Research on the Optimization Design of Trimaran Side-Hulls Location

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ABSTRACT

In recent years, great attention has been paid to the trimaran because of its great navigation performance. Its principal dimensions, hull lines, side hulls location and the allocation of volume displacement between the main hull and side hull have a significant impact on the trimaran performance. In this paper, the author has studied on the optimization design of trimaran side hull location based on the theory of viscosity with the minimum total resistance as the optimization objective, and obtained a scheme of the optimal resistance performance. Results indicate that the optimization method of trimaran side hulls location adopted in this paper is feasible, and this research can provide reference for trimaran hull form design.

KEY WORDS: Trimaran; side-hull position; the total resistance; approximate model.

INTRODUCTION

The trimaran has lots of prominent advantages, like good transverse stability, seakeeping, rapidity, invisibility and flexible layout, which ensure itself a wide range of potential applications. In recent years, research on trimarans has become a promising part of high performance marine technology since applications of them have been gradually increased. It is one of its advantages that the high-speed trimaran can reduce the wave resistance with the wave interference between its main hull and side hulls. However, the resistance components are so complex that it is quite difficult to determine the optimum location of side hulls. Nowadays, research on trimarans mainly centers on predicting wave and wave resistance by using potential flow theory without much consideration of the viscous resistance, or calculating the viscous resistance by using empirical formulas and then discussing the optimization of sidehull layout under favorable interference, while study based on numerical simulation of viscous flow theory is rare. However, those empirical formulas are mostly for monohull, it is apparently not right to apply them to calculate the frictional resistance of trimarans with complex interference. Furthermore, within a certain speed range, the layout of main hull and side hulls will bring about complicated viscous interference as well as affect the wave interference. For trimarans, the viscous resistance also accounts for a large proportion of the total resistance. Therefore, it is extremely significant to predict the viscous resistance of trimarans precisely and apply the result to optimize the ship design.

Based on the trimaran model test and the total resistance as the optimization objective, using viscous flow numerical method considering the free-surface and adopting the neural network approximation model instead of the time-consuming numerical calculation, the paper has an research on the optimization of side hull location and obtains a feasible optimization method.

OPTIMIZATION PROCESS

In this paper, with the longitudinal and transverse location of side hull as the optimization variables, the total resistance as the optimization objective, Ship form sample plans are generated by uniform experimental design method, and then the total resistance of each sample scheme is obtained using viscous flow numerical calculation method. According to the results, the approximation model between design variables and the optimization goal is set up by the artificial neural network. Finally, using the approximate model instead of numerical calculation and adopting the non-dominated sorting genetic algorithm (NSGA II) for optimization research, we can get the scheme of the trimaran side hulls location of the optimal resistance performance. The optimization process is as follows: