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Experiment and Numerical Study on Gliding-hydrofoil Craft Rapidity

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ABSTRACT

In this paper, a new type of high-speed craft with better performance Gliding-Hydrofoil Craft (GHC) has recently been developed in Jiangsu University of Science and Technology, China. Then a fiberglass gliding-hydrofoil craft is designed and built. Experiment method is chosen to study the rapidity of GHC. The experiment measurements show the rapidity of gliding-hydrofoil craft is improved. Meanwhile, one case of GHC is run with software FLUENT, the results show this software is fit for studying the hydrodynamics of surface ship.

KEY WORDS: Gliding-hydrofoil craft; rapidity; ship experiment; FLUENT

INTRODUCTION

With the development of marine transport, greater number of high-speed craft are being designed and operated widely. There are many applications for high-speed craft, such as the increasing requirement for high-speed craft from the maritime transport and offshore industry, because of the high speed and low cost of these types of vessels. Particularly in deeper seas where large-scale helicopter operations become expensive, high speed craft are more advantageous. In addition, the military's requirement for high-speed craft is also increasing. In many cases, military crafts need to run at high speed to fulfill their mission even in bad sea conditions. Therefore, development of a high-speed craft for a seaway is a new challenge that is being demanded from the naval architects of today. This requires further research and investigation of various high-speed vessels.

There are a wide variety of high-speed vessels in use, such as hydrofoil-supported vessels (e.g. hydrofoil craft, as shown in Fig.1.1.a) and submerged hull-supported vessels (e.g. planing craft, as shown in Fig.1.1.b).

A planing hull craft is a high powered water-craft and is typically a submerged hull-supported vessel. Theoretical research on steady planing dates back to the early of 1930's. Compared with traditional displacement type vessels, planing crafts are more complicated. So, planing problems have been approximately solved by applying the basic assumption of zero-gravity, zero-viscosity and zero-compressibility. Some examples of these approaches via 2-D impact solution and slender body theory are Tulin (1957), Cointe (1991), Zhao&Faltinsen (1996), Vorus (1996), Savander (1997). Royce and Vorus (1998), and Royce (2001). Lai & Troesch (1996) performed a 3-D lifting surface solution for planing but it relied on 2-D predictions (Vorus, 1996) for the position of the jet-head boundary.

(a) Hydrofoil craft in waves
www.hydrofoils.org/Star/star.html

(b) Planing craft in waves
http://www.defenseindustrydaily.com/
Fig. 1 High-speed crafts in waves

Hydrofoil craft are hydrofoil-supported vessels with either fully submerged or free surface-piercing foils. The hydrofoils provide lift forces to support the weight of the craft. Johnston (1985) pointed out that important aspects when selecting foil and strut configurations of hydrofoil craft. A vortex-lattice method for a non-cavitating hydrofoil of finite-span under linearized free surface condition was presented in Thiart (1997). The two-dimensional hydrofoil problem without cavitation was also modeled and solved by Kelvin type of singularities in Bal (1999a). On the other hand, the flow around cavitating three-dimensional hydrofoil beneath a free surface has been modeled by Kelvin and Rankine type of singularities, in Lee et al. (1992) and Bal et al. (2001), respectively. Linearized free surface condition has been used in both studies. The iterative boundary element (panel) method for the solution of this problem was described in detail in (Bal and Kinnas, 2000) and (Bal and Kinnas, 2002). The method was extended to include the walls of (numerical) wave tank and the second-order free surface effects into the calculations in Bal (2001). The method was also applied to cavitating swept and V-type hydrofoils and some design figures were given in Bal (2005).