LIGHTHOUSE

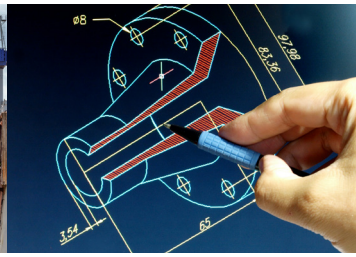
SWEDISH MARITIME COMPETENCE CENTRE

LIGHTHOUSE REPORTS

Dynamic design of ships

Author:
Jonny Nisbet, SSPA



A feasibility study initiated and sponsored by Lighthouse 2016

www.lighthouse.nu

Dynamic design of ships

designing for hydrodynamic performance and structural response for ships in waves

Author

Jonny Nisbet, SSPA

Coordinated by

Jonas Ringsberg, Chalmers / Department of Shipping and Marine Technology

Anders Rosén, KTH / Department of Aeronautical and Vehicle Engineering

Harry Robertsson, Stena Teknik

Jonny Nisbet, SSPA Sweden AB

Peter Grundevik, SSPA Sweden AB

Initiated and sponsored by Lighthouse 2016

LIGHTHOUSE
SWEDISH MARITIME COMPETENCE CENTRE

Core partners

SSPA

CHALMERS

KTH VETENSKAP OCH KONST

Stena Teknik
CARE, INNOVATION & PERFORMANCE

Summary

There is a big potential to develop ships for more efficient transport at sea by optimize the construction to reduce weight and steel to lower the cost for building and operate the ship. To ensure that legislations are fulfilled with respect to structural strength, seaworthiness, environment and safety at sea more knowledge is required to understand how requirements and solutions affect the complex construction of the ship. Today there is a lack of guidelines and regulations which do not fully account for the interaction between the wave loads and the structural response with enough safety margin with respect to the structural strength.

This pre-study was initiated and sponsored by Lighthouse with the goal to establish a joint collaboration under the framework of Lighthouse with participants from the academia and the industry with representation from the hydrodynamic and structural community in Sweden. Another goal was to define the project “Dynamic Design of Ships” and apply for external R&D funding in order to pursue the project.

A collaboration between Chalmers University of Technology, KTH Royal Institute of Technology, SSPA Sweden AB and Stena Teknik has been established.

Both strategic and technical goals have been defined and applications for external funding have been submitted to the Swedish Energy Agency and the Swedish Maritime Administration.

Sammanfattning

Det finns en stor potential att förbättra ett fartygs effektivitet genom att optimera skrovkonstruktionen för att reducera vikt och stålåtgång så att kostnaden för att bygga och operera fartyget minskas. För att säkerställa att en lättare skrovkonstruktion klarar kraven på hållfasthet, sjöegenskaper, miljö och säkerhet till sjöss krävs ökad förståelse kring hur olika krav och lösningar påverkar hela den komplexa fartygskonstruktionsbilden. Idag tar inte dimensionerande regelverk fullt ut hänsyn till interaktionen mellan vågornas belastningar och fartygs dynamiska respons med tillräckligt stor säkerhetsmarginal mot fartygskonstruktionens skadetålighet.

Förstudien har initierats och sponsrats av Lighthouse med målet att etablera ett samarbete inom ramverket för Lighthouse med deltagare från akademien och industrin med representation från aktörer inom hydrodynamik och strukturdynamik i Sverige. Ett annat mål var att definiera projektet ”Dynamisk fartygsdimensionering” samt söka extern finansiering för projektet.

Ett samarbete mellan Chalmers Tekniska Högskola, Kungliga Tekniska Högskolan, SSPA Sweden och Stena Teknik har etablerats.

Både strategiska och tekniska mål har definierats och ansökningar har lämnats in till Energimyndigheten och Sjöfartsverket.

Applications based on this pre-study:

- Dynamic design of ships to Hugo Hammars fond
- Dynamic design of ships to Swedish Energy Agency (Dynamisk dimensionering av fartyg till Energimyndigheten)
- Dynamic design of ships to Swedish Maritime Administration (Dynamisk fartygsdimensionering till Sjöfartsverket)

Table of Contents

1. Goal of the pre-study

The goal of the pre-study has been to establish a collaboration with participants from the academia and the industry in order to

- define the project “Dynamic Design of Ships” and its work packages
- apply for external R&D funding

The project is a collaboration between Chalmers University of Technology, KTH Royal Institute of Technology, SSPA Sweden AB and Stena Teknik.

