RESISTANCE PREDICTION OF 6M HOUSEBOAT

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ABSTRACT

This project is performed to build an optimum operating 6m pontoon houseboat equipped with a double hull. This study will revolve around the resistance prediction topic. Research is performed through academic resources to find the most accurate and applicable theories. The resistance prediction is estimated by a mathematical program named Michlet. This program applied the theory of Michell's thin ship theory. then result will be verified in Software for Resistance Prediction-Round Bilge Catamaran (Molland) that is practicing Insel and Molland method. Houseboat will be in normal condition when operating in fresh water. At the end of this investigation, the expected outcomes are the most suited resistance prediction will be discovered.

Keywords: Houseboat, resistance, multi hull, Michlet, Michell's thin ship theory

1.0   INTRODUCTION

Houseboats are invented through the evolution of typical boats. Water transportation is not only used for vacation purposes but also a home for those who love water. To build an optimum operating ship or boat, it is crucial to determine its resistance prediction. The most suitable method for resistance estimation must be selected, whether the statistical or empirical method. Both are crucial factors in ship analysis to build a fine operating ship and boat. Resistance and propulsion may differ for varying ships and boats.

By the 1890s, the potentiality of the model resistance trial had been discovered. After that, specific ships and various models were tested. Many discoveries have been made since then. Scholars and engineers have successfully created methods and software to help people estimate and analyze a ship's resistance and propulsion.

To build a houseboat, the basic steps are the same as making a ship or a boat. Many basic processes need to be settled on when attempting to build it. Ship hydrodynamics factors are crucially deliberated. Hence, the sole purpose of the 6m Houseboat, which is to become an optimized operated mobile house on the freshwater, is achieved. This research is specifically conducted to determine and analyze its resistance. The methods used are chosen peculiarly based on the characteristic of the Houseboat's hull, which is categorized as a multi-hull type.

Thus, this research is specifically carried out to study and determine a pontoon houseboat's resistance equipped with a double hull. The resistance prediction is calculated using a mathematical program named Michlet, which applies Michell's thin ship theory. In addition, the verification of estimated data will be verified by Software for Resistance Prediction-Round Bilge Catamaran (Molland). The software is related to Insel and Molland's theory. These theories are applicable due to the similarities of the model experimented by other researchers and stated in their analyzed journals. They are applied for determining

multi-hull boats. The properties of the Houseboat are also discussed in the literature review for comparison purpose.

2. LITERATURE REVIEW

There are model tests, CFD numerical method, Holtrop and Mennen, Hollenbach's method, Michell's thin ship theory, and Insel and Molland theory found in academic resources. However, there are limited latest academic studies using Houseboat as its model. So, to choose the most qualified theory, the characteristic of the actual model is being considered, which is a multi-hull boat. So, any experiments or academic resources related to catamaran, pentamaran, trimaran, and any multi-hull boats are analyzed. Nevertheless, the issue is that the actual model only has two hulls equipped with a pontoon design.

Meanwhile, the trimaran and other referenced models might have more than two hulls. So, it becomes a great question during the research. Later, in the journal of Sulistyawati [1], [2], it was discovered that the hull of multi-hull boats is analyzed separately, not as a whole. Therefore, the hydrostatic data is relatable. Thus, catamaran, pentamaran, and trimaran is also the experimental and reference model for the Houseboat[3].

Computational Fluid Dynamics (CFD) is an accurate computational simulation, but it is a time-consuming process. It can take several hours or days to run the program [1]. This approach also requires a high processor computer, usually provided by schools or universities. However, the resistance prediction of this experiment will be estimated using a standard laptop, so the program might not be appropriately installed on the observer's device. CFD is also impractical as it is a complex program for an amateur. Only an expert user can produce results like the model test. So, great caution must be taken when applying CFD results. Therefore, CFD is not a good choice for resistance prediction. Holtrop and Mennen, and Hollenbach's method is the most famous method to calculate ship resistance. They are undeniably great ways to produce accurate data [4]. However, based on Fundamentals of Ship Hydrodynamics, these methods are more efficient for monohull boats. So, the methods are not applicable to calculate the resistance of a houseboat. This is also the main reason why the other methods are not discussed in this review, for example, the Savitsky method.

