Analysis of the Effect of Addition of Bilge Keel, Bulbous Bow, Skeg and Combination on Value of Ship Resistance and Seakeeping of Ship using CFD Method

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Keywords: Resistance, Seakeeping, Bulbous Bow, Skeg, Bilga Keel.

Abstract: The hull added by the Bulbous Bow, Skeg, and Bilge Keel can improve the ship's ability to operate. Based on several studies it is known that the best bulbous bow model is the V model, the best Skeg form is the Foil model and the most optimal Bilge Keel form is the hollow triangle shape, where the most optimal variation is to reduce the value of the resistance and ship seakeeping. To achieve these objectives, several stages are carried out, namely making a model, then analyzing the model using CFD software. The results of this study indicate that the best resistance value occurs in the ship model with Bilge keel with a value of 8.8 kN or a decrease of 13.72% of the ship without the addition of components. Then for the value of the Motion obtained Heaving value of 0.84774 m on the ship without the addition of components, for the best pitching value that is on the ship with the addition of Bulbous bow, Skeg and Bilge keel with a value of 0.080775 radians and for the best Rolling value is on the Ship with additions Bilge keel with a value of 0.0000082404 rad.

1 PREFACE

The development of the shipping world is growing. This is related to the performance of the ship which is getting better over time. In the design of the ship there is a lot that must be considered including the resistance that occurs and the seakeeping of the ship. The resistance and speed of flow in the propeller of the ship will have a large influence on speed. In addition, high resistance also affects the power requirements to reach a certain speed. The greater the resistance of the ship, the greater the main engine power (main engine) needed to push the ship (Daud et al., 2019).

Beside of the resistance, the thing to note is the seakeeping. Seakeeping is the ability to defend itself as a result of waves that occur. We often call it Seakeeping. Seakeeping is one of the most important components to find out if the ship has the feasibility of making a cruise on the ocean waves. To get the seakeeping value can be analyzed using Towing Tank or computational or CFD methods. The vessels used in this study are mono hull vessels with modified component additions, namely bulbous bow, skeg and bilge keel.

Variations in the geometric shape of the skeg when using the bilgekeel model which has the smallest total resistance value are Foils with a value of 9.28 KN in the position of AP (stern) and model without using bilgekeel which has the smallest total resistance value ie Foils with a value of 9.31 KN in the AP position (Stern). The Foils model has the smallest resistance value because the laminar structure of the foils model can accelerate the flow of water and no flow is blocked when passing through the structure of the foils (Rishwanda., 2018).

While the shape of the bilga keel used is a hollow bilga with a triangular shape which has the smallest resistance value which can reduce the total resistance of the vessel by 20.626% at Fn 0.28 and 16.396% at Fn 0.36 (Avian et al., 2018).

This study will focus on the comparison of the values of resistance and Seakeping from each variation with the CFD method. At present, CFD has become a numerical device that is very effective in analyzing fluid flow. ABS, as one of the classification bureaus, is making efforts to implement CFD technology to apply CFD technology to assess the strength of modern commercial vessels and high-speed naval vessels. Software used is Software Analysis of seakeeping.

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From the explanation above the problem can be formulated in this study, namely the effect of adding components to the value of resistance and sea keeping and the comparison of the value of resistance and seakeeping of each variation.

2 METHODS

In this study, the authors have primary data on the main size of the KM Egon vessel:

LOA : 26.370 m
B : 5.500 m
T : 1,000 m
H : 2.622 m
V : 10 Knot
Wave Direction : 180 degree

For secondary data obtained from the literature (journals, books, and data obtained from previous studies).

