Wave Surface Simulation on Optimized Fishing Vessel Hullform

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ABSTRACT

This reseach discuss wave surface simulation on vessel from the optimization hullform. Principal dimension of vessel is LBP 14,0 m; B 2,8 m; H 2,4 m and T 1 m. Optimization method's use software aplication namely Solver as provided by Microsoft Excel. The objective function is to minimize its resistant after mother vessel is modified . Hullform is formed by measure its dimension in longitudinal, tranverse and horizontal position. After the smallest resistant is found, motion of the vessel in sea water as hydrodynamics performance is made in numerical simulation by using Hullspeed. All the wave contour will be presented as a response of the vessels in facing the wave.

Keywords: wave surface, Hullspeed, wave contour, numerical simulation

INTRODUCTION

In common practice that hullform are designed such that they have minimum wave resistance in calm water.infact traditional ship builder is rarely build the ship with optimation hull form. Traditional fishing vessel is built with adventure of the dockyard skill without make sure its performance when hull form receive a force in calm or rough water. Inefficient hullform will increase the resistance of the ship, finallnya efficient hullform can save the using of fuel consumption when she operate in sea water. An example of inefficient hullform is poured in this research by make a sample of gilnetter in Bengkalis Regency, Riau Province. The principal of the vessel is LBP 14,0 m; B 2,8 m; H 2,4 m and T 1 m. By measured the vessel in longitudinal and transversal ways, the data of offset table is used for designing the vessel in numerical simulation. Software computer as Maxsurf and AutoCAD is needed to strenghtenen the real ship. After all is clear, its resistant si calculated by using Hullspeed. Hullspeed provides different algorithms for estimating hull resistance. These are divided in different groups dependent on the type of hull. Those methods are Methods For Planing Hulls, Methods For Displacement Ships, Methods Applicable To Yachts and Analytical Method.

Methods For Planing Hulls

Savitsky (Pre-planing). This algorithm is useful for estimating the resistance of a planing hull before it gets 'onto the plane'; i.e. its pre-planing resistance. Savitsky (Planing) is used for estimating the resistance of planing hulls when in the planing speed regime. Lahtiharju is used for estimating the resistance of planing hulls when in the planing speed regime ((Hullspeed, 2005)

Methods For Displacement Ships

Holtrop. This algorithm is designed for predicting the resistance of tankers, general cargo ships, fishing vessels, tugs, container ships and frigates. Compton. This algorithm is designed for resistance prediction of typical coastal patrol, training or recreational powerboat type hull forms with transom sterns operating in the displacement and semi-planing regimes. Fung. This algorithm is applicable for resistance prediction of displacement ships with transom stern hull forms (generally used for larger vessels than Compton). The regression is based on data from tests on 739 models at the David Taylor model basin and consists over 10000 data points, Fung and Leibman (1995). van Oortmerssen is usedfor estimating the resistance of small ships such as trawlers and tugs. Series 60 is used for estimating the resistance of single screw cargo ships (Hullspeed, 2005)

Methods Applicable To Yachts

Delft Series I, II and III Sailing yacht resistance prediction, using the regression based on either Gerritsma *et al.* (1991) or Gerritsma *et al* (1992).

METHODS

The research use survey methods by review data of the vessel and make the wave simulation on it. The initial hullform will be compared to redesign hullform by tested its resistant. Its principal dimension is determined by using solver as aplication of Excel for solving opmization. The objective function is minimum resistant, and parameter are wave, gravity, sea water etc. Equation for the solution of the objective function is generalized reduced gradient (GRG) as showed bellow:.

$$GR = \nabla yf - \{[D]\text{-}1[C]T\nabla zf$$

Where:

$$\nabla yf = \begin{Bmatrix} \frac{\partial f}{\partial y_1} \\ \frac{\partial f}{\partial y_2} \\ \vdots \\ \frac{\partial f}{\partial y_{n-1}} \end{Bmatrix} \qquad \nabla zf = \begin{Bmatrix} \frac{\partial f}{\partial z_1} \\ \frac{\partial f}{\partial z_2} \\ \vdots \\ \frac{\partial f}{\partial z_{n-1}} \end{Bmatrix}$$

$$[C] = \begin{bmatrix} \frac{\partial g_1}{\partial y_1} & \cdots & \frac{\partial g_1}{\partial y_{n-1}} \\ \vdots & & \\ \frac{\partial g_{m-1}}{\partial y_1} & \cdots & \frac{\partial g_{m-1}}{\partial y_{n-1}} \end{bmatrix} \qquad [D] = \begin{bmatrix} \frac{\partial g_1}{\partial z_1} & \cdots & \frac{\partial g_1}{\partial z_{n-1}} \\ \vdots & & \\ \frac{\partial g_{m-1}}{\partial z_1} & \cdots & \frac{\partial g_{m-1}}{\partial z_{n-1}} \end{bmatrix}$$