Interaction with other parties from ship owners and shipyards, Class Societies (DNV/GL, Lloyds, ABS), Naval Architect committees ITTC and ISSC, will also be sought in the project.

The core partners in the study have been:

Professor Jonas Ringsberg, Chalmers University of Technology, Department of Shipping and Marine Technology

Assistant Professor Anders Rosén, KTH Royal Institute of Technology, Department of Aeronautical and Vehicle Engineering

Technical Director Harry Robertsson, Stena Teknik

Team leader Manoeuvre & Seekeeping group Jonny Nisbet, SSPA Sweden AB

Head of SSPA Research Peter Grundevik, SSPA Sweden AB

2. Challenge

In order to develop ships for more efficient transport at sea, with reduced specific fuel consumption and emissions, the tendency is to design larger ships (IMO 2015 - http://www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Documents/Third%20Greenhouse%20Gas%20Study/GHG3%20Executive%20Summary%20and%20Report.pdf).

There is a big potential to develop ships for more efficient transport at sea by optimising the construction to reduce weight and steel to lower the cost for building and operation of the ship. In this process, it is of first importance to ensure that any changes in the construction is done in a safe way. The effect of less steel and changed construction on the ship's damage tolerance against wind and wave loads, and the dynamic response of those external forces, has to be evaluated.

This has to be accomplished at the same time as the legislations are fulfilled with respect to structural strength, seaworthiness, environmental requirements and safety at sea.

According to a study from IMO (IMO2009 http://www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Documents/GHGStudyFINAL.pdf)

the potential is a 2-20% reduction in greenhouse gases for an optimised hull construction and reduced weight.

Photo: Pi-Lens/Shutterstock.com

3. Motivation

More knowledge and collaboration between different disciplines is required to understand how requirements and solutions affect the complex construction of the ship.

The international committees in the Naval Architects community, ITTC (International Towing Tank Conference) and ISSC (international Ship Structures Committee) report that research and development is required to design new ships with respect to the hydrodynamic performance of the ship in waves (how the ship performs in waves and how it is affected by the dynamic loads, such as wind and waves) and the structural response (how the ship construction is affected by the dynamic loads, such as wind and waves). SSPA has representation in the ITTC and Chalmers in ISSC.

ITTC and ISSC have stated that research and development of new generations of ships will require more collaboration between the hydrodynamic and structural community and have therefore created a sub-committee ITTC-ISSC to promote more interaction between the committees when developing methods.

Today, there is a lack of guidelines and regulations which accounts for the dynamic loads on the ship when it is operating in wind and waves. Studies report that ships of different types have increased problems due to wave loads leading to resonance (springing) or fading vibrations(whipping) in the hull beam. This has led to ships having cracked and constructions having broken due to a combination of fatigue and exceedance of global longitudinal strength. A lack of basic understanding may lead to the opposite effect, i.e. the ships are designed to be oversized leading to higher weight and larger displacement, leading to unnecessarily high fuel consumption and increased environmental impact.

Photo: Anatoly Menzhiliy/Shutterstock.com

4. Project goals for proposed project

The project aims to conduct joint research and development of refined methods for dynamic design of ships to

- increase the knowledge about how dynamic loads on ships affects the structural response (e.g. slamming, springing, whipping)
- strengthen the national capacity in the field of ship dynamics
- enhance the competitiveness of stakeholders (ship owners, shipyards, ship designers)

By showing both the benefit and cost structure, the hope is that lighter, more energy efficient hulls can be constructed, which reduces environmental impact and enhances the competitiveness of ship owners, shipyards and shipping.

For the participants in the project, knowledge will be accumulated that will strengthen national capacities in the field of dynamic design of ships, which is a strategically important area in the future, acknowledged by the international organisations ITTC and ISSC.

5. Technical goals for the proposed project

Three interacting areas in the hydrodynamic and structural disciplines have been identified:

- Development of a combined method and hydrodynamic model test setup in order to compare different techniques to evaluate the response of the hull beam for a ship hull in waves.
- Further development and refinement of simulation models and (quasistatic and dynamic) methods for global and local structural response
- Calibration and validation of model tests and numerical simulations against full scale sea trial and measurements

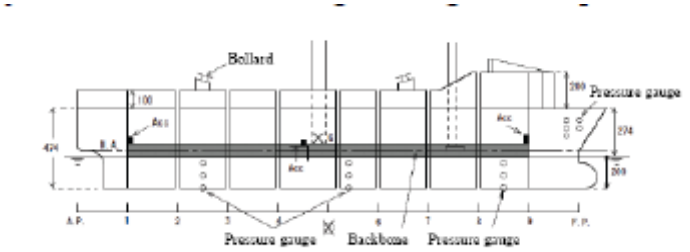


Illustration of the principles of a segmented ship model with a backbone structure. The model should have the same elastic properties and mass properties as the full-scale ship. Forces and moments is measured at several stations along the hull and provide input to the simulations models.

