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High Speed Vessels

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High Speed Vessels

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Operational Assessment of a Fast Rescue Craft
M. Garvin, T. Harris, National Research Council, St. John's, Canada

To improve operational efficiency and safety, spark-ignited diesel engines were trialed aboard a Canadian fast rescue RHIB. The vessel was outfitted with a data acquisition suite that allowed collection of vessel and engine performance data. The instrumented vessel was trialed in three seastates (approx. Beaufort 2 to 7) with star patterns and turning circles at a range of speeds and sustained near-shore running. This paper focusses on the methodologies and results for several operational factors: [1] ability to maintain heading and speed, [2] effort required to maintain heading and speed, and [3] impacts of seastate (HS, TP, & steepness), heading, and speed on fuel consumption. The variability of steering input and heading as a function of seastate, heading relative to wave direction, and speed were used as a proxy for the difficulty and the effectiveness of maintaining heading. Similarly, the variability of throttle input and vessel speed as a function of sea state heading relative to wave direction were used as a proxy for the difficulty and effectiveness of maintaining speed. The effect of seastate, heading, and speed on fuel consumption were also examined. Preliminary results show that variability of heading is very weakly correlated to all variables while steering input is moderately correlated to TP (ρ=-0.4345) & strongly correlated to steepness (ρ=0.6023). Variability of speed is moderately correlated to HS (ρ=0.5885) and throttle input is strongly correlated to HS (ρ=0.6094). Fuel consumption is very strongly correlated to speed (ρ=0.9823) with a maximum endurance achieved ~15 knots below top speed.

Improving Efficiency and Comfort of High Speed Crafts using Machine Learning and Big Data
A. Rafiee, M. Van-Someren, Technology Development, AUSTAL, Australia

It is well understood that the efficiency and motion comfort of high speed craft (HSC) are important concerns of HSC operators. Efficiency and Comfort directly relate to operational cost through fuel consumption and passenger revenue. Hence reducing fuel consumption and improving motion comfort are among the main goals of high speed ferry operators. Since early 2017 Austal has recognised the value of smart technologies, Artificial Intelligence (AI) and the Internet of Things (IoT) in improving the performance and comfort of the HSC built by Austal. As evidence of this, Austal has developed MARINELINK-Smart technology to transform Austal-built vessels into "Smart Ships" by gathering large volume of data from various sensors on-board of vessels. To date, Austal has installed MARINELINK-Smart technology on multiple large HSC operating globally. Through the implementation of MARINELINK-Smart technology Austal has collected large operational data sets. These include vessel motions, vessel particulars, engine performance, motion control settings and other relevant parameters. A smart ship brings opportunities for big data analytics to improve ship maintenance, operational efficiency, motion comfort and equipment life management. In this paper, we demonstrate how big data and state of the art machine learning techniques are used to build, test and deploy intelligent models to predict and optimize fuel consumption and motion comfort of HSC. This included addressing the challenges of predicting fuel consumption and ship motions at high-speed in real-world conditions. We also show how the deployed models helped various operators to improve on their fuel consumption and motion comfort across the globe.

Improving the nautical performance of a surface ship with the Hull Vane® appendage
H. Ferré, P. Goubault, Naval Group SA, France
C. Yvin, SIREHNA, France
B. Bouckaert, Hull Vane B. V.

The optimization of propulsive performance of ships is a primary and daily issue during design phases. For combat ships, the constant search for increasing operability through the improvement of seakeeping performance, acoustic discretion and maneuvering ability is also a concern. For this reason, Naval Group studied the hydrodynamic impacts of the integration of the appendage Hull Vane® on a corvette of its own design. The appendage has been designed and optimized especially for this ship by the Hull Vane B.V. company, then compared by CFD computations with several geometries of wedges, interceptors and flaps. This phase showed significant gains on resistance and propulsive power, on a wide range of speeds. These gains far exceeded what is obtained with the common stern appendages. The analysis of hydrodynamic performance of the corvette was continued by model tests, with and without the Hull Vane®, in order to also evaluate the other hydrodynamic impacts. Important gains have been found on seakeeping performance resulting in better operability rates for STANAG criteria and in increased comfort for the crew. Maneuverability tests showed a small downgrading of the tactical diameter. Finally, resistance and propulsion tests confirmed the gains obtained by CFD computations on propulsive performance. By the same token, new studies are currently performed to even more optimize propulsive performances for ships at Naval Group.

Towards better energy efficiency of future cargo ships
M. Kalajdžić, A. Simić, R. Pešterac, M. Vasilev, The University of Belgrade, Serbia

The global economic and industrial growth imposes Energy Efficiency as a significant environmental issue. Having in mind that more than 90% of world freight transport is done by ships and that e.g. CO2 emissions from ships exceed 1000 Mt per year, a shipbuilding industry is affected too. Thus, the energy efficiency of the most common types of cargo ships has become one of the most discussed topics. Accordingly, various international student competitions related to the energy efficiency of marine vehicles are organized by different institutions, with the main question: how to design a more efficient ship. One such event, HYDROCONTEST, supported by the HYDROS Foundation, was held in Saint-Tropez in 2018. Among 30 teams worldwide, the team of students from the Department of Naval Architecture from Belgrade, have attended with their mentors, and have achieved notable results. The main task of the competition was to design and build two vessels that can transport 200kg and 20kg of cargo respectively and to compete with teams from other universities in three races: the heavyweight cargo, lightweight cargo and endurance races. All participants have electric motors with the power output of 1200W, and the batteries with equal capacity. Additional limitations are the dimensions of the vessels, which have to fit in an imaginary box measuring 2.5x2.5x2m. Besides, the rules also define additional constraints regarding stability and seakeeping. Requirements set by the organizer brings heavyweight and lightweight cargo vessels into hydrodynamic zones that are not common to typical existing types of vessels. Namely, for the heavyweight cargo vessel, the crossing zone is between displacement and semi-displacement regime, and for the lightweight cargo vessel between the semi-planing and planing zones. This paper presents thorough research that covers optimal hulls selection, the optimization of the main dimensions of both vessels with a focus on resistance and propulsion and the selection of optimal propellers for the given electric motor with respect to required cargo carrying capacities.

BB Green 24 – The world's fastest emission-free commuter
H. Thornell, Green City Ferries, Sweden

The EU-funded project BB Green started in 2011 with the aim of developing a battery driven high-speed ferry. The 20 m prototype was launched in late 2016 and another three years of testing and development of a new battery system has led to a commercially ready product. Built with an ASV (Air Supported Vessel) hull in carbon-fiber the vessel shows unprecedented performance. Compared to a diesel-driven carbon-fiber catamaran of corresponding size, the new 24,8 m battery-driven BB Green 24 uses about 80 % less energy when operating in 25 knots. The maximum speed is set to 35 knots. The new battery system allows charging at 6 C in less than 10 minutes. Still, expected lifetime is over 10 years. Used as a 147 pax commuter ferry, the BB Green 24 can challenge the car when it comes to travel time and convenience. In many cities, the use of the inland waterways is a part solution to traffic congestion. Furthermore, being so energy efficient the vessel creates low wake wash. In tests, the prototype has shown only 16 cm wave height at 30 knots. This gives an opportunity to get exemption from speed limits and thus even shorter travel time. For longer distances the BB Green 24 can be equipped with Fuel cells.

Prediction of Resistance in Calm Water during Preliminary Ship Design
R. Skejic, S. A. Alterskjær, SINTEF Ocean, Norway

In the ship design process, the integration of computational tools for hydrodynamic prediction of the total resistance in calm water has steadily progressed in the last decades. Improvement of computational power and evolvement of user-friendly commercial tools have led to a rapidly increasing use of Computational Fluid Dynamics (CFD) for the purpose of optimizing hull designs. The time for setting up and executing CFD simulations is however still limiting the number of parameters and iterations that can be examined within the costeffective time frame of early phase vessel design studies. Hence, computations based on the potential fluid flow theory are still highly relevant for examining large design space problems within ship design particularly in the realm of concept design studies. In such studies, the relative differences between designs are more important than the absolute values of the same. Consequently, this can serve as a base for narrowing down the relevant parameters for later CFD simulations or model tests. Examples of such studies relate to identifying the most favorable monohull vessel and submarine design or, for example, the positioning of the catamaran and trimaran hull configurations over the interval of vessel's anticipated optimal service speeds while operating in deep or shallow calm water environmental scenarios. Based on the above current work discuss feasibility of application of the low/medium fidelity method which has been developed on a foundation of the linear Michell thin ship theory. The mentioned theory, which is by the way valid within the potential fluid flow, was later extended by accounting for the viscous effects. The above theories were applied on several examples accounting for modern ship hull mono- and multi hulls configurations and, as well as, submarine type of bodies operating in calm and deep or shallow water in a vicinity of the free surface. On this way it was shown that the successful and realistic agreements between the theoretical and experimental results can be also effectively achieved through usage of the low order complexity method in comparison to higher order methods such are Boundary Element Method (BEM) or CFD. Finally, the recommendations concerning the applicability and future development of the presented methods based on linear Michell thin ship theory were discussed.

Resistance Tests a Series of Chine Interceptors on a Planing Craft
M. Lakatoš, T. Sahk, K. Tabri, Tallinn University of Technology, Estonia
H. Andreasson, Flow Naval Architects AB, Sweden

Information on chine interceptors, as well as the whole topic of spray sheet deflection, is scarce and to the most extent dated. Therefore, a series of model tests have been conducted with a 19 m craft configured with chine interceptor arrangements (operating in a range of Froude numbers Fr = 0.77…1.35). The series is comprised of two benchmarks and two modifications for each of the benchmarks, altogether 6 models. Each model was tested at 4 displacements and 4 speeds. The first benchmark, a bare hull, had the following two chine modifications: a 2x2mm rectangular rail attached along the outer edge of the chine and a 2x15mm chine inclination that covered the chine, resulting in a new chine surface angled down. The second benchmark, a hull equipped with spray rails with a rectangular 5x5mm profile, was tested with a rectangular 2x2mm and a triangular 5x5mm profile attached at the outer edge of the chine. Chine interceptors on reduced the total resistance of a planing craft by more than 3% both on a bare hull and hull equipped with spray rails.

Lab Testing of Suspension Seats for High-Speed Boats- Can lab testing determine seats capacity to protect users from impact induced injuries?
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S.-Å. Eriksson, Research Electronics AB Siljansnäs, Sweden
J. I. Kåsin, Norwegian Institute of Avaiation Medicine, Norway
A. Borgen, Applica Test and Certificaion AS,Norway
D. Reynolds, University of Nevada Las Vegas, USA

Slamming induced impacts on high-speed boats can cause severe injuries, lesions, permanent disabilities, and sometimes even fatal overboard ejections. Despite that standards and rigorous legislations define limit-values for such exposure, these injuries seem to increase in numbers and severity with an increasing numbers of faster boats coming into professional use. Some suspension seats are marketed as “scientifically tested, by and ISOstandard lab test method and proven to be the safest in world”. Based on these claims government agencies have chosen suspensions seats. Such claims can increase injury risks if they lack scientific evidence. The authors of this paper joined the ISO work group, TC108/SC4/WG18 – “Laboratory evaluation of marine seat shock isolation.” This ISO work group concluded that the proposed method was not based on scientific evidence, and not useful to assess seats capacity to reduce impact exposure or prevent injury. The proposed method was rejected, and no ISO-standard was created.

An Investigation into the Resistance Characteristics of Multi-Step Hullforms
J. Fan, Newcastle University and Univesity of Michigan, UK

Existing research into stepped planing hulls have focused on the effects of step parameters, but there appears to be a lack of experimental research and in some cases, conflicting findings. Furthermore, the effect of the number of steps beyond two, and their parameters relative to each other have seemingly been neglected. This study will examine the effect on resistance of implementing multiple steps for a planing hull through a two-pronged approach: performing experimental tests and running CFD simulations. The basis hull used is the Series 62 Systematic Planing Hull Series parent model, and modifications are made to create stepped variants based on existing literature on optimum stepped hulls along with a variation of Savitsky's method to compute flow separation reattachment length. Cross-examination of experimental and numerical data for the stepless model show excellent agreement, val idating the CFD model used. Comparing results of stepless, one-step, and three-step models show that while a multi-step model can offer improved resistance characteristics over a basis stepless model in most configurations, it fails to provide better performance than an optimum one-step model in its present iteration, suggesting that further optimisation of step design can produce performance gains, or that there possibly exists a limit to the number of steps that can be applied to a hull before its performance degrades.

The design of the Super Swift Series
M. A. Bey, ST Engineering Marine Ltd., Singapore

The paper discusses the transformation of our Swift Series into Super Swift Series for speeds above 60kn. Results of various research and studies including simulations and scaled model tests on alternative hull forms and propeller configurations with specific focus and criteria on ultrahigh-speed performance, crew habitability and fast response manoeuvrability leading to the final design of the 5GPT (5th Generation Patrol Boats) for Singapore Police Coast Guard are centre point of the discussion. Development of the Air Cavity Hulls (ACH). It is ST Engineering Marine Ltd (STEML) vision to position ourselves to be the preferred solution providers for ultrahigh-speed vessels particularly for coastal defence and security applications. The paper discusses the development of ACH hull form using a proven 17m highly optimised planning hull as the benchmark. The paper presents the results of simulation and model tests demonstrating significant speed gains of 4-5 knots at high-speed ranges above 50 knots. The paper also discusses a couple of vessel designs for special operations and patrol duties ranging from 17-35m lengths.

