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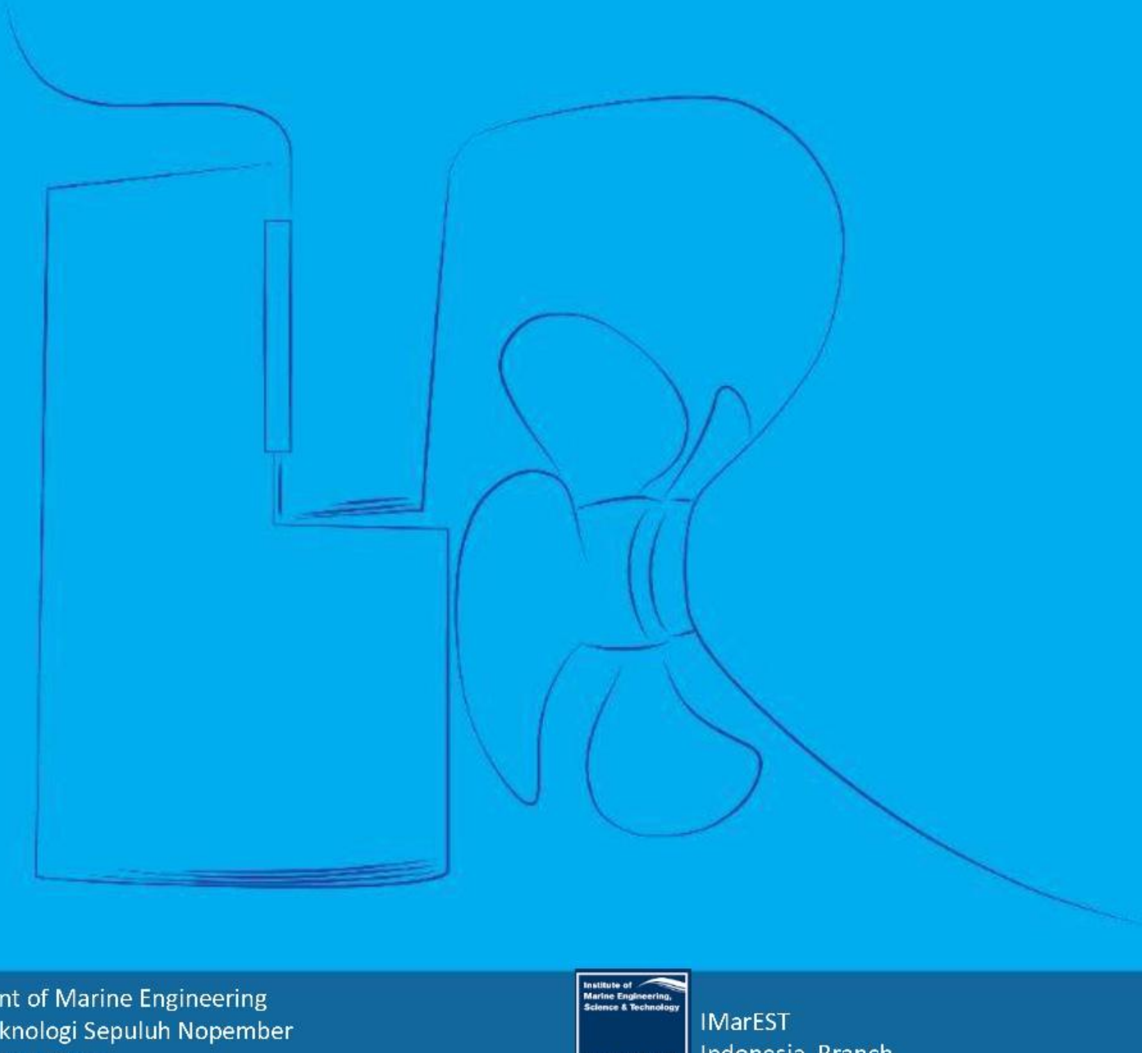

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Investigation of The Effect Hullvane and Bow Foil on Flat-Hull Ship Using CFD Approach

