

Resistance Reduction by Optimizing Bow-Stern Form of the Fishing Boat

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Abstract

Over the past decade, the development of the Fishing boat design has been increasingly done for reducing resistance and improving speed. Therefore, the aim of the present paper is to reduce resistance of the Fishing boat by optimizing bow-stern form simultaneously. In order to optimize bow-stern form of the fishing boat, we considered some different forms based on modification with the constant ship volume and used further a free software tool. The bow-stern modifications are limited by LCB inmidship -3% to 3% range to avoid trim conditions and it obtained six forms. The bow-stern forms show slightly different but the resistance reduction contributes quite high. The best form modification based on resistance reduction and LCB point movement is shown by the fourth form where the resistance is 23.88kN and LCB 0.189% from midship. This shows that modification of bow-stern form can have a major beneficial impact on a performance especially in ship resistance. In our future work, we will conduct experiment and enhance a performance of best form by fitted stern-end-bulb and also recent result will compare with numeric or CFD result.

Keywords: Ship Resistance, Fishing Vessel, Bow-Stern Form

1. Introduction

The efforts for reducing greenhouse gas are devoting widely in marine engineering field. There are two approaches recently on ship design which are studied to reduce ship fuel consumptions i.e. hull form improvement and appendage attachment. Therefore, improvements of ship performance by designing a proper hull form to reduce resistance and appendage attachment to increase speed have been done recently. However, there is an expectation on a little change of ship hull in design process to gain many benefits. Therefore, study on hydrodynamic optimization of ship hull form should be continued to obtain more proper ship design.

Bow wave which is generated by ship bow movement can be reduced by optimizing bow shape. Then, alteration of stern shape or use of an appendage as well could be reduced wave energy. The studies on improvements of stern-bow form of fishing boat have been conducted e.g., Suzuki et al. [1], Kawashima et al. [2] and Masuya et al. [3]. Then, Stern end bulb research took place mostly in Japan (Miyata et al., [4]. Gabor et al. [5] and Kim et al. [6] have conducted numerical works related with stern part improvement for reducing drag. However, studies on bow and stern part of fishing boat should be conducted more detail to obtain not only proper design but also interpretation of hydrodynamic behavior.

In this study, optimization of bow and stern part of the fishing boat are investigated to obtain proper form based on resistance reduction.

2. Methodology

Here, there are several steps which are conducted to obtain research results i.e. bow-stern part identification, resistance calculation and computation, and determination of the best bow-stern part based on resistance. Ship hull is modeled firstly and then the bow and stern lines are changed systematically. Alterations of bow and stern part of the fishing boat consider ship volume, draft, speed and fish hold. These are constant during the alteration.

Ship resistance is computed by using Delftship software. Delftship consist of two methods for predicting ship resistance. These methods are statistic method based on towing tank data. Figure 1 shows worksheet of Delftship. In this software, total resistance is calculated using DelfSeries method where the resistance components divided into friction resistance and residual resistance.