Effect of Trim and Hull Vane on Wave Making Resistance of High-Speed Displacement Vessels
S. Gouthama Chary, R. Vijayakumar, Indian Institute of Technology, India

The flow modification at the stern of vessel for achieving fuel efficiency of high-speed vessels are being worked upon by Naval Architects with the use of various hull appendages like stern flap, stern wedges, trim tabs and hull vanes. Inducing trim on a vessel can attribute to either the increment or a reduction in the total drag on a vessel. This paper aims to study this aspect on a slender displacement hull form designed at IIT Madras. Introduction of a hull vane essentially imparts increased lift on the transom for various design speeds resulting in reduced wave making resistance. The hull vane is found suitable for ships operating at Froude number between 0.2-0.7 range, like sailing vessels, fishing boats hydrofoils and high-speed displacement vessels. This paper compares the resistance, wave pattern and ship motions with and without hull vane for different trim conditions on a slender body hull form. The displacement vessel is fitted with a hull vane to experimentally evaluate the increased performance at the towing tank facility, IIT Madras. Both studies are also numerically estimated using a commercial CFD solver, STARCCM+. The k-epsilon turbulence model for an unsteady, coupled flow is solved using finite volume scheme to arrive at the hydrodynamics. The numerical and experimental results in both the cases vis-à-vis varying trim conditions on the bare hull, effect of the hull vane on the slender displacement hull are compared for different speeds and the results are analyzed. Future studies include design of an optimized hull vane for the given high-speed displacement vessel.

A novel High-Speed displacement Monohull/Catamaran/Trimaran shape for improved fuel consumption and habitability of Next Generation High Speed Marine Vehicles
M. De Giacomo, Aviomarine International Srl, Italy

The paper describes the hydrodynamics characteristics of a novel type of displacement hull called DYNAc hull – Dynamic Natual Air-cushion, which exceeds the critical speed of the typical displacement Monohull (and of course with Catamaran and Trimaran the result is much better). Simulations results of 3-dimensional CFD code are compared with towing tank data and a full scale test model of 14.5 m. Moreover, will be shown the last Demonstrator (video) of 9 mt that is complete with all the Improvements. The scalability of the new design is analyzed for a range of ship lengths and compared with reference displacement and planing hulls. The study aims to demonstrate the advantages of the design for a wide speed range. The main focus will be on substantial fuel savings due to significant reduction of hydrodynamics resistance. A very important feature of this Technology is the Low Impact in sea state (about -50%). Other important aspects such as the reduction of wave making and radar signature, as well as increase of on-board space will be presented. In conclusion will be shown the Next Generation of High-Speed Catamaran Ro-Ro with lower Fuel Consumption of about -25% in comparison of what is available on the Market.

Structural construction VS Weight saving challenges in aluminium stepped hulls
G. De Mola, A. Page, Chartwell Marine, UK

The concept of stepped hull forms is currently at the forefront of marine high speed smallcraft vessel design, with an increasing number of these being produced both for the leisure and the light duty commercial market. With the current shift of the market towards the use of more efficient means of propulsion, along with the increasing call for sustainable materials for vessel design and production, aluminium alloy is proving to be a reasonably suitable candidate to meet such requirements. The increasing number of aluminium stepped hull vessels has therefore called upon a refinement of the design process, to allow for the challenges that a stepped hull design presents to the naval architect. This paper explores, based on Chartwell Marine's experience, the key design process points that a naval architect has to face when designing aluminium stepped hulls, with particular focus on the need for adequately strong albeit lightweight scantlings to support a high speed craft, versus the always present necessity of weight saving/control where possible.. This process is critical when designing stepped hulls; for effective and safe operational use of the vessel, it is critical to correctly locate the position of the steps. It is imperative therefore that an accurate weight analysis of the vessel be carried out during the earliest stages of the design process, and be constantly reviewed throughout the entirety of the project. The outcome of this paper is to create a discussion that will generate attention within the maritime industry to aluminium stepped hulls; exploring the use, opportunities and limitations of such technology.

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