The parameters of the study were focused on the effect of adding components to the hull on barriers and vessel seakeeping. The parameters used are as follows:

1. Permanent Parameters
   The author uses primary data of the main size of the KM ship. Egon as a fixed parameter in this study.
2. Variable Parameters
   - Ship without Component Additions
   - Ship with the addition of bulbous bow type V
   - The vessel with the addition of a Bilge Keel hollow triangular shape with a 50% LOA Length
   - Ship with the addition of Skeg in the form of Foils
   - Ship with the addition of Bulbous bow, bilge keel, and skeg

The process of making a model using Modeler. Calculation of resistance and seakeeping uses the Computational Fluid Dynamics (CFD) method, which is one branch of fluid mechanics that uses numerical methods and algorithms to solve and analyze problems related to fluid flow (Kim, 2011).

The Computational fluid dynamics method consists of three main elements, namely:

- *Pre Processor*
- *Solver Manager*
- *Post Processor*

Computational fluid dynamic cannot completely replace measurements experimentally, but the amount and cost of experiments performed can be reduced.

3 RESULTS AND DISCUSSION

3.1 Data Processing

This Design Modeling using Modeler.

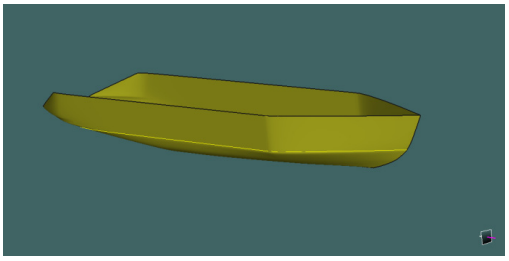

Figure 1: Model of Ship Without Additional Components.

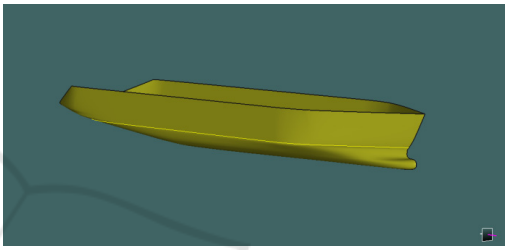

Figure 2: Model of Ship with Bulbous Bow Model V.

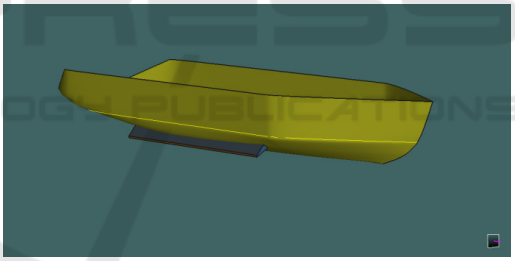

Figure 3: Model of Ship with Hollow Triangle Bilge Keel.

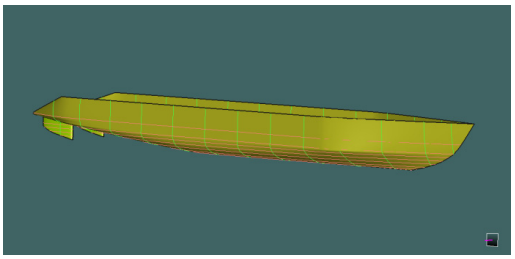

Figure 4: Model of Ship with Skeg Shape Foil.

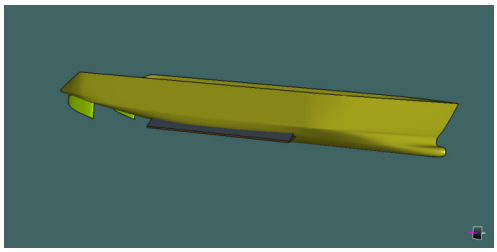

Figure 5: Model of ship with bulbous bow, Bilge keel, and Skeg.

After the model is ready, then the resistance values are tested and the motion is performed on the CFD software.

3.2 Value of Resistance

To get the resistance value, the author uses CFD software with the Hulltrop method, an efficiency of 85% and a speed of 10 knots. The test results of each variation can be seen in the following figure

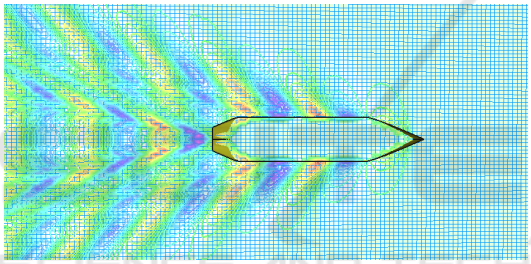

Figure 6: Ship Surface Image without Additional Components.

