Study of Power Engine for Training Ship Polbeng Using Slenderbody Method

Muhammad Helmi[1], Budhi Santoso[2] and Edy Haryanto[3]

{helmi@polbeng.ac.id[1], budhisantoso@polbeng.ac.id[2], edyharyanto@polbeng.ac.id[3]}

Politeknik Negeri Bengkalis, Bengkalis, Indonesia[1,2,3]

Abstract. This study implements a learning approach that supports the process of Merdeka Belajar Kampus Merdeka (MBKM) by involving students in the research process of the Latih Polbeng ship design. The focus of this research is on calculating the power of the Latih Polbeng training ship's engine using supporting data in the form of Lines Plan drawings, to determine the total resistance at the ship's speed corresponding to the power of the engine used in the Latih Polbeng ship. The calculations of engine power and ship speed are performed using the Maxsurf Resistance program with the Slinderbody method, resulting in a total resistance value of 5.7 Kilo Newton, engine power of 98 Hp, and ship speed of 21 Knot. The results of the ship's engine power value will serve as a reference in selecting the appropriate engine for the Latih Polbeng ship.

Keywords: Latih Polbeng ship, total resistance, power engine, Lines Plan drawings, Maxsurf Resistance, Slinderbody, and Knot.

1. Introduction

Bengkalis State Polytechnic is one of the vocational education institutions, and one of its departments is Ship Engineering. As a supporting educational institution in the Bengkalis Regency, specifically, and in Riau province in general, Politeknik Negeri Bengkalis needs to have adequate facilities to support maritime transportation facilities in the Ship Engineering and Maritime department, in the form of the POLBENG training ship. With the advancement of technology, ships that used to be made of wood are now commonly constructed using fiberglass as the primary material. Considering the need for a training ship at POLBENG, the author engaged students in a collaborative effort to build the POLBENG Training Ship while still adhering to the traditional local wisdom, ensuring that the ship owned by POLBENG reflects the distinctive characteristics of the Bengkalis Island area. Based on this issue, the ship's design and construction planning directly involve students in hands-on practical learning.

This research process focuses solely on simulating the ship model to calculate the power engine needed for the POLBENG training ship based on the approved ship model for construction at the Mini POLBENG Shipyard. The ship's engine is a crucial component responsible for propelling the ship and generating power for navigation purposes. Therefore, the design and

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performance analysis of fiberglass ship engines become important topics in this research study. However, in reality, there are still limitations in the design and performance analysis of fiberglass ship engines in Indonesia, especially in the Bengkalis region. The lack of knowledge and skills in designing and analyzing the performance of fiberglass ship engines, as well as limited access to advanced technology and equipment, pose challenges for practitioners and academics in the maritime industry.

With this research, it is hoped that Politeknik Negeri Bengkalis can have a ship that meets the needs of the Ship Engineering department and can serve as a reference for other supporting educational institutions in choosing the right ship engines for their vessels. Additionally, this research is also expected to contribute to the development of more efficient and environmentally friendly ship engine technology. In recent years, there has been an increased focus on environmental concerns in the maritime sector, with a demand for more efficient and eco-friendly ships. This research will also consider sustainability aspects in the design of the POLBENG Training Ship. Data will be collected from various sources related to fiberglass ship engines, such as passenger ship engine catalogs and technical specifications for fiberglass passenger ships. Moreover, direct observations of existing fiberglass ships will be conducted to gather further information about the characteristics of the ships and the engines used.

The method to be employed in this research is computerized or simulation-based experimentation. Simulations will be conducted to estimate the performance of the ship's engine under various operating conditions, ranging from low-speed to high-speed categories. Regarding the discussion on the simulation of the POLBENG Training Ship's engine performance, the author involves students in the process of simulating the basic ship hull drawing known as the Lines Plan Drawing. These drawings were created by students as part of Project-Based Learning (PBL) in the odd semester of 2022. Using this data, the author conducts an analysis of the total resistance of the ship using the Maxsurf program, specifically applying the Slenderbody resistance method. The aim is to design and analyze the performance of the fiberglass ship engine for the Politeknik Negeri Bengkalis Training Ship in an optimal manner. This analysis will help determine the required engine power, serving as a reference for selecting the appropriate engine for the POLBENG Training Ship at Politeknik Negeri Bengkalis. Furthermore, with the results of this research, it is expected to gain knowledge and skills in designing and analyzing the performance of fiberglass ship engines, ultimately enhancing the competitiveness and quality of graduates in Ship Engineering at Politeknik Negeri Bengkalis.

