Computational Fluid Dynamics Analysis into The Improvement of Seakeeping Characteristics of A Fast Craft Using AXE-Bow

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Abstract - It is obviously understood that hull shape affects the movement characteristics and operability of a ship. There are several ways which can be conducted in order to improve the operability of a ship one of those is by improving ship bow. Recent development known as AXE-Bow was introduced by Delft University of Technology in collaboration with DAMEN Shipyard, in the Netherlands. It was reported that the AXE-Bow can improve the seakeeping characteristics of the vessel at higher speed (Froude number above 0.60), such as reduce vertical acceleration. The current work is carried out numerically using Computational Fluid Dynamics (CFD) approach together with the use of CFD code called Hydrostar provided by Bureau Veritas (BV). The overall results showed that there are good agreement between CFD method and the work by Delft University of University and DAMEN Shipyard. Comparative studies were also carried out with published data and demonstrated similar findings

Term Index - AXE-bow, seakeeping, CFD, potential flow theory, diffraction method, strip theory.

INTRODUCTION

For recent years, fast craft ship is used for passenger ship, war ship, and rescue ship, survey and crew boat. There are many reasons for naval architect better used Axe Bow than planning Hull in fast craft ship [6]. In this fast craft ship, one of the samples is in crew boat by using Axe Bow. AXE Bow is a characteristics ships which has sharp and small hull in vertical way and looks like an axe.

A. Crew boat

Crew boat is a marine transportation vehicles used for carrying crew or workers who normally work offshore, or drilling facilities. This vessel operates just like for a passenger ship in general. This type of ship is too big and not too much carry passengers or workers, because this type of ship priority to comfort.

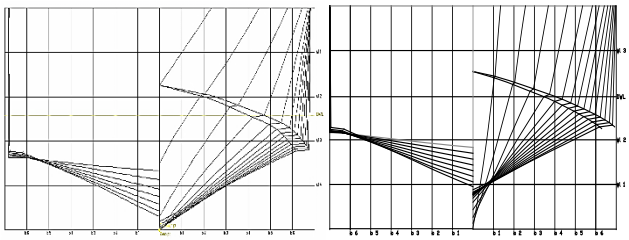

Figure. 1 Crew Boat Type Planning hull and AXE-Bow.

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Seakeeping is one of the important performances for a fast craft ship. Once the ship has been designed, it is very difficult to optimize the inherent seakeeping performance. Therefore, in order to obtain a good seakeeping performance, the ship engineers should carefully consider the ship dimensions, ship lines and other design parameters. In this paper, the seakeeping performances of the fast craft ship during concept design phase are studied with model tests and Potential Flow Theory in frequency domain by using the commercial code HydroSTAR, which is developed by Bureau Veritas (BV). According to the results, the influences of variation of design parameters (center of gravity, inertial radius, damping criteria, etc.) are given as suggestions for engineers during concept design stage.

METHOD

A. Diffraction Radiation Computation

The radiation solutions are the potential flow around the vessel when the vessel moves in the otherwise quiescent fluid. The added-mass is defined by the load on the vessel due to its unit acceleration while the radiation damping is the ratio between the load and vessel's velocity. The diffraction solutions are the potential flow around the vessel remaining immobile in incoming waves. The wave excitation loads are obtained by integrating the dynamic pressure on the fixed vessel in incoming waves. For example, the research [3]. With regard to the ship seakeeping prediction Luxury Cruise Ships with forward speed engineers introduce the assumption of low forward speed and use zero forward speed Green function to handle the problems, performed the prediction of relative motion using three dimensional pulsating source Green function with zero forward speed.

The module HydroSTAR solves the problem of diffraction and radiation around fixed and floating bodies and it's based on the following [2]:

- First and second order potential theory of free surface flow;
- Integral equations / boundary element method;
- Efficient evaluation of associated Green functions;
- Elimination of irregular frequencies;
- Independency of the mechanic properties of the system.

B. Numerical Computation

The Numerical computations are simulated in frequency domain by using commercial code Hydrostar, which is developed by BureauVeritas

(BV). Seeakeeping formula is associated with a model for considering the free liquid motion [5].

$$\left[-\left(M + M_a(\omega)\right)\omega^2 - iB_\omega(\omega)\omega + K\right]x = F\omega \qquad (1)$$

ω = Oscillation frequency
M_a = Added-mass
M = Initial matrix of the ship
B_ω = damping Component
K = Stiffness matrix
F = *Excitation load amplitude*
X = Motion amplitude

RESULT AND ANALYSIS

The result at the Froude number 0-0.2 AXE-Bow models have vertical direction relative value higher than Planning Hull Chine models, but on the Froude number 0.4-1.8 models AXE-Bow models have a value of 30-40% relative good vertical direction than the model Planning Hull. This is similar to the research conducted [4] that AXE-Bow hull have the vertical direction is better than conventional models.

Table 4. Operability Crew boat in the sea state of Natuna.

Hs (m)	0.245	0.745	1.245	1.745	2.245	2.745	3.245	3.745	4.245	4.745	5.245	5.745	Total
Operability Model HPC(%)	16.34	32.1	19.44	12.34	7.84	5.73	3.23	0	0	0	0	0	97.02
Downtime (%)	0	0	0	0	0	0	0	1.7	0.55	0.33	0.1	0.04	2.72
Operability Model HPCAB (%)	16.34	32.1	19.44	12.34	7.84	5.73	3.23	1.7	0.55	0	0	0	99.27
Downtime (%)	0	0	0	0	0	0	0	0	0	0.33	0.1	0.04	0.47

Table 4 above provides information that percentage operability crew aboard the ship model boat Planning Hull Chine (HPC) for the year was 97.02% and the time is not the operation was 2.72%, further models planning hull chine AXE Bow (HPCAB) for one year was 99.27% and the time is not the operation is 0.47%. From the comparison of the value of the operability of the model can be known AXE-Bow models have operability high compared to most other models. In other words, in a year (365 days) AXE-Bow models capable of operating for 362.34 days, the model is capable of operating Hull Planning Chine (HPC) models 354.12 days

CONCLUSION

It is concluded that the types of hotel that are possible to be built in Semarang are the boutique hotel and the budget hotel with 2 star, 3 star and 4 star hotel as tourism hotel.

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