AN EFFICIENT APPROACH AT HOLISTIC SHIP DESIGN'S SERVICE FOR STRUCTURAL OPTIMISATION

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SUMMARY

This paper concerns structural optimisation within an holistic ship concept design platform. The main focus of the present research is to demonstrate an integrated workflow for automated rule-based structural design optimization process of a typical 2D midship of RoPax vessel which has been developed within the framework of EU HOLISHIP project (2016-2020). To this end, a number of existing tools along with their new script/batch-mode developments (namely MARS2000® and STEEL® BV tools and modeFRONTIER®) as well as some new in-house tools/modules (e.g. Scantling-Spacing Updater) have been integrated under an automated iterative routine.
In the integrated optimization workflow developed, steel weight is considered to be the objective function to be minimized, and the constraints required by the relevant BV rules and by the shipyard are also taken into consideration.
Using the present approach- in an appropriate computing platform- a number of feasible optimized designs can be generated overnight.

1. INTRODUCTION

Shipbuilding and the shipping sector face increasing pressure to balance the conflicting needs and requirements of improving safety, reducing environmental impact, increasing flexibility for varying operational conditions, improving life cycle cost/performance, etc, within the context of a highly competitive market.
Meeting such significant challenges requires the use of a holistic, multi-disciplinary and multi-objective design optimization platform from the earliest design stages in the traditional ship design process. The creation of such a platform was to some extent addressed during some former research-based EU-funded projects such as IMPROVE [1] (for examples see [2-3] which are associated to this project), and BESST [4] (for example see [5] which is associated to this project).
In continuation of preceding work undertaken, the EU launched a new R&D project in 2016, first initiated by Papanikolaou in 2010 [6]. A very large team of European partners set out to comprehensively develop the concept of a holistic approach to the optimization of ship design and has been collaborating to implement the approach within the context of the EU Horizon 2020 R&D project dubbed HOLISHIP, or the "Holistic Optimization of Ship Design and Operation for Life Cycle" [7].
The HOLISHIP project addresses the different design steps from the concept and contract design of vessels to virtual prototyping for design, and operational assessment. It aims to consider all relevant design aspects, namely energy efficiency, safety, environmental compatibility, production and life-cycle cost using holistic optimization platforms that aim to deliver the right vessel(s) for future transport tasks. To this end, a modern, flexible computer-aided engineering (CAE) environment, based on CAESES® (www.caeses.com) as the process integration and design optimization (PIDO) environment, is being used to integrate all the important disciplines of conceptual and contractual design under the greater umbrella of advanced parametric modeling tools to enable the parametric, multi-objective and multi-disciplinary optimization of ship products. (A detailed description of the project can be found in [8], while a quick overview can be gained from [9-10].
Recent feedback from shipyards indicates that efficient and effective weight reduction is one of the main technical requirements of the design process (Rigo et al. [11]). To meet this need, within the EU HOLISHIP project, an integrated workflow for automated rule-based structural optimization process (see Section 2, Fig. 1) has been developed to systematically serve relevant application cases in concept design stage where simplified/innovative rules-based assessment methods/tools are necessary. In the continuation of the works carried out by Bayatfar et al. [12-14], the main objective of this paper is to demonstrate the integrated workflow for automated rule-based structural design optimization of a typical 2D midship of RoPax vessel. To this end, a number of existing tools along with their new script/batch-mode developments (namely MARS2000® and STEEL® BV tools and modeFRONTIER®) as well as some new in-house tools/modules (e.g. Scantling-Spacing Updater, Rule Violation Indicator) have been integrated under an automated iterative routine (see Section 3).

2. GENERAL METHODOLOGY

The present integrated rule-based structural optimisation workflow for serving holistic ship concept design platform is shown in figure 1. The structural optimisation is performed based on 2D midship using MARS2000® and STEEL® BV tools. MARS2000® and STEEL® initial built models are considered as the reference midship structural designs for structural optimisation process.
First, MARS2000®-based workflow is called to optimise the plating and longitudinal stiffeners, considering the appropriate BV rule-based loads (e.g. hull bending moment, pressures on hull, …).