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Review

Reducing air resistance acting on a ship by using interaction effects between the hull and accommodation

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ABSTRACT

A study on saving energy as well as reducing resistance acting on a ship is important in maritime transportation. In this study, we present a study on reducing air resistance acting on a ship by using interaction effects between hull and accommodation. Firstly, we apply CFD tool to determine air resistance acting on the hull and the accommodation of the ship separately. Simulation result of air resistance then is compared with experimental data to validate the accuracy of the CFD. Secondly, air resistances acting on the ship with the accommodation as a whole system is computed. The results demonstrate that the interaction effects between the hull and the accommodation can be applied to reduce the total air resistance.

Contents

1. Introduction

Matumoto et al. (2003) and Nihei et al. (2008) studied on keeping a ship as Pure Care Carrier (PCC) safety in strong wind at ballast condition and reducing resistance acting on the original ship. The authors suggested a new hull design which total resistance reduced by 15% at wind speed 14 m/s and 22% at wind speed 10 m/s accordingly. A study on the influent of wind is very important in studying the effect of wind on the ship motion to avoid risks of collision and grounding. In other study, presented by Fujiwara et al. (2009), wind force acting on container ship has been investigated experimentally. The aerodynamic characteristics on various types of external forms of the container ships were investigated in wind tunnel with a 1.5 m block model. A new method for estimating wind force coefficients of container ship had been proposed in this regards. In other study presented by Sugata et al. (2010), reduction of wind force acting on a non-ballast ship had been focused. A new type of model of the non-ballast ship which helps to reduce 44% of wind force in full loaded condition and by 33% of wind force in the nonballast condition have been reported.

In studies published by Mizutani et al. (2013), the authors presented a study on reducing air resistance acting on a hull of the chip

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carrier by using commercial Computation Fluid Dynamic (CFD) software, "ANSYS-Fluent". As the results, the authors had suggested a new design for accommodation and hull. The modeling results showed that air resistance on the hull and the accommodation of the ship can be reduced by interaction effects. Measurement of air resistance acting on the ship was carried out in a towing tank of Osaka Prefecture University (OPU). The obtained results show that the new hull and accommodation can reduce the total air resistance from 2% to 15%. The data is in agreement with modeling results. In our previous paper He and Ikeda (2013), the authors proposed an optimal accommodation shape made of only flat plates, which reduces air resistance drastically. It was also showed that interaction effects on air resistance between hull and accommodation were significantly reduced. Mizutani et al. (2014) studied on effects of cargo handling equipment on wind resistance acting on a wood chip carrier by using both CFD simulation and experiment. The study concluded that total air resistance of ship can be reduced by 10%. The modeling results were also in good agreement with the experimental data. In this paper, interaction effects of a hull and an accommodation on air resistance are investigated in more detail to find a method to reduce air resistance acting on a ship by using interaction effects between the hull and the accommodation on its deck.

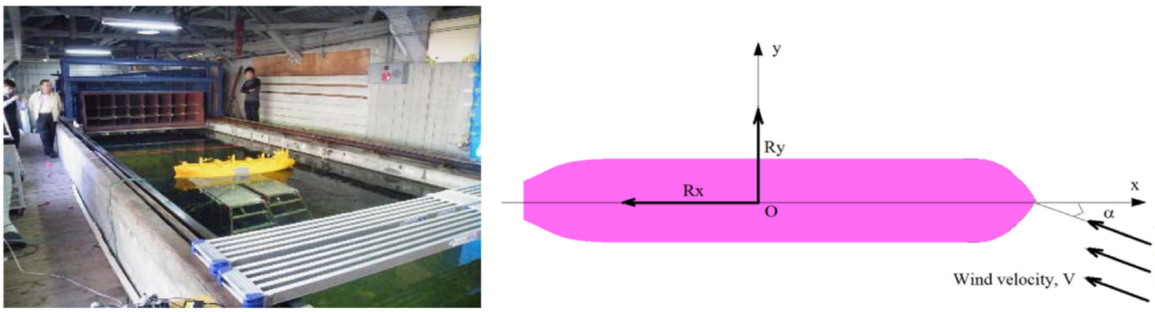

Fig. 1. Experimental views and coordinate system.

Table 1
Principal particulars of model.

Name	Description	Model	Unit
L	Length	1.60	m
B	Breadth	0.282	m
H	Depth	0.171	m
d	Draft	0.0485	m
C_b	Block coefficient	0.774	–
V	Wind velocity	14.50	m/s
α	Wind attack angle	0–180	deg

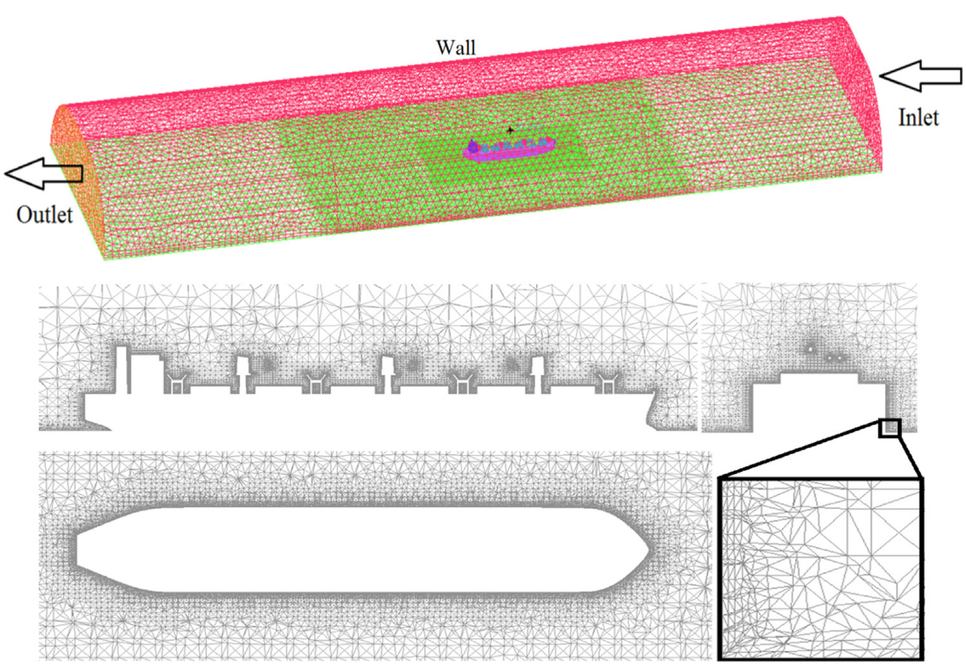

Fig. 2. Computational domain and mesh.