Analytical Method for ship resistance
Slender Body Method

A slender body method, based on the work of Tuck et al (1999) and Couser et al (1996) is available in Hullspeed. This method uses a Michell (1898) based approach to compute the wave resistance of a port/starboard symmetrical monohull. This method may be applied to many different hullforms including multihulls. However the individual hulls should be slender (have narrow beam compared to their length) and should be symmetrical about their local centreline. Planing forces are neglected in the slender body method which limits speed range applicability for this method. In general, sensible results can be obtained for a wide range of mono- and multihull vessels operating at normal Froude numbers. This method predicts only the wave pattern resistance component. To calculate the total resistance, Hullspeed calculates and adds the viscous resistance component using the ITTC'57 friction coefficient calculation method and the specified form factor.

RESULT AND DISCUSSION

Data of resistant of vessel can be seen in the Table 1. Speed of the vessel is originated from zero untill maximum speed namely 20 knot. This way is done twice both existing and modification hullform.

The graph of speed ve power is closely to parabolic graphic, where as addition for speed will increase the power. Comparison of both graph describe that reduction of fuel consumption occurs until reach 8% for the similar hull form (Fgure 1).

Tabel 1. Speed vs Power of Vessel

Speed	Holtrop		Van Oortmeersen		Speed	Holtrop		Van Oortmeersen	
knot	kN	kW	kN	kW	knot	kN	kW	kN	kW
0,5	0,01	0	0	0	10,5	4,44	23,96	8,47	45,77
1	0,02	0,01	0,02	0,01	11	4,91	27,78	9,43	53,34
					11,5	5,39	31,88	10,16	60,11
					12	5,82	35,95	10,75	66,37

2,5	0,11	0,14	0,08	0,11	12,5	6,19	39,82	11,27	72,45
3	0,16	0,24	0,12	0,18	13	6,54	43,76	11,77	78,73
3,5	0,21	0,38	0,16	0,29	13,5	6,88	47,81	12,31	85,49
4	0,27	0,56	0,21	0,43	14	7,23	52,04	12,91	92,98
4,5	0,35	0,8	0,26	0,6	14,5	7,57	56,47	13,59	101,34
5	0,44	1,13	0,32	0,83	15	7,92	61,15	14,34	110,69
5,5	0,56	1,59	0,39	1,11	15,5	8,29	66,09	15,18	121,06
6	0,72	2,22	0,51	1,57	16	8,66	71,31	16,09	132,46
6,5	0,89	2,98	0,73	2,45	16,5	9,05	76,83	17,07	144,88
7	1,1	3,97	0,91	3,29	17	9,45	82,66	18,1	158,28
7,5	1,41	5,44	1,12	4,33	17,5	9,86	88,81	19,17	172,59
8	1,88	7,76	1,68	6,93	18	10,29	95,28	20,28	187,77
8,5	2,58	11,29	2,76	12,08	18,5	10,73	102,08	21,41	203,75
9	3,05	14,13	4,23	19,57	19	11,17	109,21	22,56	220,47
9,5	3,51	17,14	5,8	28,35	19,5	11,63	116,68	23,71	237,86
10	3,97	20,42	7,26	37,34	20	12,1	124,49	24,87	255,89

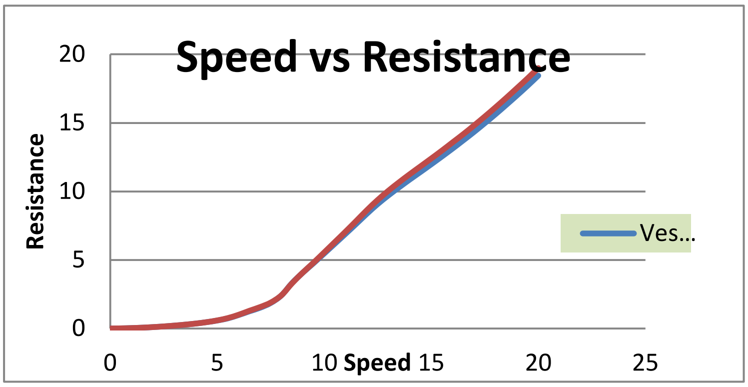

Figure 1. Comparison of Speed vs Resistance Vessel 1 (Existing) and Vessel 2 (Redesign).

Model Validation

Except for the wetted surface area, the input data for the slender body method is not displayed in the input table and can thus neither be validated nor modified by the user. To make sure that Hullspeed interprets the surface model correctly, it is recommended to check the slender body mesh. This can be done by turning on the SB mesh option in the Display menu. The number of sections used can be increased for greater accuracy, though this will increase the computation time. Particular attention should be paid to the mesh of multihulls and vessels with transom sterns (Hullspeed, 2005).