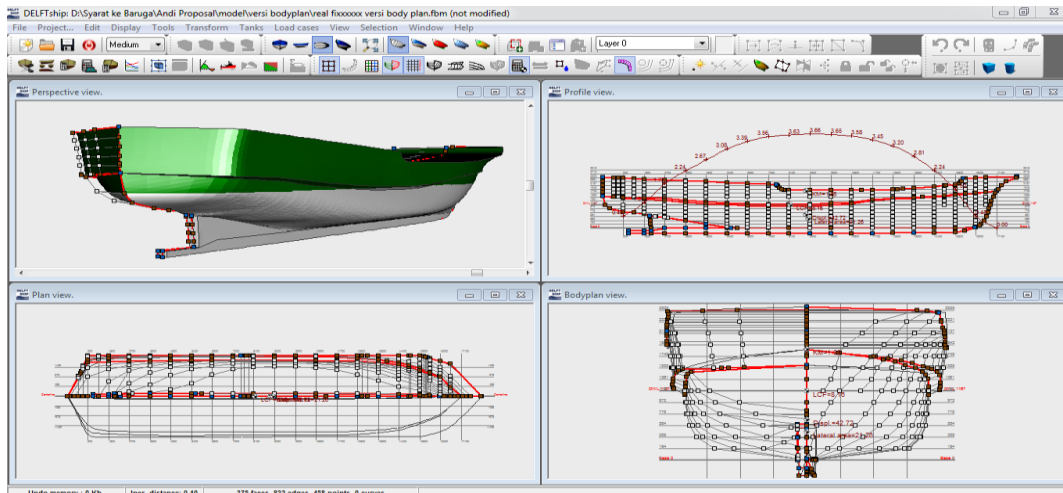


Fig.1 Delfship worksheet

3. Result And Discussion

The main dimensions and body lines plan of the fishing boat are presented in Table 1 and Figure 1, respectively. Then the fishing was modeled in three dimensions by using Delfship as shown in Fig.2. The initial volume properties of the fishing boat before altering is shown in Table 2.

Table 1. The fishing boat's dimensions

Loa	18 m
B	4,2 m
H	1,9 m
T	1,15 m
V	10 knot

Table 2. The initial volume properties of the fishing boat

Volume Properties	
Moulded volume	41,682 (m ³)
Total displaced volume	41,682 (m ³)
Displacement	42,725 (tonnes)
Block coefficient	0,6189
Prismatic coefficient	0,7395
Vert. prismatic coefficient	0,6887
Wetted surface area	80,802 (m ²)
Longitudinal centre of bouyancy	8,823 (m)
Longitudinal centre of bouyancy	6,132 (%)
Vertical centre of bouyancy	0,687 (m)

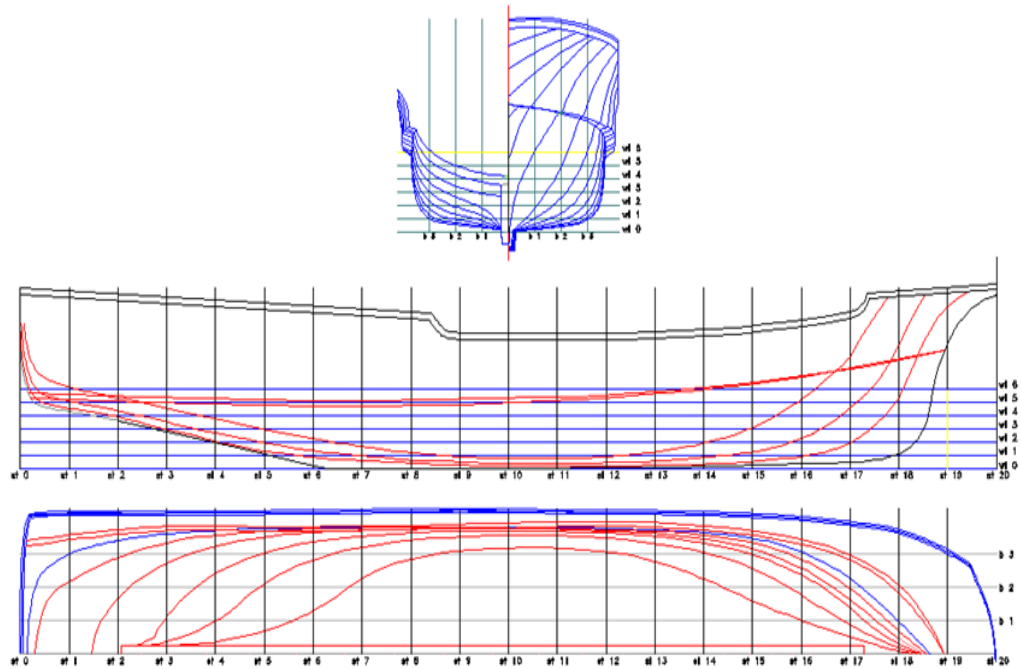


Figure 1. Lines plan of the fishing boat

Here, bow and stern part were only modified simultaneously. Figure 3 is shown an example bow and stern part modification. The bow-stern modifications are limited by longitudinal centre buoyancy *LCB* inmidship -3% to 3% range to avoid trim conditions and then the fishing boat could be modified into six forms; BS1, BS2, BS3, BS4, BS5, BS6.