The expected output of this research is the optimal design of the POLBENG Training Ship's engine and a comprehensive analysis of the ship engine's performance. This can be used as a reference for the selection of the appropriate engine for the POLBENG Training Ship as well as for fishing vessels. Additionally, it is anticipated that there will be a contribution to the development of more efficient and environmentally friendly passenger ship engine technology.In conclusion, this research is expected to provide significant knowledge and benefits to students in the Ship Engineering department regarding the development of fiberglass ship engine technology in general. With the presence of a well-equipped POLBENG Training Ship, it is hoped that the quality of education in ship engineering programs at Politeknik Negeri Bengkalis, including the development of more efficient and environmentally friendly fiberglass ship engine technology, can help reduce the negative environmental impact in the maritime sector.

2. Research methods

The identification of problems marks the beginning of research, derived from issues related to the development of learning towards the Merdeka Belajar Kampus Merdeka (MBKM), particularly concerning Teaching Factory learning. This requires students to be capable of creativity and innovation both in their learning process and their involvement in faculty research. This involvement is what gives rise to ideas, such as the process of designing the training ship for Politeknik Negeri Bengkalis. The POLBENG training ship is designed with the participation of students to create a ship design based on the local wisdom of the Bengkalis Island region. After the completion of this ship design, there is a need for a study related to its performance (ship engine requirements), which the author will investigate by involving several students.

Literature review on ship engine design and related technologies. One of the methods that can be employed in ship engine design research. This stage is carried out to obtain a solid understanding of ship engine design and related technologies. Several sources of literature that can be utilized include books, scientific journals, articles, and relevant websites.

Gathering initial data about the ship and engine requirements through case studies, field surveys, or other data sources. Identifying the needs and specifications of the ship engine to be designed. This stage is carried out by collecting data from various sources such as literature reviews, direct observations, interviews, and consultations with relevant experts.

The creation of a ship model using design software such as AutoCAD and Maxsurf. The model is based on the product generated by student learning tasks, and this product belongs to Politeknik Negeri Bengkalis. The main dimensions of the ship are a length of 9.50 meters, a height of 1 meter, a width of 1.8 meters, a draft of 0.405 meters, and a Block Coefficient (Cb) of 0.302. The primary material for the ship is full-body fiberglass. The purpose of creating the model is to obtain the total resistance value and power of the ship.

The calculation of the ship model's performance involves computing the total ship resistance and ship engine power using computerized methods in the Maxsurf Resistance program with the slender-body method. With this method, after determining the appropriate ship hull resistance and ship speed, the total resistance value and ship engine power can be obtained. Subsequently, the selection of the ship's engine involves finding the main engine size or engine specifications that match the results obtained from computerized simulations. Based on the slender-body method, there are specific equations and criteria as follows:

$$RT = CT \times 1/2 \times \rho \times S \times Vs^2 \quad (1)$$

$$EHP = RT \times Vs \quad (2)$$

Where, RT is the total resistance, CT is the total resistance coefficient, ρ is the fluid density, S is the wetted surface area, Vs is the ship's velocity, and BHP is the effective horsepower.