Through the journals, this method works well for calculating the resistance of multi-hull boats. It operates optimally and generates precise results when the Froude (Fn) value is above 0.4. The wave contour can be observed from the generated diagram. This program only took several minutes or hours to process the data. This program also consumes less time when optimizing the process of multi-hull [5]. Hence, observers can save a lot of time during the experiment. The pattern produced from Michlet program is also proved to be consistent with the pattern from the model test, so it can be concluded that this method is entirely accurate in predicting resistance. On top of that, the program can also calculate the resistance of a monohull boat [4]. In conclusion, Michlet is a simple tool that is perfect for investigating houseboats' hydrodynamics properties, especially in resistance prediction.

The same goes for Insel and Molland method. The process will be done by entering the hydrostatic data into software for Resistance Prediction-Round Bilge Catamaran (Molland) software [6]. This software does not need to be installed on an electronic device because it can be used online. This method suits the pontoon houseboat as it is used to estimate catamaran resistance [7]. The program does not include interference effects on drag and trim, which is not a big concern for validating results. The catamaran properties in the experiment have similarities with the Houseboat, which is that it has a symmetrical hull, and it is observed in the calm water condition [8]. The process is also fast and straightforward. Thus, this method can be used to validate the resistance of a houseboat.

3.   RESEARCH METHODOLOGY

Then, the resistance of the Houseboat is calculated using computational approaches. The resistance prediction is estimated by a mathematical program named Michlet. This program applied the theory of Michell's thin ship theory. On the other hand, the result will be verified in Software for Resistance Prediction-Round Bilge Catamaran (Molland) that is practicing Insel and Molland method. The General Arrangement of the houseboat as in Figure 1

Figure 2 shows the process of analyzing the best method for propulsion design's estimation of a 6m multi-hull houseboat. First, the study is performed by researching suitable statistical or empirical methods to design and calculate a houseboat's resistance prediction and propulsion system. Then, the most suitable method and the system are selected. These methods are accepted after being justified by facts and experimental results presented in academic resources. Next, the process of estimating resistance prediction started. The hydrostatic data from Lines Plan is entered in Michlet. Then, the data is verified using Software or Resistance Prediction-Round Bilge Catamaran (Molland). The results are analyzed.

