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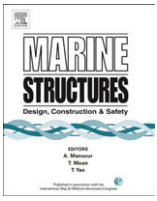

Concept for a risk based Navigation Decision Assistant

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ABSTRACT

A concept for a risk based decision support system for navigation of ships that face degrading weather conditions and dangers of damages to a ship at its cargo is outlined. Similar systems exist in various forms, mostly as prototypes, and are based on different ideas of how decision parameters should be communicated to a master as improved basis for decision making. The paper advocates that it is possible to develop a system that systematically is built on risk assessment approaches with the intention of being applicable for a specific ship with a specific loading situation in a real-time environment. The concept is based on modern reliability methodology and relies on state-of-the-art hydrodynamics software and information sources relating to the environment. Based on the various consequences that may occur, the study suggests a selection of limit states and shows how they can be integrated in the decision support system described. The paper presents the risk based concept only while testing of the concept is still in progress.

1. Introduction

Enhancing maritime safety is one of the main concerns of the shipping industry in general and of the Classification Societies in particular. With the increasing availability of real-time or near real-time information about the weather situation, the actual loading condition and the ship behaviour in a seaway, one contribution to improving safety at sea is the development of a decision support system that senses the environment from actual situation data and predicts the ship motions accordingly, thereby ensuring optimal ship operational performance.

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Several decision support systems are used by the industry today. Unfortunately, these systems are not sufficiently documented and a consistent concept based on the state-of-the-art risk approaches is still not available, even though such concepts have been used for a long time in ship design. The potential for risk based approaches is therefore not fully exploited. The main difference between these concepts relates to the time frame. At the design stage the time frame is usually the intended design life of a ship. For a real-time decision the time frame may be hours (tactical decisions) or days (strategic decisions relating to route planning). Decision criteria for consistent evaluation of risk of damages or losses of ship, cargo, crew and/or passengers on board is currently lacking for the tactical and strategic navigation. Existing knowledge regarding the metocean environment is hardly fully utilized to evaluate the risks connected to sailing in certain conditions. There is a strong need for a system at the navigation bridge that takes into account newly described phenomena such as parametric rolling and predicts the consequences in terms of motion induced phenomena considering all possible navigational decisions regarding course and speed.

The this study proposes a consistent risk based concept for a Navigation Decision Assistant (NDA) which will support a master and his crew in making decisions. The NDA presented herein is intended to provide information and guidance by offering an evaluation of probabilities and consequences; giving insight into the uncertainty of the information and into the risk related to relevant hazards. It is based on the modern reliability methodology and addresses uncertainties related to environmental models, load predictions, ship data and response calculations. To limit the study the presentation in the following is related to tactical decisions only. However, the system is sufficiently generic to allow for inclusion of information for strategic decisions such as decisions regarding route planning.

2. Framework for providing a definition of an NDA

Prior to developing a definition of an NDA the following questions collected from various stakeholders need to be answered:

- Which data will be used and how will they be monitored and collected?
- What kind of models and calculation codes will be used?
- Will uncertainties in data and models be included?
- How is the risk defined and in which units should the risk be assessed?
- How are probabilities calculated?
- How should critical values of parameter/parameters representing a hazard be established?
- How will costs related to occurrence of hazards be calculated and who will provide the cost estimates?
- Which decision parameters will be used in risk control options, and how will they be implemented in an NDA?
- Should a mathematical formulation cover each hazard separately (each hazard is checked separately) or all hazards combined?
- Should an NDA be based on the total risk, risks related to different risk categories or risks related a specific hazard?
- What kind of software should be installed on a ship and what used on land as a supporting tool prior to an NDA installation?
- How will the information be communicated through the user interface?
- Is the proposed concept satisfying stakeholders' requirements?

Answers to these questions can be based on different assumptions as well as adopted measuring techniques. Since the NDA development is a long term process, and has to relate and adapt to safety regulations it is important that the choices made provide a theoretically consistent approach that is also consistent with the basis for safety regulations.

From these considerations it seems clear that decision criteria for an NDA should be risk based and satisfy stakeholder requirements. An NDA should follow standard risk assessment approaches such as a Formal Safety Assessment (FSA). It should consist of five inter-dependent steps: (1) a hazard