

INFORMATION ON NEW CONTRIBUTIONS OF THE DOCTORAL DISSERTATION

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Title: "Research on Improving the Hull Form of VR-SB Class Cargo Vessels Suitable for Vietnam's Inland Waterways to Reduce Ship Resistance"

Major: Transport Mechanical Engineering

Code: 9520116

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Training Institution: Vietnam Maritime University

SUMMARY

1. Research Objectives, Subjects, and Scope

- **Research objectives:** To develop a methodological framework for improving the hull form of VR–SB class cargo vessels to reduce ship resistance, taking into account the specific characteristics of Vietnam’s inland waterway routes. The developed model is applied to optimize the hull form of a representative VR–SB cargo ship series currently operating widely on these inland routes. The study also evaluates the influence level of each hull-form parameter on ship resistance.

- **Research subjects:** VR–SB class cargo vessels and Vietnam’s inland waterway routes. In particular, the 4,600-DWT cargo ship series, one of the most widely used series on these routes, is selected as the case study for hull-form improvement.

- **Scope of the study:** The dissertation focuses on hull-form improvement to reduce resistance of a selected ship model operating in still water conditions without current, and under the full-load condition.

2. Research methods

To achieve the stated objectives, the dissertation employs the following methodologies: Survey, synthesis, and statistical analysis; Hydrodynamic theories and conventional ship-hull form design methods; The Taguchi method combined with Grey relational analysis; and Computational Fluid Dynamics (CFD) method.

3. Scientific and practical significance of the dissertation

- **Scientific significance:**

- Proposes a methodological model for hull-form improvement of VR–SB class cargo vessels to reduce resistance, taking into account the characteristics of the national inland waterway routes.

- Evaluates the influence levels of hull-form parameters on ship resistance, thereby enabling designers to identify key parameters that should be adjusted to achieve the most effective resistance reduction.

- **Practical significance:**

- Improving the hull form of VR–SB cargo vessels to match Vietnam’s inland waterway routes. By enabling fuel savings, this optimization significantly enhances economic efficiency and contributes to environmental protection for the VR–SB fleet. In the application to a 4,600 DWT VR–SB cargo ship, the optimized hull form reduces total resistance by 4.8%. If implemented widely in VR–SB ship designs, the economic and environmental benefits would be substantial.

- The research results provide both practical value and a useful reference source for ship designers in their professional activities.

4. New contributions of the dissertation

The dissertation presents several scientific and practical contributions:

- Develops a complete methodological model for improving the hull form of VR–SB class cargo vessels to reduce resistance, explicitly incorporating the operational characteristics of inland waterways. The model consists of 16 clearly described steps, enabling designers to apply it effectively to enhance hull-form design efficiency for VR–SB ships.

- Provides a scientific analysis and justification of the effects of operational conditions on ship resistance, thereby proposing the selection of an objective function and the determination of weights for component objectives in the hull-form design process. Specifically, the multi-objective resistance function is transformed into a single-objective function corresponding to each distinct operational condition. The weighting factors are determined based on the proportion of time the vessel operates in each condition.

- Analyses and explains the physical mechanisms underlying resistance variation due to changes in hull-form parameters by presenting vivid flow-field visualizations that highlight the differences in flow patterns around the hull for various design alternatives.

- Evaluates the influence levels of five hull-form parameters: half entrance angle ($1/2\alpha_E$), the length coefficient of the bulbous bow (C_{LPR}), the cross-sectional area coefficient of the bulbous bow (C_{ABT}), volume coefficient of bulbous bow C_{VPR} , and the longitudinal center of buoyancy (LCB). Among these, LCB is identified as the parameter with the greatest impact on ship resistance, whereas the half entrance angle ($1/2\alpha_E$) has the smallest effect.

- Applies the proposed hull-form improvement model to the 4,600-DWT VR–SB cargo ship. The optimized hull form yields a 4.8% reduction in total resistance compared with the original form. The results are highly reliable, as the CFD-based resistance prediction model was validated indirectly by comparing the computed results with experimental data obtained by the doctoral candidate using JBC and DTMB model tests.

SUPERVISORY COMMITTEE

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