The resistance for all modification forms tends to increase in increasing speed. The comparison of resistance between all forms is shown in Fig. 4. The original form has total resistance 25.521 kN where the residual resistance is 23.1503kN as shown in Fig.5.

Based on Table 3, the BS6 has lowest total resistance 23.687kN comparing with others. In addition, the friction resistance of the BS6 is also lowest. This means that the modification of bow and stern part of a ship could reduce wave bow resistance. However, alteration of bow and stern part contribute *LCB* movement wheretThe*LCB* of theBS6 is -1.189% from midship. This means that the SB6 has stern trim condition.

The SB4 has low total resistance 23.883 kN comparing with original form. Moreover, it has small *LCB* movement 0.189% from midship. Regarding to those results, the SB4 is the best modification based on total resistance and *LCB* point. Then, it has also small residual resistance 21,5250kN comparing with original form.

Finally, the residual resistance is dominant value in total resistance. Then, the total resistance has the same tendency with the residual resistance. Therefore, to reduce the residual resistance, alteration of bow-stern part of a ship is possible and proper way.

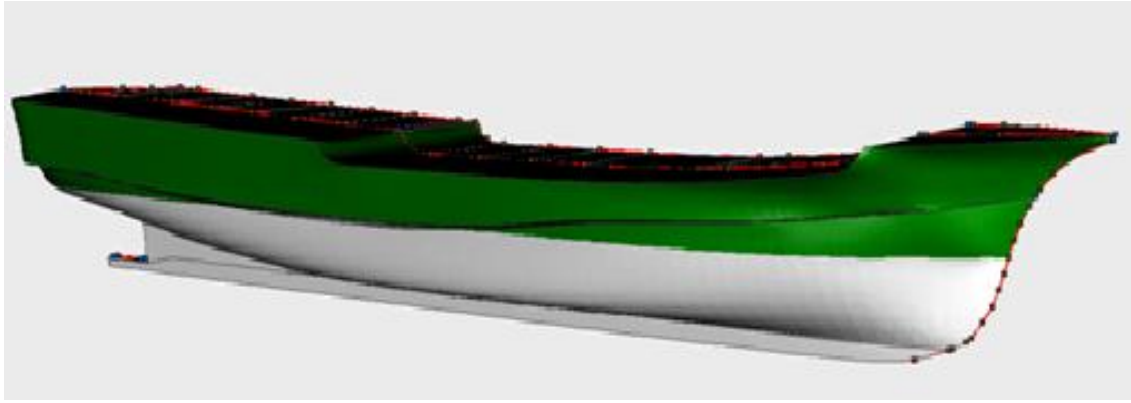


Figure 2. The fishing boat snapshot in 3D

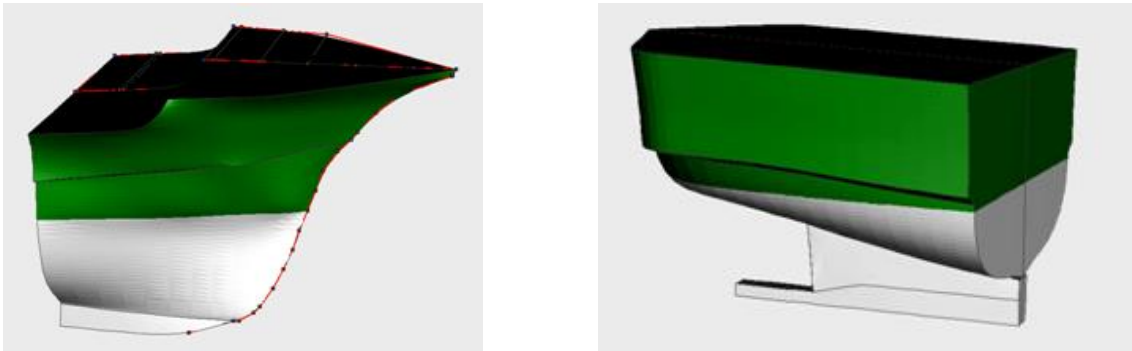


Figure 3. An example Bow and Stern part modification

Table 3. Total resistance for all modification forms of the fishing boat

Item	Rf (kN)	Rr (kN)	Rtotal (kN)
Original Form	2,3707	23,1503	25,5209
BS1	2,3830	24,5093	26,8923
BS2	2,3778	23,6815	26,0594
BS3	2,3616	22,8079	25,1696
BS4	2,3581	21,5250	23,8831
BS5	2,3544	21,3822	23,7366
BS6	2,3365	21,3471	23,6837