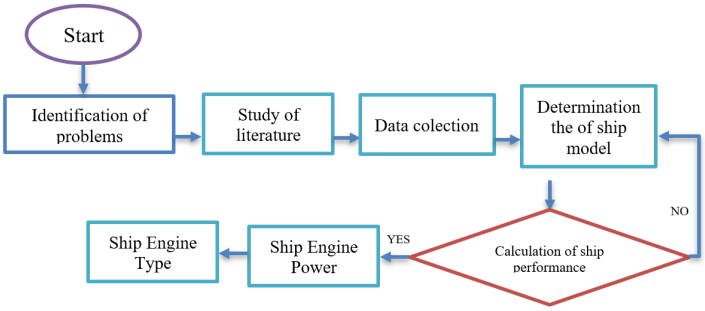

Fig. 1. Flowchart reaserch

3. Result and discussion

3.1 Ship hull model making process for polbeng training ship

The creation of the POLBENG Training Ship model is a result of the learning process implemented in the Ship Engineering Department for students in the form of ship lines plan drawings or basic ship drawings. The creation of the ship's basic drawing starts from the ship design concept, which involves a series of planning stages such as ship dimensions, ship capacity, ship speed, operational location, geographical waters, and so on. Based on the learning process carried out by Ship Engineering students, the ship's hull shape is determined, with the main data seen in Table 1 and Fig.1. The ship's basic drawing (Lines Plan) serves as the fundamental reference for analyzing the ship's performance, including the required engine power for a speed of approximately 21 knots, representing a ship at that speed. To determine the required engine power for the Bengkalis State Polytechnic Training Ship, the author uses the Sliderbody method in the Maxsurf program, as this method adheres to the condition:

$$(L/V1/3 > 4) \quad (3)$$

Where, L is the ship's length (in meters), V is the ship's displacement volume (cubic meters/m^3).

Table 1. Ship dimensions

No.	dimensions	Size
1.	Ship Length	9,50 Meters
2.	High	1, 00 Meters
3.	Width	1,6632 Meters
4.	Loaded	0,405 Meters
5.	Coefisien Block	0,302
6.	Speed	21 Knot

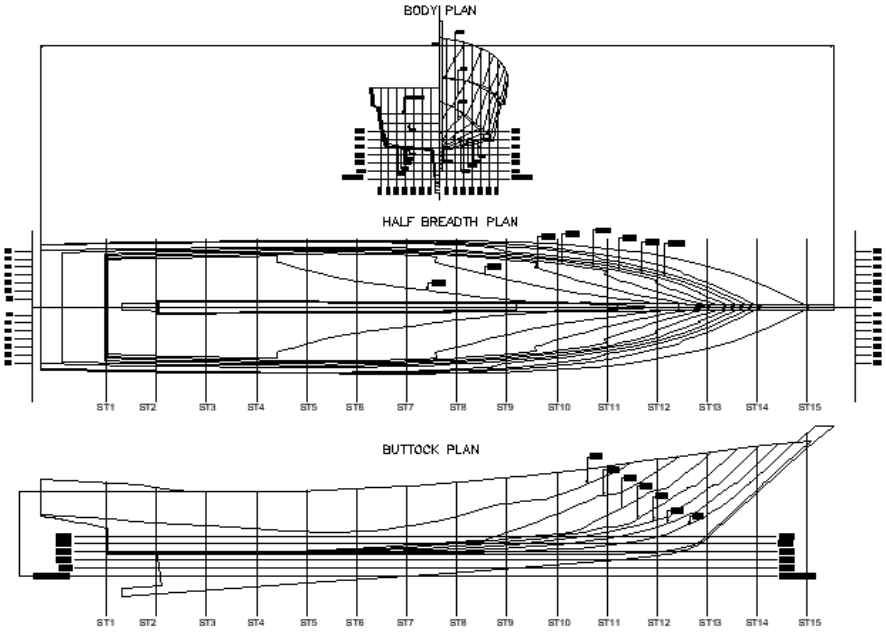

Fig. 1. Lines plane latih polbeng ship

Based on the data in Table1, the shape of the Bengkalis State Polytechnic Training Ship's hull can be determined as follows:

$L/V1/3 > 4$

$8.340 / (2.626)1/3 > 9.53$

With the application of the recommended criteria from the slender-body method in the Maxsurf program to determine ship resistance, it is concluded that the hull model of the Politeknik Negeri Bengkalis Training Ship is suitable for using the slender-body method.

3.2 Calculation of Total Ship Resistance

The calculation of the total resistance of the POLBENG Training Ship was determined at a ship speed of 21 knots by applying the slender-body method analysis and using equation (1). The results of the total resistance calculation can be seen in Fig. 2.