At the same time, researchers observed whether the results were acceptable or not, the process of estimating the resistance system will be repeated by Michlet and validated by the Software or Resistance Prediction-Round Bilge Catamaran (Molland). Specific parameters will be adjusted. After successfully gaining the correct data, the results are recorded. Finally, the validated data can be used to fabricate an actual 6m houseboat.
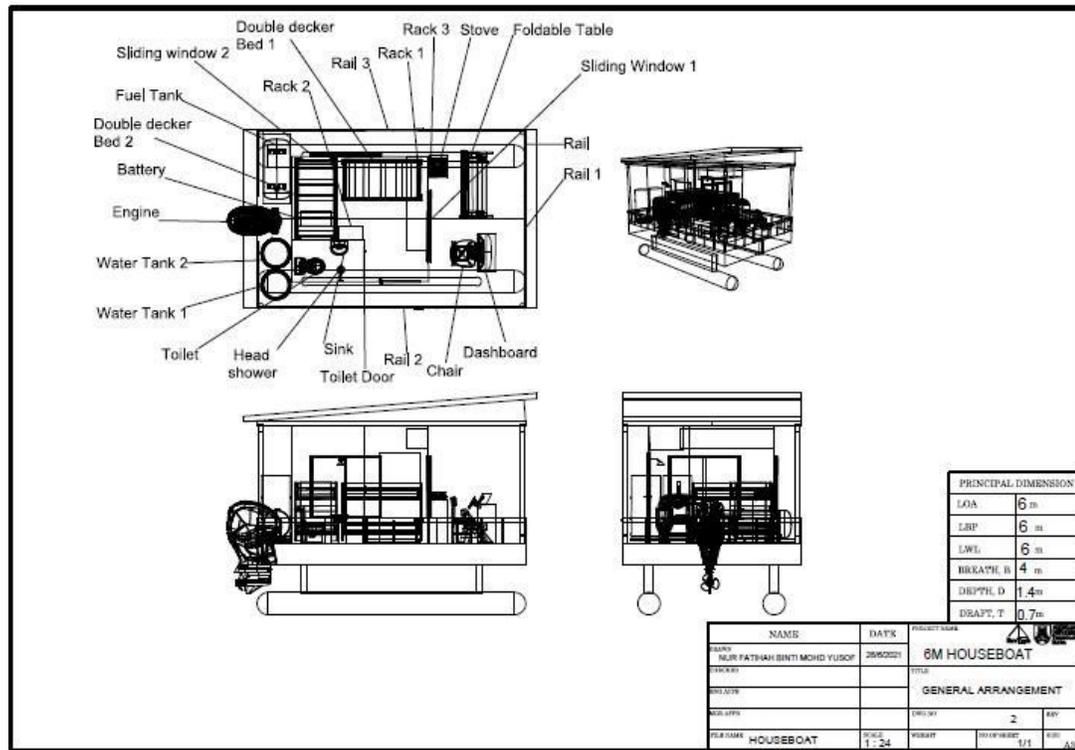

Figure 1: General arrangement drawing of 6m houseboat

3.1   Estimation of Ship Resistance

A mathematical program that applies Michell's thin ship theory is used to calculate the resistance of the 6m Houseboat. It is called as Michlet. This program automatically generates the output data after the input file is filled. The SWATH T-Agos is used as the reference model test to evaluate the resistance of a multi-hull pontoon-type houseboat. Values of resistance parameters are mostly taken from T-Agos's input data file. Only certain things must be changed. For example, the Speed of a Houseboat is 8.9 knots. The most evident similar properties between T-Agos and the 6m Houseboat is that both are equipped with multi-hull pontoons. The figures show the interface generated by Michlet and the outcome of the result that is produced from it. However, only specific parameters are analyzed in detail for ship resistance estimation, which will be explained in the result and discussion section.