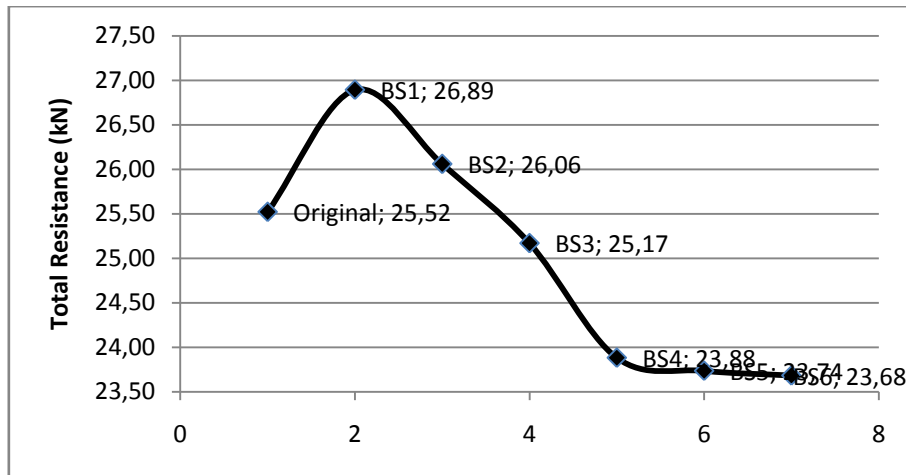


Figure 4. The total resistance for all modifications

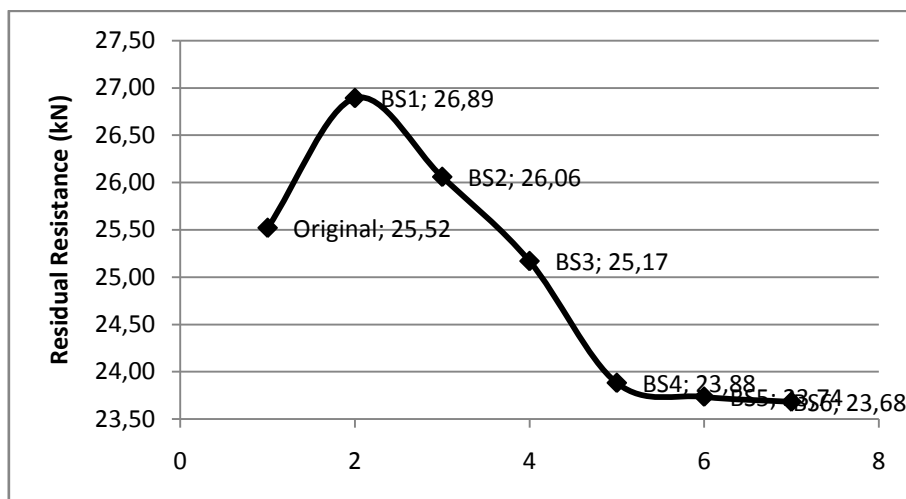


Figure 5. The residual resistance for all modifications

4. Conclusion

The bow and stern part of the fishing boat was optimized and modified into six forms. The total resistance of all modification forms was predicted by using Delfship tool. The bow-stern forms show slightly different but the resistance reduction contributes quite high. The best form modification based on resistance reduction and LCB point movement is shown by the fourth form where the resistance is 23.88kN and LCB 0.19% from midship. This shows that modification of bow-stern form can have a major beneficial impact on avessels performanceespecially in ship resistance. To reduce the residual resistance, alteration of bow-stern part of a ship is possible and proper way.

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