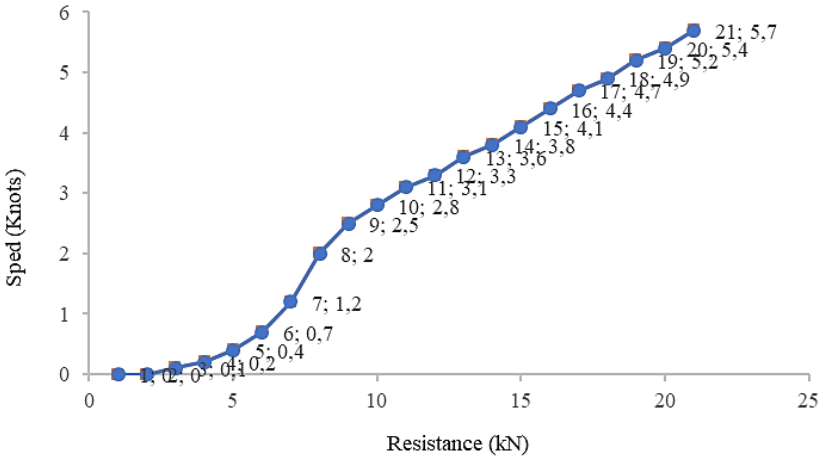

Fig. 2. Resistance total

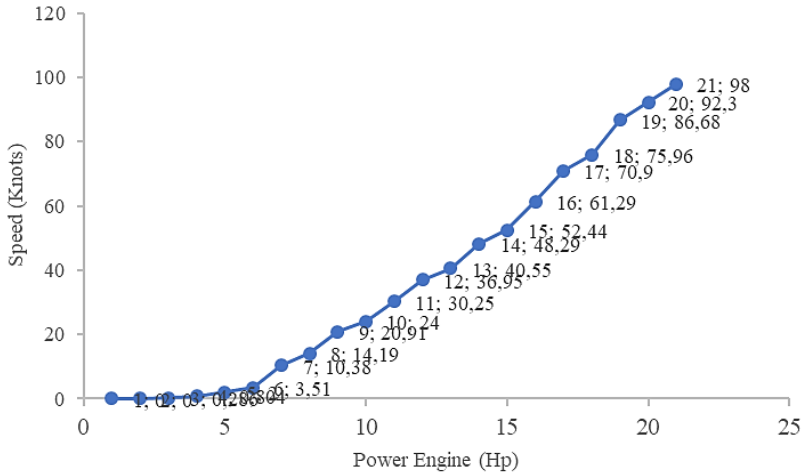

Fig. 3. Power engine (Hp)

3.3 Determination of Ship Engine Power

The main driving power, Effective Horse Power (EHP), is the power received by the ship's propulsion system transmission shaft, which is subsequently continuously operated to propel the ship at its service speed (Vs). The required power for the main propulsion motor or PB in the planning of propellers and propeller shaft tubes is calculated using equation (2), and it takes into account the efficiency of the gear and transmission system denoted as ηG. This is because it is planned in the power transmission system relationship between the main motor and the installed propeller shaft with a 3:1 reduction gear ratio. Therefore, at a ship speed of 21 knots, a ship engine power of 98 HP is required. The calculation of the power engine can be seen in Fig. 3.

3.4 Engine specifications

Based on the table of engine specifications, we can make the following analysis: Engine Type: The engine used for the ship is a diesel engine manufactured by Mitsubishi. Diesel engines are known for their fuel efficiency and high torque, making them suitable for marine applications. Fuel Type: The engine is powered by solar, which is another term for diesel fuel. Diesel fuel is commonly used in marine engines due to its availability and energy density. Engine Power: The engine has a power output of 98 Hp (Horsepower). This indicates the amount of power the engine can produce to drive the ship's propellers and achieve the desired speed. RPM Max Power: The engine's maximum power is achieved at 3500 RPM (Revolutions Per Minute). This is an important parameter as it indicates the engine's performance capabilities at its peak power output. Engine Capacity: The engine has a capacity of 2268 cc (Cubic Centimeters). Engine capacity is related to the total volume of all the cylinders in the engine and can influence the engine's overall performance and efficiency. Torque: The engine produces a torque of 200 Nm (Newton Meters). Torque is the rotational force generated by the engine and is crucial for the acceleration and overall performance of the ship. In conclusion, the engine chosen for the ship is a diesel engine from Mitsubishi with a power output of 98 Hp. It operates on diesel (solar) fuel, and its performance characteristics, such as RPM Max Power and Torque, suggest that it is well-suited for powering the ship and achieving the desired speed and performance.