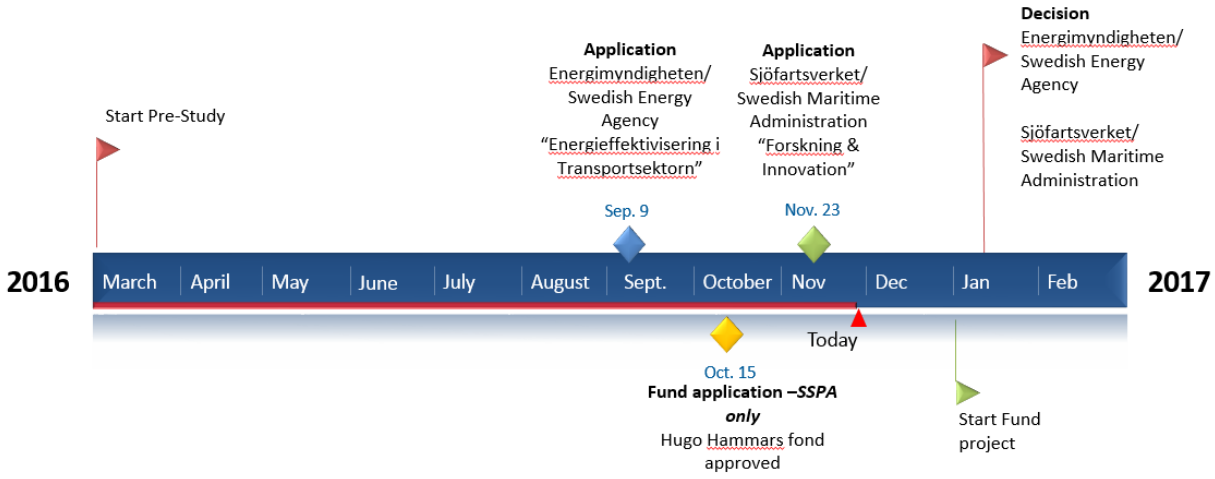
The results from the project will provide guidelines for how much the steel weight of a ship can be reduced, how this affects the ships dynamic performance and damage tolerance, potential reduction in fuel consumption and cost for the ship owner, and reduced impact on the environment.

The development of methods and simulation models is essential together with the model tests and full scale sea trials to evaluate the validity of the quasistatic and dynamic analysis. The project will contribute to the international research at the leading edge led by the ISSC-ITTC committee by proposing a rational and reliable methodology applicable when designing new ships and retrofitting.

6. R&D funding applications

Two applications for R&D funding have been submitted to national authorities. The first application was submitted to Energimyndigheten (the Swedish Energy Agency) in September, 2016, and the second to Sjöfartsverket (the Swedish Maritime Administration) in November, 2016. Application to Sjöfartsverket was approved in December, however, the application to Energimyndigheten was rejected in January, 2017.

The project has since then been granted additional funding and work is still underway to secure full funding for the project.



Lighthouse gathers leading maritime stakeholders through a Triple-Helix collaboration comprising industry, society, academies and institutes to promote research, development and innovation within the maritime sector with the following vision:

Lighthouse – for a competitive, sustainable and safe maritime sector with a good working environment




LIGHTHOUSE PARTNERS

CHALMERS

KTH VETENSKAP OCH KONST

Linnæus University Sweden

UNIVERSITY OF GOTHENBURG

REGION VÄSTRA GÖTALAND

SWEDISH MARITIME ADMINISTRATION

THE SWEDISH MERCANTILE MARINE FOUNDATION

SVENSK SJÖFART SWEDISH SHIPOWNERS ASSOCIATION

VINNOVA

LIGHTHOUSE ASSOCIATE MEMBERS

SSPA Your Maritime Solution Partner

Swedish Maritime Technology Forum

SWEDISH ICT VIKTORIA

ivl

Tryckt December 2016