard.

Vulnerability analysis is extended to include also the actual operational environment, especially the nearby traffic, and how this affects the potential for a collision or grounding accident. New methods to account for the complexity of navigation, and its effects on the vulnerability assessment, are being developed. The new methods will be tested and demonstrated with real historical AIS data.

In order to ensure that the voice of the end-user is properly heard, a short questionnaire was prepared and sent to various operators of Cruise and Ropax vessels. The questions considered both operational practices for watertight doors and navigational matters for collision and grounding avoidance. The questionnaire results will be utilized for applying reasonable parameters in the developed methods.

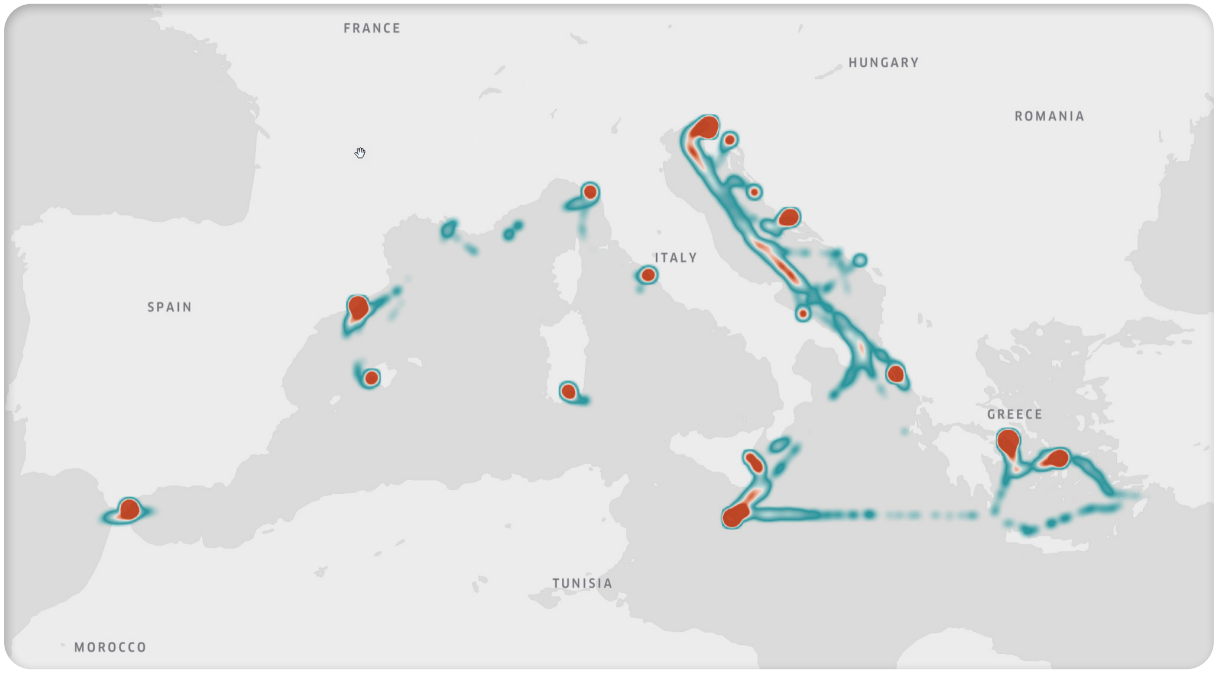


Figure 5: Visualization of encounters for a cruise ship in the Mediterranean Sea from historical AIS data.

6 Risk-based design demonstrators

The main objective of this workspace is to demonstrate the applicability of the FLARE Framework developed in workspace 4 and the implementation of the mitigation measures of the flooding risk identified for designs in workspaces 2 and 4. Activities will therefore start after the delivery and testing of the FLARE Framework – foreseen for December 2020.

7 IMO-recommendations for a risk-based regulatory framework

In order to achieve the highest benefit from the developments that will be made in FLARE, amendments and updates to the international regulations and the regulatory framework of the International Maritime Organisation (IMO) will be suggested. Main activities for this workspace are therefore scheduled for the last months of the project.

8 Dissemination and Exploitation

Dissemination and exploitation are crucial to enable and optimize the impact of FLARE, and pave the way to market-uptake of the project results. Since February 2020, the following activities have been ongoing and will continue throughout the lifetime of the project:

- Coordination of project dissemination and communication activities aimed at society and general public in broad terms and the maritime industry in particular;
- Coordination of efforts for dissemination within the FLARE consortium.
- Liaison with the European Commission, the International Maritime Organisation as well as the Advisory Board;
- Development and sharing of experiences and innovative solutions with external stakeholders and end-users;

As an important milestone, a FLARE mid-term conference will be organised in the first months of 2021. Further details on the matter will be provided in due course.

INFO

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