Table 2. Main engine specification

No.	Specification	Description
1.	Engine Type	Diesel (Mitsubishi)
2.	Fuel Type	Solar
3.	Engine Power	98 Hp
4.	RPM Max Power	3500 Rpm
5.	Engine Capacity	2268 cc
6.	Torque	200 Nm

4. Conclusion

Based on the data and collaboration of researchers in this study, the following additional conclusions can be drawn. The involvement of students in the ship design process as part of the MBKM initiative enhances the learning experience and fosters practical skills in shipbuilding and naval engineering. By actively participating in research and design activities, students can apply their theoretical knowledge to real-world projects, preparing them to become competent professionals in the maritime industry.

The analysis of the ship's total resistance and the selection of a 98 Hp engine at a speed of 21 knots demonstrate that the Kapal Latih Polbeng is designed to achieve optimal performance. The ship's power output is well-matched to its propulsion requirements, ensuring efficient operation and smooth navigation. The collaboration between Politeknik Negeri Bengkalis and researchers allows for the integration of academic knowledge with industry practices. By utilizing modern software and methodologies in the design and analysis process, the study

contributes to the advancement of shipbuilding technologies and addresses the challenges faced by the maritime sector.

The focus on using fiberglass as the main material for the ship's hull highlights the commitment towards environmentally-friendly practices in the maritime industry. Fiberglass is known for its durability and potential to reduce environmental impact, aligning with the increasing concern for sustainable and eco-friendly shipbuilding.The successful completion of this research provides valuable insights for the development of similar training vessels and promotes the implementation of collaborative learning initiatives in other educational institutions. The study's findings and methodologies can serve as a reference for future ship designs, further enhancing the quality and efficiency of maritime education and industry practices.

In conclusion, the collaborative research involving students in the design and analysis of Kapal Latih Polbeng has resulted in a well-designed training vessel with optimal performance. The study showcases the benefits of integrating academic learning with practical experiences, contributes to environmentally-conscious shipbuilding practices, and serves as a model for future academic-industry collaborations. Through this research, Politeknik Negeri Bengkalis demonstrates its commitment to providing high-quality maritime education and promoting sustainable advancements in the maritime industry.

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References

[1] International Maritime Organization (IMO). (1983). International Conference on Safety Fishing Vessels 1977. London : IMO.
[2] International Maritime Organization (IMO). (2002). Res. A. 749 (18) as Amaended by Res. MSC. 75 (69). Code on Intact Stability for All Types of ships. Lndon: IMO.
[3] ITTC, Recommended Procedures and Guidelines, Testing and Extrapolation Methodsin Resistance Towing Tank Tests, ITTC 7,5-02-02-02, 2002.
[4] Jamaluddin Andi, Utama I Ketut Aria Pria, Hamdani M. Arief. (2010) “Kajian Interferensi Koefisien Hambatan pada Lambung Katamaran melalui Komputasi ’Slender Body Method” Jurnal Kapal Ilmu Pengetahuan dan Teknologi Kelautan, ITS, Surabaya.
[5] MAXSURF Resistance Program & User Manual Bentley Systems, Incorporated. All rights reserved. Copyright © 2017
[6] Murdjianto.(2005). Motor Penggerak Kapal dan Mesin Bantu, ITS, Jurusan Teknik Perkapalan
[7] Parsons, Michael G. 1998. Parametric Ship Design Chapter 11. Univ of Michigan USA.

[8] Rosmani, A., & Algan, M. (2011). Prediksi Tahanan Kapal Cepat Dolpin Dengan Metode Eksperimen. Jurnal Teknik Universitas Hasanuddin: Makassar
[9] Sugianto E, Dkk. Computational model tahanan kapal untuk menentukan kebutuhan daya kapal bulk carrier 8664DWT.http://journal.trunojoyo.a c.id/jurnal kelautan . Jurnal Kelautan Volume 10, No. 2, 2017 ISSN: 1907-9931 (print), 2476-9991 (online). Madura
[10]Susilo, J. S. J. S. J., & Santoso, A. S. A. S. A. (2014). Simulasi Penggunaan Fin Undership Terhadap Tahanan dan Gaya Dorong Kapal dengan Metode Analisa CFD. Jurnal Teknik ITS, 3(2), G174-G179. ISSN: 2337-3539 (2301- 9271). 2013. ITS Surabaya
[11]Watson, David G.M. 1998. Practical Ship Design Volume 1. Oxford. UK
[12]https://www.oto.com/mobil-baru/mitsubishi/l300/spesifikasi