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A comparison study on the deck house shape of high speed planing crafts for air resistance reduction

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ABSTRACT: *Planing crafts were specifically designed to achieve relatively high speeds on the water. When a planing craft is running at high speed, dynamic pressure on the bottom makes the boat rise on the surface of the water. This reduces the area of the sinking surface of the boat to increase air resistance. Air resistance means the resistance that occurs when the hull and deck house over the surface of the water come in contact with the air current. In this paper, we carried out a CFD numerical analysis to find optimal deck houses that decreased air-resistance on the water when planing crafts are running at high speed. We finally developed the deck house shape of high-speed planing crafts that optimally decreased air resistance.*

KEY WORDS: Air resistance; Planing crafts; Deck house; Computational fluid dynamics (CFD); Resistance reduction.

NOMENCLATURE

B	Breadth	VOF	Volume of fluid
D	Depth	C_T	Total resistance coefficient
R	Total drag resistance	S_1	Wetted surface area
F_i	An external force	S_2	Upper deck surface area
g_i	Gravitational acceleration	S_3	Total surface area
LOA	Length overall	u_i	The speed of the fluid
P	Pressure	$\overline{u_i' u_j'}$	Reynolds stress
R	Total resistance	ρ	The density of the fluid
t	Time	μ	The viscosity of the fluid

INTRODUCTION

The number of people enjoying marine leisure activities has been rapidly increasing in Korea owing to a rise in GNI and the introduction of the five-day workweek. As a result of this, the demand for ships as a major mean for marine leisure activities, therefore, has been continuously increasing. Furthermore, the government recognized the importance of the marine leisure industry and has tried to foster it as a new growth engine so that it can create added value for associated industries and success-

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fully accomplish the national policy of 'low-carbon green growth'. High speed leisure boats, the key equipment for marine leisure activities, include two kinds: planing crafts and hydrofoil boats that can reach high speed by dynamic methods, while hover crafts are typical boats that can reach high speed by static methods (Lee and Lew, 2003). The major fluid dynamic feature of high speed planing crafts that occupy more than 80% of all the high speed boats is as follows: dynamic pressure between the hull and the surface of the water makes them rise to the surface of the water, reducing air resistance and makes them run at high speed (Park et al., 2012; Savitsky, 1964). Then, the dynamic pressure also generates trim and changes the running posture, giving a large effect to major performance of the planing crafts (Park, 2008). On the other hand, when the planing craft is running, the wind passing by it gives both friction and buoyancy; and the air friction resistance by the wind passing by the deck house increases the resistance of high speed planing crafts, acting as a cause of decreasing the speed of boats. Most research on resistance reduction for planning leisure boats have concentrated on reduction of wave resistance through the optimization of the hull and of frictional resistance by decreasing the area of sinking surface below the water (Park et al., 2012). However it has been known that a large portion of total resistance at the high speed occurs above the water as air resistance. According to CFD numerical results and wind tunnel tests, when speed planning crafts are running with 30 *kts* and 1-4 degrees of trim, air resistance occupies up to 30% of total resistance (Kim and Hwang, 2010; 2013)

This paper deals with the development of deck house shapes that optimally decreases air resistance above the water when planning crafts are running at high speed. We carried out CFD numerical analysis for four types of deck houses to find deck houses of high-speed planing crafts that optimally decrease air resistance.

AIR RESISTANCE REDUCTION PLANING CRAFTS

Design of hull forms

High speed planing crafts have the hull made of FRPs and their design speed is 40 *knots*. They have multiple chines of the V shape to smoothly run even when the tide is high; they are designed to have a high stem for excellently breaking waves even when the tide is extremely high. A major feature of the hull of high speed planing crafts is their straight body to decrease resistance at high speed and to reduce shock load when tide is high (Jang et al., 2010; Katayama and Ikeda, 1996; Savitsky, 1981). To reduce the shock load by stripping the bottom and to improve dynamic performance, two spray strips of triangular shape are attached to the left and right sides of the bottom, respectively (Tanaka, 1991). Table 1 shows the principal particulars of the planing hull, the subject of air resistance reduction, and Fig. 1 shows lines.

Table 1 Principal particulars of high speed planing hull.

LOA (*m*)	Lpp (*m*)	Bwl (*m*)	Depth (*m*)	Engine power	Persons
8.76 *m*	7.24 *m*	2.40 *m*	1.20 *m*	250 *hp*	6~8

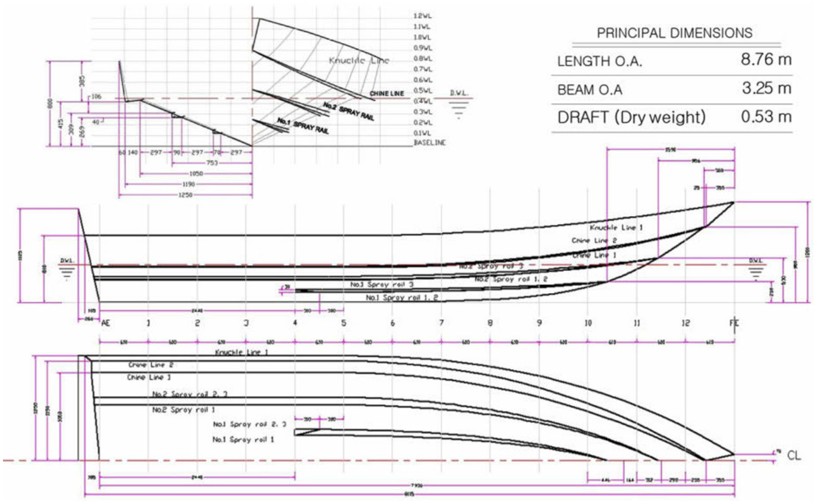

Fig. 1 Lines of the high-speed planing hull.