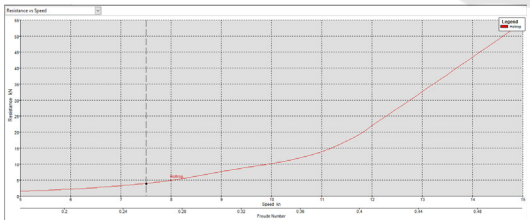

Figure 7: Resistance and Ship Speed Chart without Additional Components.

From testing on ships without additional components, the value of the total resistance was 10.2 kN at a speed of 10 knots.

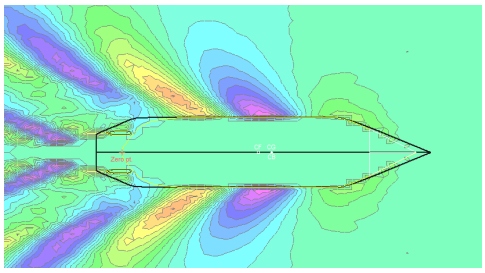

Figure 8: Ship Surface with Skeg.

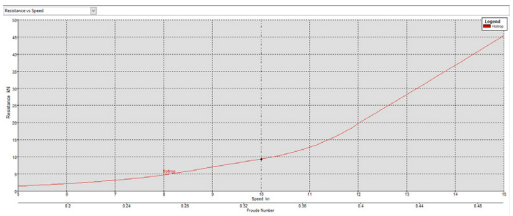

Figure 9: Resistance and Ship Speed Graph with Skeg.

From testing on a ship with Skeg, the total resistance value of 9.4 kN was obtained at a speed of 10 knots.

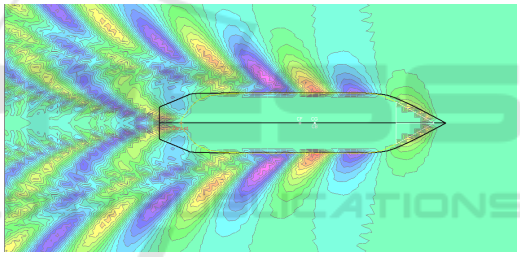

Figure 10: Surface Ship with Bulbous Bow.

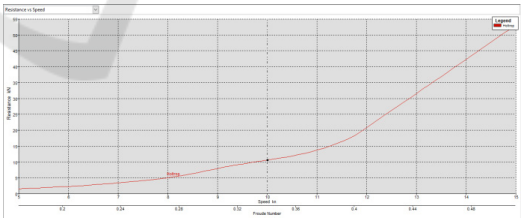

Figure 11: Resistance and Ship SpeedGraph with Bulbous Bow.

From testing on a ship with a bulbous bow, it was found that the total resistance was 10.6 kN at a speed of 10 knots.

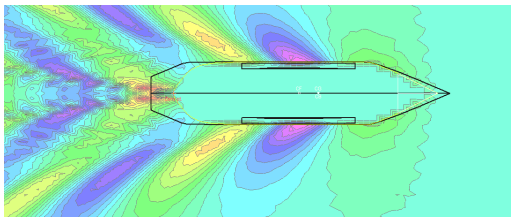

Figure 12: ShipSurface with Bilge Keel.

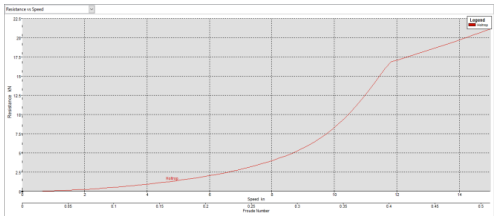

Figure 13: Resistance and Ship Speed Graph with Bilge Keel.