Accuracy of Wave Pattern Calculations

Several features of the numerical methods required to compute the wave pattern cause it to be less accurate than the calculation of the wave resistance. Not least of these, is the fact that the computation for the wave resistance is equivalent to computing the wave pattern at one single grid point on the free surface and thus significantly less computational intensive. Also, in the case of the resistance computation, the functions that must be integrated are smoother and can thus be integrated with more accuracy. The "Integration precision" option in the Free Surface Calculation Parameters dialog controls the precision with which the main integration is performed and this will affect the smoothness and accuracy of the calculated wave pattern. For accurate results, this should be above 50.000 and in most cases it is advisable to use 100,000. However, this can take a on the number of grid points being evaluated.

Thus the wave pattern calculation is generally to be used for presentation purposes or where an indication of the likely wave pattern is required. This is particularly true closer to the vessel since the accuracy of the wave pattern will be higher several vessel lengths aft of the vessel (Hullspeed, 2005).

The figure of wave surface simulation can be seen in Figure 2 and Figure 3.

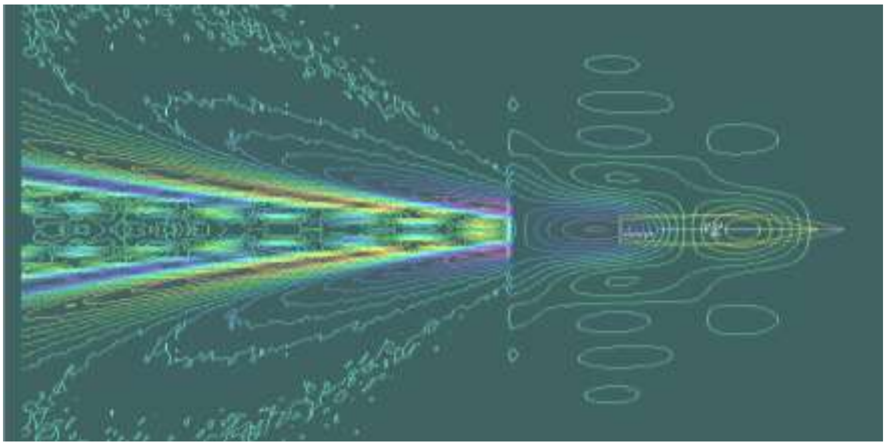

Figure 2. Wave pattern from Up View

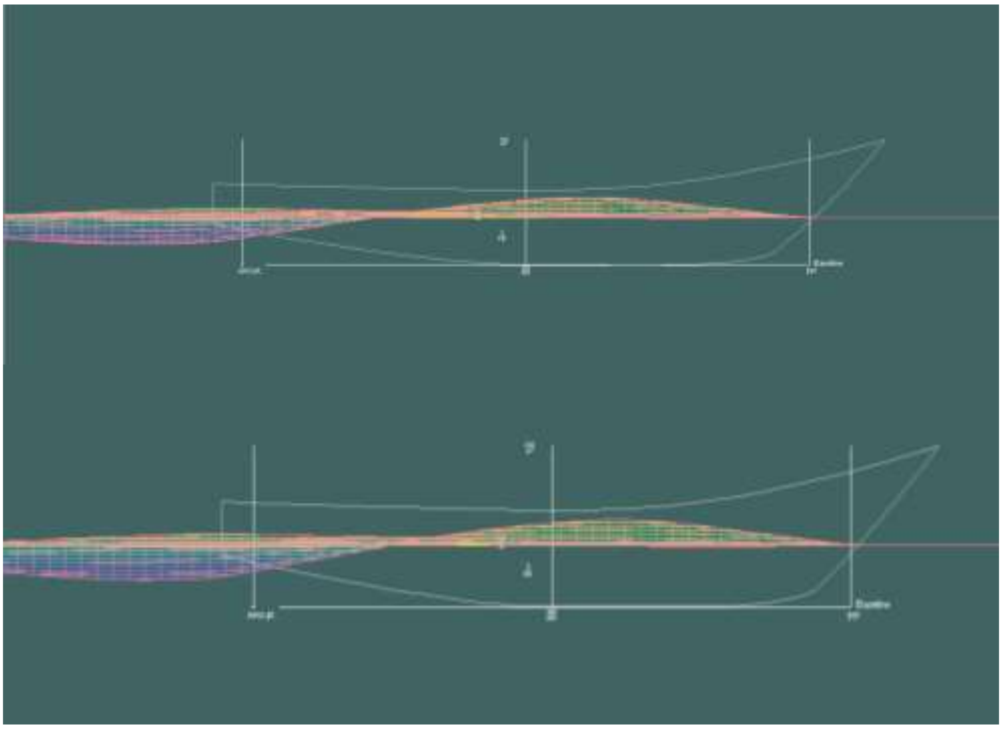

Figure 3. Wave pattern from Up View

CONCLUSION

Higher wave contour will effect pressure resistance on vessel . Resistance of a vessel can be reduced almost 8% in the small changing of displacement. The wave simulation on fishing vessel describe the pressure resistance.

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