HASARD

Holistic Assessment of Ship Survivability and Risk after Damage

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ABSTRACT

This paper is an outline of the recently started research project HASARD. Some preliminary results are also presented.

HASARD is the acronym for Holistic Assessment of Ship Survivability and Risk after Damage. The project is funded by VINNOVA and by Lighthouse. HASARD is part of a coordinated European research program on maritime safety which is called SURSHIP – Survivability of ships.

KEYWORDS

HASARD, risk after damage

INTRODUCTION

A comprehensive calculation procedure useful for quantitative assessment of damaged ships survivability (incorporating structural collision resistance, structural stability and collapse (FEA), and time simulation of ship flooding and stability in waves) will be developed. The calculation procedure will be implemented in existing, modified, numerical simulation tools and it will be tested for a number of ship types/ship configurations and compared to existing model test data for validation.

Results from systematic simulations through this calculation procedure could be used in recommendations for future IMO rule making. It could also be used directly in a ship design process. Enhancement of the understanding of the physical processes involved in the chain of events following a collision between ships will also be obtained in the project.

The project constitutes two parts, structure and stability. Deliverables from the former will include among others phenomenological models which with satisfying reliability can mimic collapse and rupture phenomena in ship-ship collision simulations, and a methodology for estimation of the residual strength of a damaged ship structure. Deliverables of the latter will include among others further enhancement of the SIMCAP calculation tool, Schreuder (2005), and formulation of procedures which may quantify damaged ships ability to stay upright. These procedures are also proposed for use as a measure of the safety performance of e.g. Ro-Pax ferries.

The two parts of the project will work in close collaboration by exchange of information and results that will lead them towards a common aim: to develop a calculation procedure to become a useful tool for risk analysis (structural collapse

and ship stability) of the survivability of a collided and flooded ship.

AIMS AND OBJECTIVES

The main aim with the project is to outline a comprehensive calculation procedure which quantitatively can be used for assessment of damaged ships survivability, incorporating structural collision resistance, structural stability and collapse, and ship flooding and stability in waves. The main aim can be further refined as follows.

- **Structure perspective:**
  To increase knowledge and understanding of the consequences from collision impact on various side shell structures for various collision scenarios. Residual strength calculations for damaged structures will be carried out in order to make judgements of structural stability after collision. Necessary improvements and further developments of existing fracture/rupture criteria and phenomenological models have to be carried out.

- **Stability perspective:**
  To increase knowledge of the impact of different design solutions for e.g. passenger ships regarding the ability to keep also seriously damaged ships upright and prolong the available time for evacuation.

- **Structure and stability perspectives:**
  - To increase the knowledge of which physical phenomena that are relevant and must be involved in the assessment of the behaviour of damaged ships, and also how to incorporate them in numerical models in a comprehensive calculation procedure as proposed in this project.
  - To quantify the survivability of a ship subjected to different collision events. Here, various ships, collision scenarios, and sea state conditions will be accounted for.

