

Resistance Prediction of Planing Hulls: State of the Art

John M. Almeter¹

There are literally dozens of different ways that the boat designer can predict the resistance of planing hulls. The term planing hull is used generically to describe the majority of hard chine boats being built today. No single prediction method is good for all types of planing hulls. Some methods can be relied on to give good predictions for certain boats and other methods can't be relied upon at all. This paper is meant as a reference for designers in selecting resistance prediction methods for planing hulls. It describes numerous resistance prediction methods and gives their variable ranges and the type of planing hulls they are based on or are intended for. Inherent problems or limitations of the methods are stated. The concept of hull shape, which is often neglected in resistance prediction, and its important role are discussed.

Background

THE VARIABLES commonly used in resistance prediction methods include speed, weight, length, beam, midship deadrise, and longitudinal center of gravity. These variables define the basic dimensions and loading of the hull but they fail to accurately describe the hull shape. Hull shape includes terms or variables such as

- beam taper,
- hull warp, and
- concave, convex, or straight sections.

The hull shape can have a major if not dominant impact on a boat's resistance. These characteristics or variables of hull shape are often difficult to describe mathematically. The lines drawings [1] in Fig. 1 all have the same basic dimensions but show a wide variety in hull shape. Even if all the hull shape variables could be described, the problem of trying to incorporate all of these variables into a resistance model is too difficult. The growth in the complexity of the model far exceeds the growth in number of additional variables. The designer needs to select a resistance prediction method which minimizes the error caused by "omitting" hull shape in the resistance prediction. This is done by selecting a resistance prediction method which best reflects the designer's hull shape. Planing hull series try to keep the hull shape fixed by simply stretching the hull in one direction or the other. Good resistance prediction methods are based on a particular hull type or class (hull shape). The boat designer needs to make sure that the craft not only falls in the dimensional and nondimensional range of a resistance method, but also within the hull shape range.

Inspection of a prediction method's parent hull lines drawing or hull shape description may tell the designer if a method will match his hull. The selection of a prediction method is simplified if the designer can place the design into a class or category. Planing craft often fall neatly into categories or types such as offshore high-speed monohull raceboats. In this example almost all of the boats have very similar hull shapes and their nondimensional variables fall in a small range. The hull shape is for all practicality fixed, and the powering or resistance prediction model can be reduced to a comparatively few variables based on a few random craft of this class.

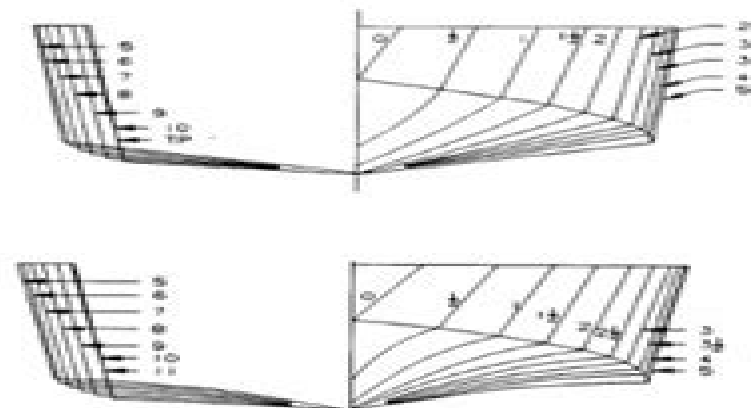


Fig. 1 Different hull shapes

It is not uncommon for designers of this type of craft to accurately predict resistance or power using simple formulas or graphs based on their experiences. These same models would probably give a poor prediction for other types of craft such as a 20-knot crewboat.

By knowing the type of hull shape a resistance prediction method is based on or is intended for, it becomes much easier to select the appropriate method. Planing hulls with the same basic dimensions intended for the same speed regime often have a very similar hull shape and similar resistance. The following are basic speed regimes which can drive hull shape.