From testing on a ship with a bulbous bow, it was found that the total resistance was 8.8 kN at a speed of 10 knots.

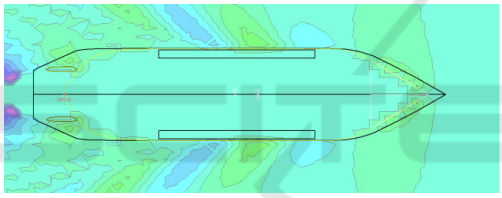

Figure 14: Ship Surface Combination.

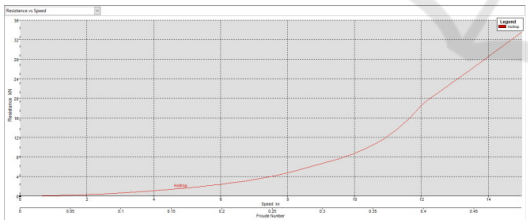

Figure 15: Resistance and Ship Speed Graph Combination.

From chart above can be summarized in the following diagram

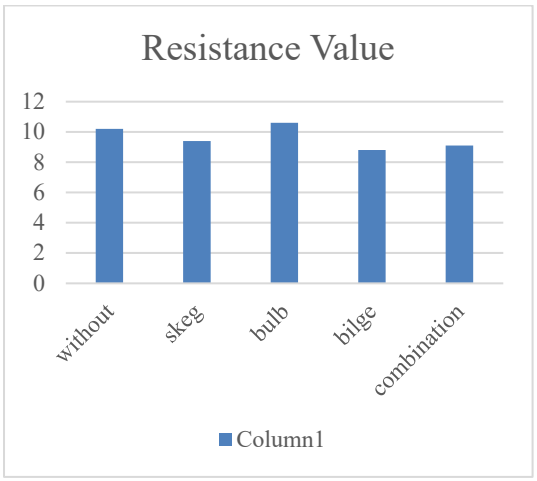

Figure 16: Resistance Value Graph for each variation.

Based on the graph above, it can be concluded that the most optimal resistance value of each predetermined variation is on the ship model with the addition of Bilge Keel with a value of 8.8 kN. When compared with the resistance value of the ship without adding components, the addition of bilge keel components can reduce the value of the resistance by.

3.3 Value of Seakeeping

The seakeeping sought in this study is the natural response of an object when hit by waves, including Heaving, Pitching and Rolling.

The waves used are regular waves with a wave frequency of 0.04 Hz, wave height of 1 m and the direction of the wave is 180 degrees.

The results of the ship seakeeping from each variation can be seen in the following Table and Diagram:

Table 1: Heaving value for each variation.

Model	Heaving Value (m)
Without	0.84774
Bulb	0.85998
Skeg	0.86012
Bilge	0.85881
Combination	0.86621

From Table 1 it is known that the smallest value of Heaving occurs in the model without the addition of components with a value of 0.84774 m. This can happen because the Heaving seakeeping displacement value greatly affects the value of the Heaving.

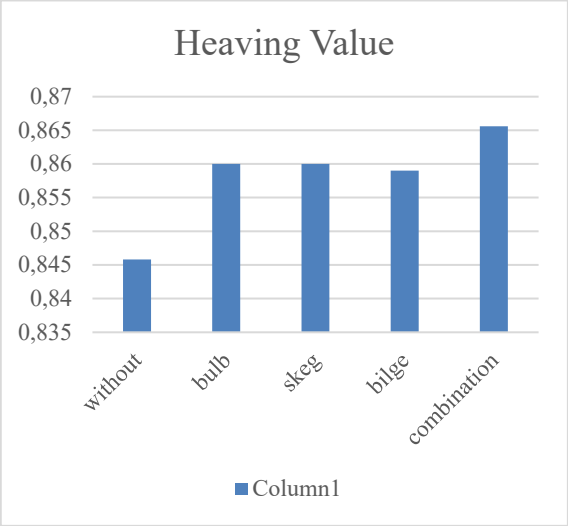

Figure 17: Heaving Value Diagram.