Andi Trimulyono[1], Wahyu Ananda[2], Kiryanto[3], Ari Wibawa Budi Santosa[4]

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***Abstract*—The flat-hull ship design is an innovative concept that saves costs and speed-up the fabrication of the ship. Even though the flat-hull ship was hydrodynamically inefficient, some shipowners probably experienced an issue with its unusual shape and disadvantages where drag is greater than that of conventional ships. This paper aimed to improve the design of a flat-hull vessel using hull vane and bow foil to reduce ship resistance. The asymmetric foil NACA 4412 and 0012 were used for the hull vane. For bow foil, only NACA 4412 is used. In addition, the angle of the strut of the hull vane was varied to find out the effect to ship resistance. This study was performed in a numerical approach using computational fluid dynamics (CFD). The mesh-based CFD with RANSE solver was used in this study, and numerical analysis will be conducted to determine ship resistance of flat-hull ships with hull-vane and bow foil. It was found that the effectiveness of hull vanes on ships failed to improve resistance for flat-hulled vessels. Because of the addition of the WSA on the ship, the total resistance of the ship increases following the installation of the hull vane. As an alternative, using bow foil can reduce ship resistance at Fn 0.44 and 0.59 by 10% and 24%, respectively.**

Keywords—*Flat-hull ship; hull vane; angle strut; bow foil; resistance; CFD* .

I. Introduction

The flat-hull form ship is one innovation in ship design by the Blohm + Voss AG shipyard in 1968. The first novelty is the flat-hull form, the shell consisting exclusively of a flat-hull, to save costs and speed production designed to eliminate all curves and bending work. Compared with a flat-hull form ship, the conventional ship hulls are smooth, round, and streamlined. It was found that the propulsion power of the flat-hull ship was close to an equivalent round hull. However, in a scaled calculation, the flat-hull model requires about 5-10 percent more power than the round hull. However, in a full-scale model, it was found that the power needed for the flat-hull ship was 15% lower than the scaled calculation. [1]. While hydrodynamically successful, the flat-hull ship probably has an issue with some shipowners despite its unusual shape [2].

Many studies have been carried out for ships with flat-hull form, ship design using the flat-hull method for different types and sizes of ships has become the hallmark of ships in Indonesia [3]. Research on the resistance of the semi-trimaran flat-hull ship by comparing the numerical and experimental methods results in an increase in each method's resistance with a trend of similar resistance values [4]. Apart from increasing drag by about 5%, flat-hull monohull ships also experience a diving effect in the aft trim that occurs when the ship is sailing [5]. Apart from the ship's character, which has slightly higher resistance than conventional models, the stability performance of the semi-trimaran flat-hull hull ship has also been analyzed to show that this ship has good ship stability by meeting IMO standards [6].

Various studies on overcoming losses caused by the form factor of the flat-hull has been carried out by various researchers before; research on analysis with the numerical method of flat-hull form ship resistance by varying the shape of the bow to reduce ship resistance showed that of the several types used, the raked bow model experienced the slightest ship resistance [7]. Nabawi et al. studied ship resistance on the flat-hull ship using hull vane and stern foil [8]. The study revealed that hull vane could reduce ship resistance due to lifting force. A similar study of stern foil to reduce ship resistance was carried out by Budiyanto et al. [9]. The study evidence that stern foil could be one alternative way to reduce resistance and stabilize the ship's motion. Hereafter, Amiadji et al. [10] analyzed the seakeeping of a flat-hull monohull ship and reported enormous turbulence flow around the stern hull. A smoother flow pattern at the bow caused the increase of resistance and bow diving in calm water phenomena.