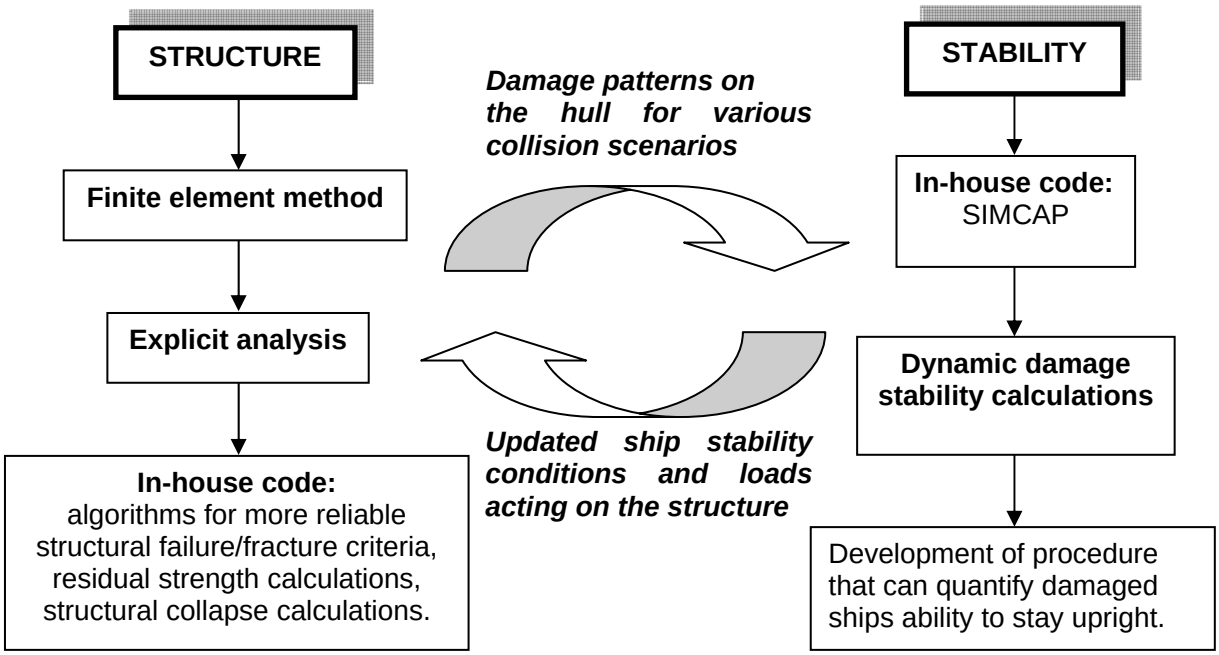
APPROACH OF STABILITY PART

A tool called SIMCAP has been developed at the department for dynamic ship stability calculations. This prediction tool will be further developed to include arbitrary wave direction

and irregular wave effects on the damaged ship response, i.e. the possibility to evaluate any/general load situations will be added to the existing code. There will be a close collaboration with the structure part of the project, especially regarding properties of structural damages, damage scenarios, and damage patterns (e.g. projected area of damage) on the hull structure. Static stability analysis will be performed in a number of case studies to analyse and evaluate the risk of different design solutions for passenger ships regarding capsize. Procedures to quantify damaged ship's ability to stay upright will be studied incorporating structural collapse assessment provide by the structure part.

OUTLINE OF INTERACTION AND WORK FLOW BETWEEN STRUCTURE AND STABILITY PARTS OF THE PROJECT

It is crucial that geometry description and modelling of the ships under investigation in SURSHIP will be compatible with the tools and softwares used in the current project (or the opposite). In addition, the flow chart in Figure 1 is a schematic illustration of the work flow for the parts of the project and the interaction between them. Together, they outline a calculation procedure in accordance with to the aims of the main project.