From Figure 17 above, it can be seen the difference in the value of heaving from each model variation where the effect of adding displacement actually adds to the heaving value of the ship

Table 2: Pitching value for each variation.

Model	Pitching Value (radian)
Without	0.081658
Bulb	0.080820
Skeg	0.081457
Bilge	0.081250
Combination	0.080755

From Table 2, it can be seen that the lowest pitching value is on the Ship with a combination of the addition of Skeg, Bulbous Bow and Bilge keel with a value of 0.080755 radians.

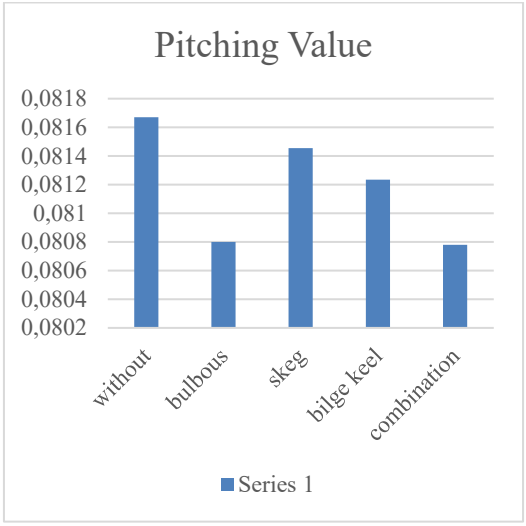

Figure 18: Pitching Value Diagram.

From Figure 18 it can be seen that the Pitching value is influenced by the addition of components in the longitudinal section, namely the bulbous bow even though the addition of the keel and skeg bilge also reduces the pitching value but is not significant.

Table 3: Rolling value for each variation.

Model	Rolling Value (m)
Without	0.0000157195
Bulb	0.0000122404
Skeg	0.0000102404
Bilge	0.0000082404
Combination	0.0000092404

From Table 3, the lowest rolling value can be seen on the Ship with Bilge Keel with a value of 0.0000082404 radians.

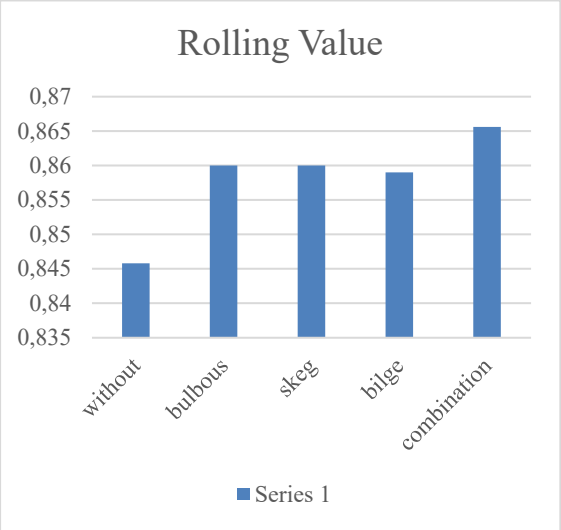

Figure 19: Rolling Value Diagram.

From Figure 19 it was affected by the addition of components in the transverse direction such as Bilge Keel and Skeg, but the addition of Bilge Keel was more significant in reducing the Rolling value.

4 CONCLUSION

Based on the experiments that have been done, it can be concluded as follows:

The value of total resistance is best for ships with the addition of triangular and hollow bilge keel which can reduce ship resistance by 13.72% with a total resistance value of 8.8 kN.

For the value of sports, each boat has a significant difference. The best value of Heaving is on a Ship without Component Addition with a value of 0.84774 m, for Pitching the best value is found on a Ship with a combination of adding a bulbous bow, skeg and keel bilge with a value of 0.080775 radians and in Rolling the best value is on the Ship Bilge Keel with a value of 0.0000082404 radians.

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