Figure 2: Interface of Michlet after generating the input data

Both hulls are analyzed. The calculation parameters are chosen, which is the ITTC 1957. The hull geometry is generated, includes a reference to the offsets, displacement, waterline length and beam. The interface above shows view of waterline and body plan, showing all the stations. The pontoon's real shape is shown in the output diagram.
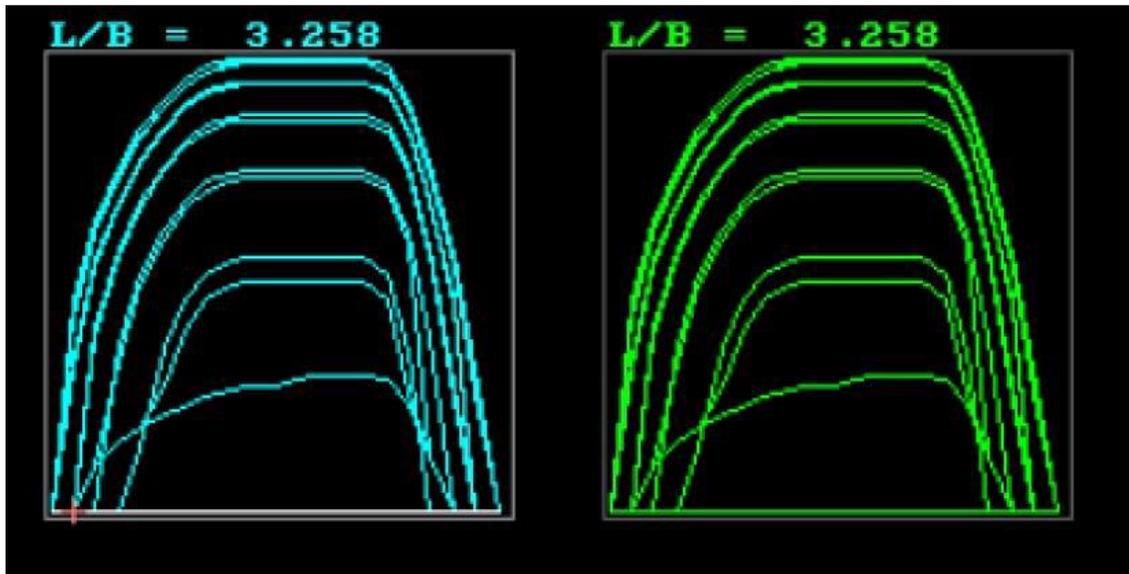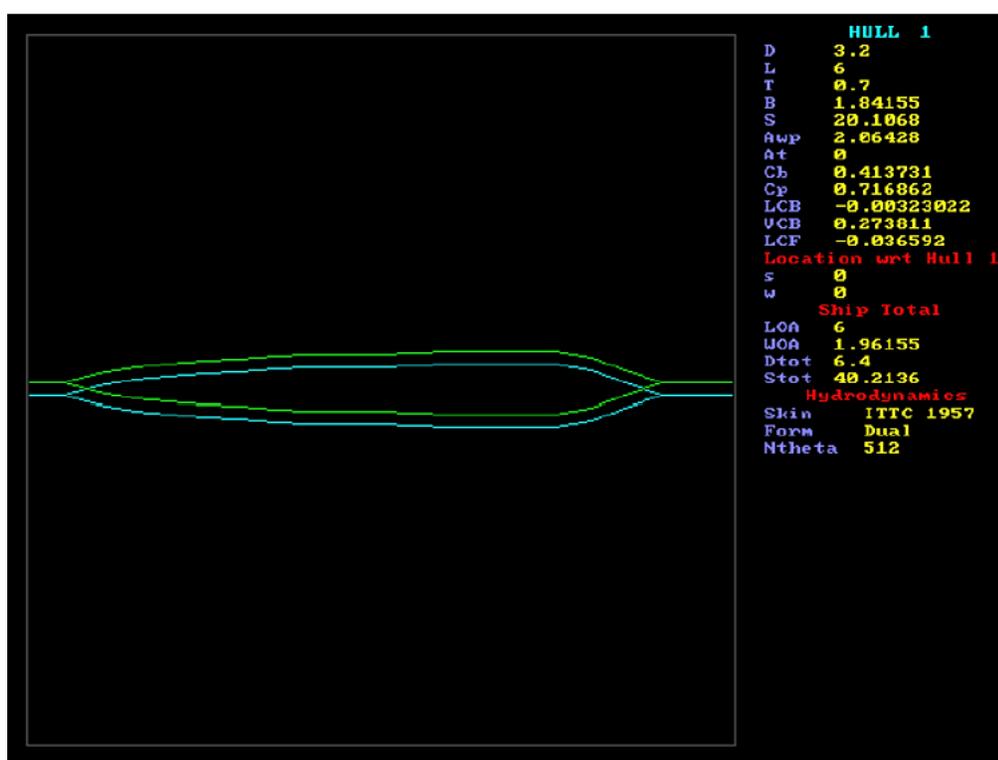
Figure 3: Horizontal waterline of all hulls

Figure 4: True scale view of the hull arrangement in the waterplane

Both shallow and deep-water resistance values are calculated. The wave resistance is calculated by applying Michell's thin ship theory. In the figure above, Rt is considered to have an average trend. The pattern shows that viscous resistance dominates at low speeds, and at high speeds, the total resistance curve turns upward dramatically as wave-making resistance dominates. It is a typical curve of total hull resistance.

