Integrative Performance Optimization of Hybrid Monohull Based on Numerical Simulation and Model Experiment

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ABSTRACT

A kind of high seakeeping performance hidden monohull with deep-V section was proposed based on round bilge monohull and a series of semi-submerged appendages with different shapes and dimensions were designed for it. CFD simulation and STF method with viscous correction were used to optimize the integrative performance of deep-V monohull. Then tank model experiment was taken to verify the numerical results. The accordance of experiment results with numerical results indicates that integrative performance of deep-V hybrid monohull outperforms the round bilge monohull further.

KEY WORDS: Deep-V hybrid monohull; resistance; seakeeping performance; CFD; model test.

INTRODUCTION

In recent years, a new form of monohull with semi-submerged appendage was proposed owing to its excellent navigation performance. The performance of resistance and longitudinal motion will greatly improved by rational design of the shape and dimension of the semi-submerged appendage. Deep-V monohull which has excellent performance of seakeeping and stealth compared with the traditional ship with round bilge was proposed. The new scheme was that fixing a streamlined elliptical cross-section semi-submerged appendage to the bottom of bow on monohull with deep-V section.

In this paper, a kind of high seakeeping performance hidden hybrid monohull with deep-V section was proposed based on one ship with round bilge. A series of new design was advised with the semi-submerged appendage of different shapes and dimensions. The numerical simulation of calm water resistance was carried out by CFD and the longitudinal motion was calculated by STF method with viscous corrections. At last tank model experiment was conducted for further optimization of semi-submerged appendage for better integrative performance.

SHIP MODELS AND OPTIMIZATION PROJECT

A ship with round bilge was been select as the parent ship. The model is shown in Fig. 1. The proposed ship with deep-V section after optimization is shown in Fig. 2. The principal dimensions of the two models are given in Table 1. The scaling factor is 1:50.

Fig. 1 Round bilge monohull

Fig. 2 Deep-V hybrid monohull

<table>
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<tr>
<th>Options</th>
<th>Length (m)</th>
<th>Width (m)</th>
<th>Depth (m)</th>
<th>Draft (m)</th>
<th>Displacement (kg)</th>
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<td>R</td>
<td>3.20</td>
<td>0.40</td>
<td>0.28</td>
<td>0.14</td>
<td>94</td>
</tr>
<tr>
<td>V</td>
<td>3.60</td>
<td>0.48</td>
<td>0.28</td>
<td>0.14</td>
<td>114</td>
</tr>
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</table>

Six kinds of semi-submerged appendage were devised for the deep-V monohull to improve its integrative performance, including reduce calm water resistance and improve seakeeping performance. NACA airfoil was designed for the form of semi-submerged appendages. Sketch map of the semi-submerged appendage was shown in Fig. 3. The particulars of the six kinds of semi-submerged appendage are given in Table 2.