- *Pre-planing:* Up to approximately $F_{v,0}$ 2.5. This normally covers up to and including hump speed. In pre-planing the bulk of the craft's weight is supported by buoyancy.
- *Semi-planing:* Approximately from $F_{v,0}$ 2.5 to 4.0. At this speed range the craft's weight is supported by both hydrostatic and dynamic forces. As the speed increases the dynamic forces increase, hydrostatic forces decrease and dynamic trim tends to decrease.
- *Fully planing:* Approximately $F_{v,0}$ 4.0 and above. At this speed range the craft's weight is almost entirely supported

¹ Carderock Division, Naval Surface Warfare Center, Combatant Craft Department, Norfolk Detachment, Norfolk, Virginia.

² Numbers in brackets designate References at end of paper.

Presented at the February 28, 1991 meeting of the Hampton Roads Section of The Society of Naval Architects and Marine Engineers.

Resistance Prediction Of Planing Hulls State Of The Art

Eric Nels Anderfaas



Resistance Prediction Of Planing Hulls State Of The Art:

Power Prediction Modeling of Conventional High-Speed Craft Dejan Radojčić, Milan Kalajdžić, Aleksandar Simić, 2019-10-29 The proposed book addresses various power prediction methods a principal design objective for high speed craft of displacement semi displacement and planing type At the core of the power prediction methods are mathematical models based on experimental data derived from various high speed hull and propeller series Regression analysis and Artificial Neural Network ANN methods are used as extraction tools for this kind of models The most significant factors for in service power prediction are bare hull resistance dynamic trim and the propeller s open water efficiency Therefore mathematical modeling of these factors is a specific focus of the book Furthermore the book includes a summary of most of the power prediction relevant literature published in the last 50 years and as such is intended as a reference overview of the best high speed craft modeling practices Once these mathematical models have been developed and validated they can be readily programmed into software tools thereby enabling the parametric analyses required for the optimization of a high speed craft design The proposed book is intended primarily for naval architects who design and develop various types of high speed vessels yachts boats etc as well as for students who are interested in the design of fast vessels The book includes useful Excel Macro Codes for the outlined mathematical models Moreover software for all considered models is provided

Reflections on Power Prediction Modeling of Conventional High-Speed Craft Dejan Radojčić, 2018-08-25 This SpringerBrief focuses on modeling and power evaluation of high speed craft The various power prediction methods a principal design objective for high speed craft of displacement semi displacement and planing type are addressed At the core of the power prediction methods are mathematical models for resistance and propulsion efficiency The models are based on the experimental data of various high speed hull and propeller series The regression analysis and artificial neural network ANN methods are used as an extraction tool for this kind of mathematical models A variety of mathematical models of this type are discussed in the book Once these mathematical models have been developed and validated they can be readily programmed into software tools thereby enabling the parametric analyses required for the optimization of a high speed craft design This book provides the foundational reference for these software tools and their use in the design of high speed craft High speed craft are very different from conventional ships Current professional literature leaves a gap in the documentation of best design practices for high speed craft This book is aimed at naval architects who design and develop various types of high speed vessels *HSMV 2020* E. Begovic, 2020-11-03 This book presents the proceedings of the 12th International Symposium on High Speed Marine Vehicles held virtually as an e conference for the first time on 15 and 16 October 2020 High Speed Marine Vehicles Conference has almost 30 year history since the first Conference held in Naples in 1991 Since then it has been an opportunity to present and discuss developments in the design construction and operation of High Speed Marine Vessels More than 40 abstracts were submitted for this edition of the conference and following a rigorous review

process 26 papers were selected for inclusion in this book These have been divided into 7 sections CFD EFD sea trials hydrofoils multi hull hydrodynamics planing hull hydrodynamics propulsion and ship machinery second generation intact stability criteria and structures loads strength and materials Topics covered include updated aspects of and developments in ship design numerical and experimental hydrodynamics seakeeping and maneuvering and marine structures and machinery This publication will be of interest to researchers from academia industry government agencies and certifying authorities as well as designers and operators of high speed vessels Design Principles of Ships and Marine Structures Suresh Chandra Misra,2015-12-01 The Definitive Reference for Designers and Design Students A solid grasp of the fundamentals of materials along with a thorough understanding of load and design techniques provides the components needed to complete a marine platform design Design Principles of Ships and Marine Structures details every facet of ship design and design integr