3.2   Validation of Ship Resistance's Calculation

Figure 5 shows the Software for Resistance Prediction-Round Bilge Catamaran (Molland). This software applies Insel and Molland's theory to validate the result generated from the Michlet program. Other than Speed, all parameter values are taken from weight estimation data. The speed value is 8.7 knots as the Houseboat will be used mainly for leisure activities like fishing.

Figure 5: Interface of Software for Resistance Prediction-Round Bilge Catamaran (Molland)

4.   RESULTS AND DISCUSSION

The results are divided into two parts. The first part is Michell's thin ship theory in the Michlet program. In contrast, the second part is the result of Insel and Molland's theory in Software for Resistance Prediction-Round Bilge Catamaran (Molland).

4.1   Michell's thin ship theory

A mathematical program that applies Michell's thin ship theory is used to calculate the resistance of a 6m houseboat, as shown in the figures below. In Figure 6, the interface shows the body view of the multi-hull. The shape of the pontoon is cylindrical and does not misshape for both hulls. That means the hulls can withstand the resistance prediction from the outer and inner factor-like wave resistance and load

Figure 6: Waterline and body plan of 6m Houseboat

In Figure 7, the resistance graph shows the total resistance components. Rt is considered to have a usual trend. The pattern shows that at low speeds, viscous resistance dominates, and at high speeds, the total resistance curve turns upward dramatically as wave-making resistance begins to dominate. This is a normal curve of total hull resistance.
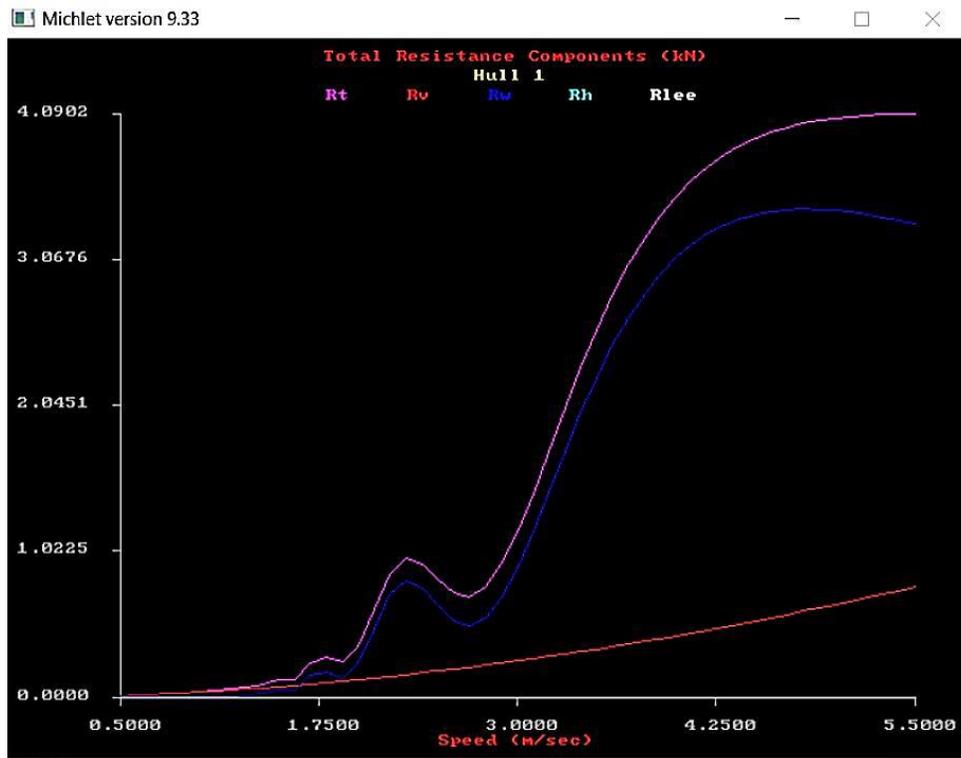
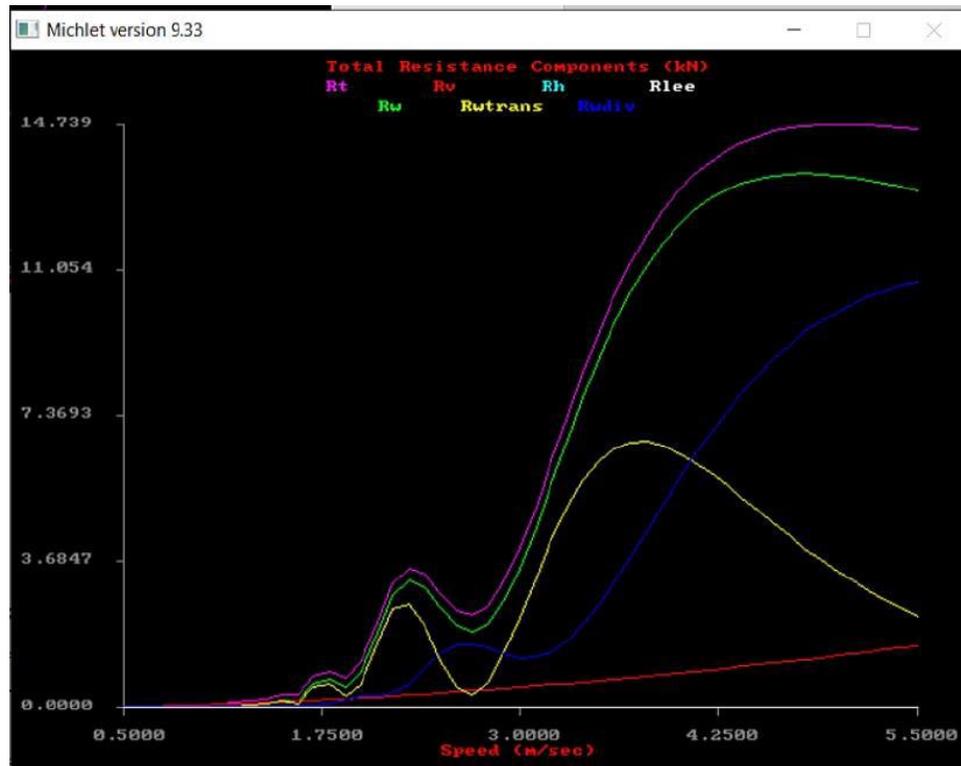Figure 7: Total resistance components, Rt components vs Speed