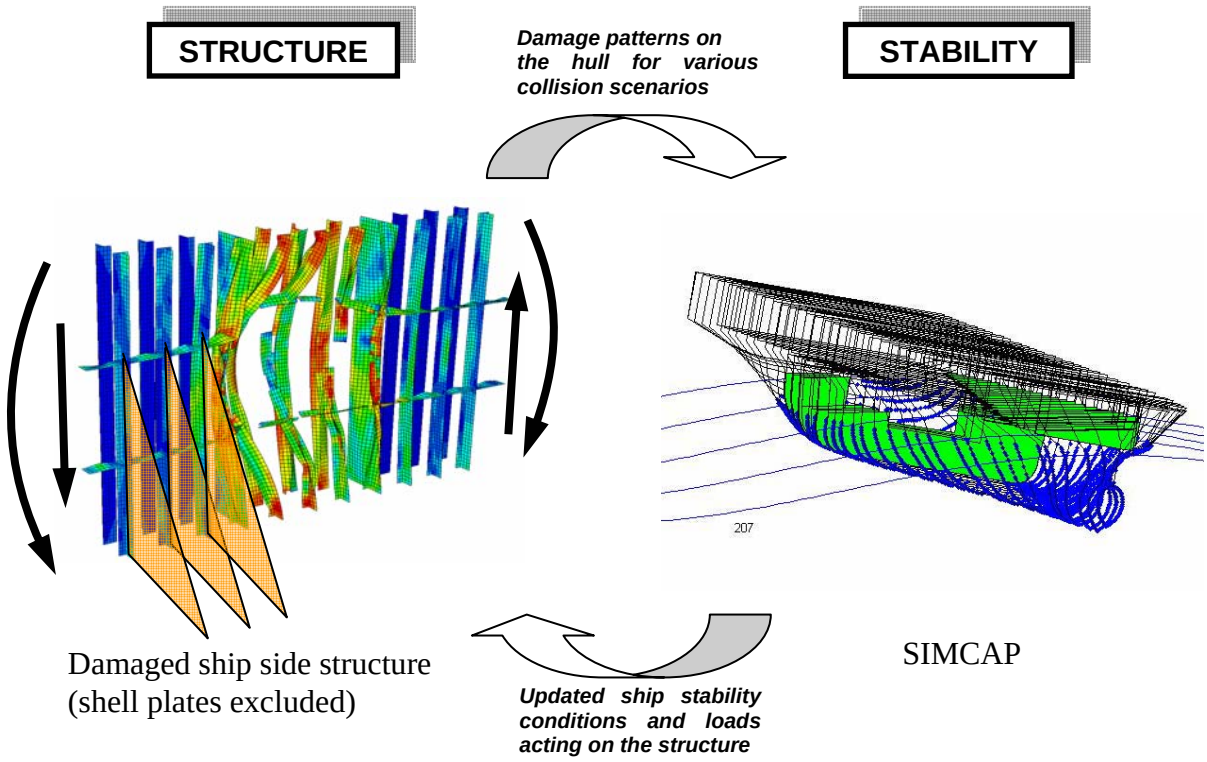


Figure 1**:** Schematic illustration of the work flow and interaction between the structure and stability parts of the project.

RESULTS AND IMPACT

- Further enhancement and validation of the existing SIMCAP numerical simulation tool.
  A preliminary result from development of the code is exemplified in Figure 2. Results also show capability of parametric roll resonance simulation.
- A comprehensive calculation procedure which quantitatively can be used for assessment of damaged ships survivability, incorporating structural collision resistance, structural stability and collapse, and ship flooding and stability in waves will be developed, see outline in Figure 1.
- New improved phenomenological models will be developed which with satisfying reliability can mimic structural collapse and rupture phenomena in ship-ship collision simulations even better in contrast to known models, methodologies and criteria found in the published literature. A methodology for estimation of the residual strength of a collided ship structure will be proposed.
- The impact of different design solutions regarding the ability to keep a damaged passenger ship upright also for large damages will be presented.
- Risk analyses of the survivability of a collided/damaged ship structure for various collision events will be investigated using the proposed calculation procedure.

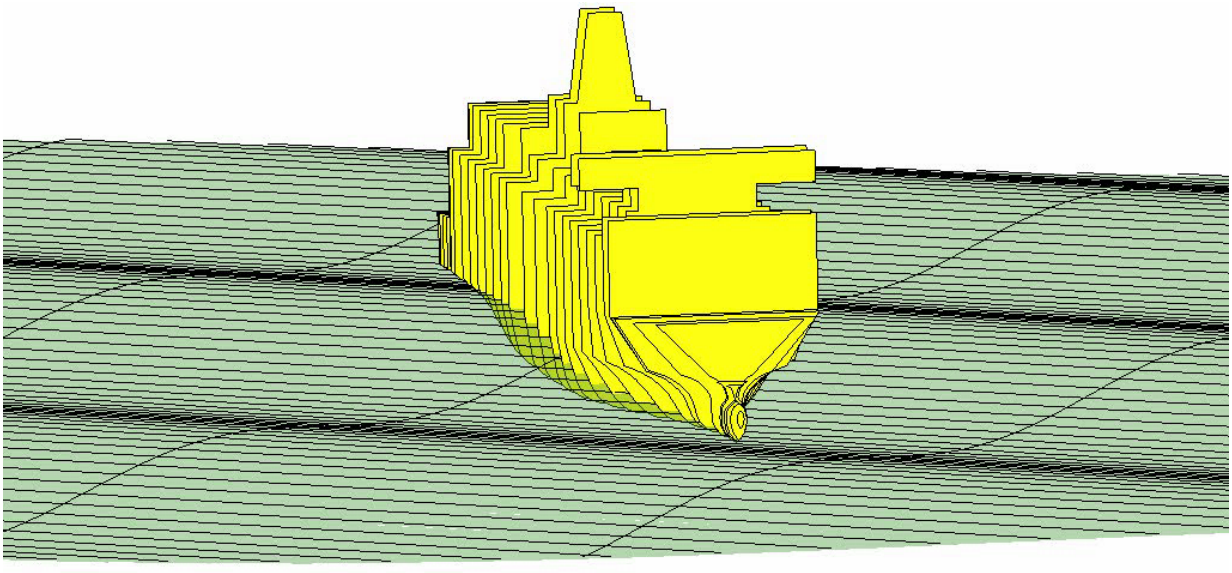


Figure 2**:** Snapshot from simulation in arbitrary wave direction

REFERENCE

Schreuder, 2005, “Time Simulation of the Behaviour of Damaged Ships in Waves”

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