High-Speed Monohull and Hydrofoil Craft Zu-Shun Dong,Liang Yun,Raju Datla,Alan Bliault,2024-12-24 High Speed Monohull and Hydrofoil Craft Performance Technology and Applications provides comprehensive coverage of the basic hydrodynamics of high speed monohulls and hydrofoil craft useful to students and engineers alike The first half of the book introduces different hull shapes for semi planing and planing craft with examples from their development through the last century Succeeding chapters then describe the hydrodynamic theory behind their performance in calm water and a seaway They also document the extensive series of model test programs naval architects use to create prediction models for resistance and powering Electronic versions of a number of these are included for readers use A final chapter on monohulls looks at hull geometric form that has been developed to provide the best possible combination of resistance in waves and motion response through a combination of a deep and sharp forefoot and a hard chine cross section towards the stern for patrol vessels and offshore logistics craft The book s second half introduces the various geometries and planform configurations of hydrofoils under a fast craft hull It reviews the development of these craft for inland waterways such as major river systems and the rougher environment of seaways such as the Mediterranean and Atlantic oceans It is followed by hydrofoil theory in an ideal fluid close to a free surface Then the theory for a real fluid includes the vorticity and effect of planform dihedral and surface interaction Hydrofoil craft design and analysis are covered next Finally there is a chapter on special configurations such as craft having foils just at the bow and hydrofoil craft based on catamaran hulls **Marine Technology and SNAME News** ,1996 **Proceedings of Twenty-first Century Shipping** ,1995 **Hydroplane Performance, Stability and Control** Eric Nels Anderfaas,1995 **Proceedings of the Twenty-Third American Towing Tank Conference** Robert G. Latorre,1993 **Ship Technology Research** ,2005 **Maritime Information Review** ,1993 Jahrbuch Schiffbautechnische Gesellschaft,1980 Journal of Hydronautics ,1980 A publication of the American Institute of Aeronautics and Astronautics devoted to marine science and technology Index of SNAME Publications Society of Naval Architects and Marine Engineers (U.S.),1986 Index of SNAME Publications ,1961 Marine Design XIII,

Volume 1 Pentti Kujala,Liangliang Lu,2018-06-04 This is volume 1 of a 2 volume set Marine Design XIII collects the contributions to the 13th International Marine Design Conference IMDC 2018 Espoo Finland 10 14 June 2018 The aim of this IMDC series of conferences is to promote all aspects of marine design as an engineering discipline The focus is on key design challenges and opportunities in the area of current maritime technologies and markets with special emphasis on Challenges in merging ship design and marine applications of experience based industrial design Digitalisation as technological enabler for stronger link between efficient design operations and maintenance in future Emerging technologies and their impact on future designs Cruise ship and icebreaker designs including fleet compositions to meet new market demands To reflect on the conference focus Marine Design XIII covers the following research topic series State of art ship design principles education design methodology structural design hydrodynamic design Cutting edge ship designs and operations ship concept design risk and safety arctic design autonomous ships Energy efficiency and propulsions energy efficiency hull form design propulsion equipment design Wider marine designs and practices navy ships offshore and wind farms and production Marine Design XIII contains 2 state of the art reports on design methodologies and cruise ships design and 4 keynote papers on new directions for vessel design practices and tools digital maritime traffic naval ship designs and new tanker design for arctic Marine Design XIII will be of interest to academics and professionals in maritime technologies and marine design

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