Figure 8: Total resistance components, Ship Rt components vs Speed
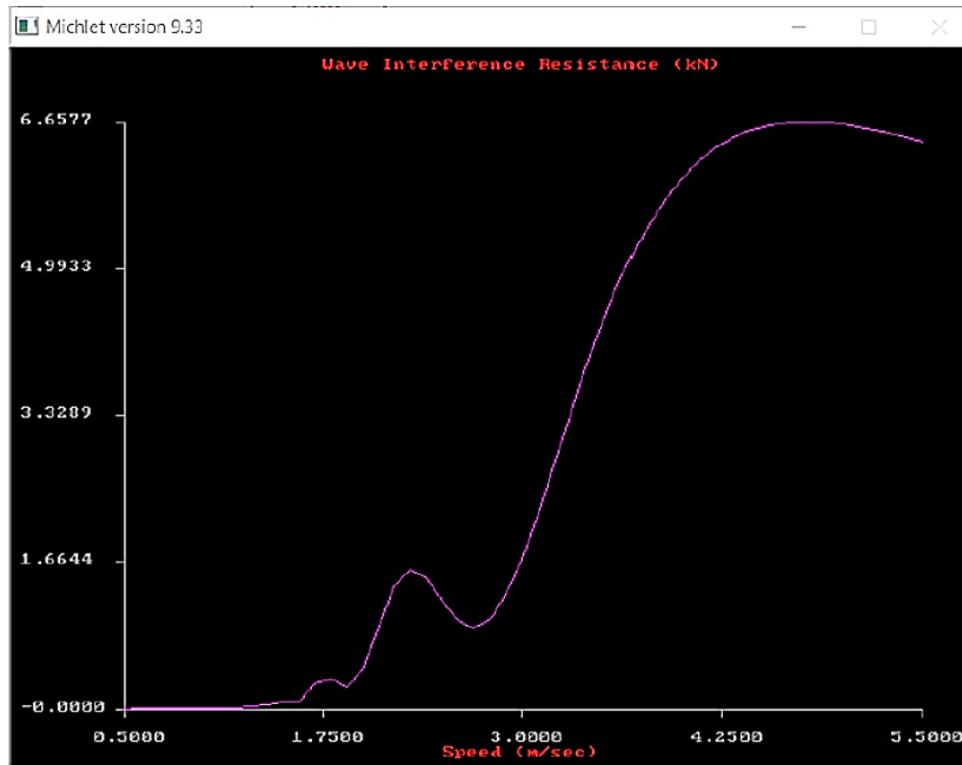
Figure 9: Wave resistance interference components, Ship wave interference vs Speed

Based on Figure 8 and Figure 9, the resistance curve is not linear but increases more steeply at higher speeds. All curve generated by Michlet shows that the hulls are going through a usual resistance trend for a ship.

Thus, the result is acceptable, so the Houseboat can work as an optimum moving pontoon boat. The hump at both curves is familiar for all ship resistance curves. On the other hand, in Figure 8, the wave resistance is in a standard curve. As Speed increases, the wavemaking also increases, but there will be a problem in the propulsion system that is to reduce the wave-making. Theoretically, it can be reduced by adding the length of hulls which might be the pontoon or the deck part.

4.2   Insel and Molland theory

A software called Software for Resistance Prediction-Round Bilge Catamaran (Molland) is used to estimate and verify the result gained from the Michlet program. This software applies Insel and Molland method. The results are shown in Figure 10 and Figure 11.

Figure 10: Software for Resistance Prediction-Round Bilge Catamaran (Molland)

Figure 11: Software for Resistance Prediction-Round Bilge Catamaran (Molland)

The result generated from Software for Resistance Prediction-Round Bilge Catamaran (Molland) shows that this Houseboat will be in normal condition when operating in fresh water. The parameters, which are block coefficient, breadth over the length, and the others, show positive output while the Froude number of this Houseboat is acceptable as it is still in the normal range.

Michell's thin ship theory helped analyze multi-hull ships while Insel and Molland theory used in Software for Resistance Prediction-Round Bilge Catamaran (Molland) validated the resistance estimation of the 6m Houseboat.

The mistake made through resistance calculation is that the value for lateral ship separation that has entered in the Michlet might have a little deviation. The central point used as a reference point to measure the length between two hulls in Houseboat's drawing draft is not set up automatically. Thus, it might have a little deviation and inaccuracy.

5. CONCLUSION AND RECOMMENDATION

This research focuses on analyzing resistance and verifying the resistance estimation of a 6m multi-hull houseboat. The estimation and verifying of resistance values are performed using Michlet and Software for Resistance Prediction-Round Bilge Catamaran (Molland). These programs applied methods that most suit the hull type, pontoon type (multi-hull). The results obtained conclude that the 6m Houseboat can work optimally in the freshwater.

To improve the calculation of the resistance process, these are the recommendations. To better analyze, use the model test method to prove that the Houseboat will operate most optimum and stable when moving on freshwater. Next, use different shapes or lengths of pontoon to compare which part of the pontoon can be improved for a better propulsion system.

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