Based on previous studies, the hull vane technology is often used as an energy-saving device to overcome ship resistance in the flat-hull ship [11-13]. This paper aimed to improve the design of a flat-hull vessel using hull vane and bow foil to reduce ship resistance. The asymmetric foil NACA 4412 and 0012 were used for the hull vane. For bow foil, only NACA 4412 is used. In addition, bow foil was compared with hull vane installation in the flat-hull ship. Numerical computation of ship resistance was carried out with computational fluid dynamics (CFD). The mesh-based CFD with RANSE solver was used to calculate ship resistance. Using the CFD approach, the hull vane and bow foil are expected to overcome the increased drag and bow trim problems that occur on flat-hull monohull ships. The results showed that bow foil can reduce ship resistance due to a change of trim by stern and it was one solution to improve design of flat-hull ship.

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Motion Response on The Water Ambulance Ship

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***Abstract*- In designing a ship, it is necessary to know the response of the ship's motion before sailing. The purpose of this research is to determine the ship's motion response to waves as well as ship speed in ship loading operational conditions. The method used in this study is the B-spiline mathematical equation and the strip theory method, with the help of ship motion software, which varies the ship's load by 100% DWT, 50% DWT, and 25% DWT. While the highest significant amplitude heave value occurs on a ship with 100% DWT conditions with a speed of 18 knots and a wave direction of 90^0, which is 2.70 meters, the highest significant value of amplitude pitch occurs on a ship with a condition of 25% DWT with a speed of 6 knots and a wave arrival direction of 180^0, namely 1.10 degrees, and the highest significant value of roll amplitude occurs in ships with 25% DWT conditions with speeds of 18 knots with a wave arrival direction of 90^0, which is 3.42 deg. The research results detected at a speed of 18 knots for the significant amplitude heave value, the significant amplitude pitch value, and the maximum RAO value still meet the Nordforsk criteria.**

Keywords-Water Ambulance, RAO, following sea, beam sea, nordforsk

I. Introduction

Hydroplanes are the most widely used type of ship for various needs, such as racing purposes, military applications, recreation in tourism, and even health facilities, namely water ambulances. The increasing demand for high-speed marine vehicles has led to the development of several sophisticated hull shape designs to increase speed performance and efficiency of use. [1]. A water ambulance is a ship that functions as a floating hospital or can also be used to deliver patients who are in critical condition to riverbank areas far from the hospital [2]. On the one hand, sea transportation has a much greater risk of accidents than other means of transportation. This is because the plane of motion tends to be dynamic, causing many movements that are difficult to predict and disturb comfort. Based on the area of operation, boats are mostly used in waters that tend to be shallower with not too far sailing distances and less extreme water conditions [3].

In previous research, a general plan for water ambulance was designed for the waters of the Upper Mahakam River [4]. A water ambulance has the potential to make patients experience excessive shocks or vibrations. In-depth studies are needed regarding the behavior of hydrodynamic motion when operating in river waters. Several similar studies were carried out related to hydrodynamics, including ship stability in determining the main size of the ship design [5]. Paroka (2008) states that the size of the angle of inclination of the ship when receiving forces from outside or from the ship itself depends on the width and height of the ship's draft in the transverse direction and depends on the length and height of the draft in the longitudinal direction [6]. In addition, the ship's maneuvering behavior to remain stable is also influenced by the placement of goods on board the ship's cabin [7]. Heaving motion is the ups and downs of the ship vertically caused by changes in the magnitude of the buoyancy and weight of objects due to changes in momentum in a wave spectrum [8]. Meanwhile, swaying motion is a side-to-side movement experienced by objects due to translational impulses from waves. In contrast to swaying, yawing has the opposite direction of motion between the bow and stern of the object [9]. When operating in water, there are five general directions that represent the direction of waves that hit the ship's hull [10]. Waves with directions of 120° and 150° are referred to as complete bow oblique waves, or bow waves for short [11].

Several theories are used in analyzing the ship's motion response at sea. For different types of ships, seakeeping forecasts based on strip theory and the panel technique on maxsurf movements are possible to be made with a considerable amount of accuracy. The quickness of analysis and the incorporation of Maxsurf features make Maxsurf motions very useful at the initial design stage [9]. Nasar et al. (2013) studied ship maneuvering due to sloshing behavior that occurred in ship tanks [12]. The prediction of ship response under real-world sailing conditions is very important to ensure effective ship design. Most ships prefer a slanted wave for less resistance and greater propulsion when at sea, and they rarely sail in severe swell conditions. Using the commercially-based potential flow breaker (PF), HydroSTAR, Rahaman et al. (2017) give tilted wave modeling results for container ships, tankers, and bulk carriers to provide comparative comparisons in trends in

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An Analysis of Service Capacity at Ambon Port

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Abstract - This research aims to determine container services, to determine projections and the need for container facilities in relation to traffic projections. This study used qualitative descriptive analysis, namely a method that explains in the form of numbers from the growth of activities. This research was conducted with interviews, library research and documentation. The results of the study show that the flow of container ships has increased. In 2020 it was projected to be 355 calls. It will continue to increase until it is projected to be 560 calls in 2029. Meanwhile, the projected realization of the flow of goods in containers in 2020 was 1,243.164 tons, and the realization of containers is predicted to be 2,015,767 tons. The Berth Occupancy Ratio can be maintained at a maximum of 70% according to the standards, so the length of the wharf at Ambon Port where in 2021, the flow of containers has reached 128,662 TEUs with the number of container ships 377 Calls, the length of the container reached 352 meters. As for the storage yard, the required storage area is 42,316 m2. As for the storage yard at Ambon Port, until 2029, the required storage area is 42,316 m2.

Keywords: accumulation field, containers, port of Ambon, service capacity

I. INTRODUCTION

Transport by sea plays an important role in the current trading system. Transportation is a very important element [1] for human needs, both for individuals and to support economic life in a region [2]. Eighty-five percent (85%) of world trade is by sea, while 90% of trade in Indonesia is by sea [3]. Sea transportation is the main route of trade, Domestic and International. With increasingly stringent regulations at the port, there will be a decrease in the number of exports/imports of goods through the port [4].

The port is a facility especially important for sea transportation, with this transportation, the required mileage will be felt more quickly, especially for the economic development of an area where the production center of consumer goods can be marketed quickly and smoothly. Apart from that, in the economic field, ports have a positive impact on the development of an isolated areas, especially water areas where accessibility by land is difficult to do properly [5]. That's why the port plays an important role [6], in controlling the movement of goods in the import and export process. PT Pelabuhan Indonesia III (Persero), known as Pelindo III, is a State-Owned Enterprise (BUMN) engaged in port terminal operator services.

Therefore, the Port is a very vital company component because production activities, in this case, loading and unloading services, occur there [7]. A Port is a place that consists of land and waters around it with certain boundaries [8] as a place for governmental activities and economic activities used as a place for ships to dock, dock, board passengers and/or load and unload goods equipped with shipping safety facilities and port support activities as well as a place for intra- and inter-mode transportation [3]. Port buildings used to dock and moor ships carrying out the loading and unloading of goods and boarding and disembarking passengers [9].

Port as infrastructure transportation that supports the smooth running of the sea transportation system has a function that is closely related to social and economic factors. Economically, the port functions as one of the driving wheels of the economy because it is a facility that facilitates the distribution of production results, while socially, the port is a public facility in which interactions between users (community) take place, including interactions that occur due to economic activity [10].

More broadly, the port is the central node of a support area (hinterland) and a link with areas outside it.

Port capacity assessment is intended as an effort to determine the utilization and performance of port management so that it clearly shows the level of effectiveness and operational efficiency of various port facilities. Port capacity assessment is expected to be useful as evaluation material in making investment decisions, as well as planning for container terminal development [11].

The operation of a container terminal is one of the important things to support activities at a port. In the operation of container terminals, there are quite a number of obstacles, such as lack of information, traffic, trucks, waiting time, berth windows, inaccessible operators, and slow terminal performance [12].

The smooth performance of the container crane itself is influenced by the age of the tool, duration of use, maintenance, and professionalism of human resources who operate, including good coordination with related parties, so that services become more efficient and prices become competitive. Therefore, the factors mentioned above must be the concern of related parties in order to

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