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Focused Wave Interaction with Floating Structures by Virtual Boundary Force Method

Lin Cheng and Jinhai Zheng
Key Laboratory of Coastal Disaster and Defence, Ministry of Education, Hohai University
Nanjing, Jiangsu, China

Hanbin Gu
School of Architecture, Civil and Environmental Engineering, Ningbo University
Ningbo, Zhejiang, China

Xiwu Gong
School of Naval Architecture & Mechanical-electrical Engineering, Zhejiang Ocean University
Zhoushan, Zhejiang, China

Dandan Chen
College of Flight Technology, Civil Aviation Flight University of China
Guanghan, Sichuan, China

The CCP-WSI Blind Test Series 3 have been conducted by an in-house code NEWTANK, which is a robust model solving NS-type equations by the finite difference method using the VOF method to track free surface, combing the virtual boundary force (VBF) method to simulate floating structures. In this study, the focused wave is first simulated and compared with experimental data obtained from the Coastal Laboratory at Plymouth University. Then, two kinds of tests of the floating structures under the focused wave are simulated. Float size and simulation status are the same as the experimental settings in the laboratory. Results are analyzed and compared with experimental data. Based on the reliable numerical model, this paper would supply a reasonable solution to the relevant issues of wave interaction with floating structures.

INTRODUCTION

A special session titled CCP-WSI (Collaborative Computational Project in Wave Structure Interaction) Blind Test 3 was held in the ISOPE-2019 conference, which aims to supply experimental data to compare different numerical models, in order to improve related simulation techniques, to validate models, and to deepen understanding of physics in the computational fluid dynamics community. In the Blind Test 3, focused waves are generated, and focused wave interaction with a hemispherical cylinder and a moon-pool cylinder are simulated in the COAST Laboratory Ocean Basin at Plymouth University, UK. Figure 1 shows the details of the ocean basin used in the experiment. Flap-type wave makers are applied to generate waves with water depth of 4.0 m and mounted at a position with water depth of 2.0 m at still water level. The basin bottom has a slope with water depth from 4.0 m to 3.0 m at the wave-making end. A constant water depth of 3.0 m with length of 14.0 m is used for the focused wave, formed at a distance to the wave maker of 14.8 m. Floating cylinders are moored with their vertical axis at focusing position at still water level. There are 13 wave gauges set in experiment with No. 5 at focusing position, as shown in Fig. 2.

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KEY WORDS: Focused wave, floating structure, VBF, NS equations, numerical simulation.

Two kinds of cylinder floats are adopted in the experiment. Figure 3 shows details of the hemispherical cylinder, and its parameters used in the test are listed in Table 1. Figure 4 shows details of the moon-pool cylinder, and its parameters are listed

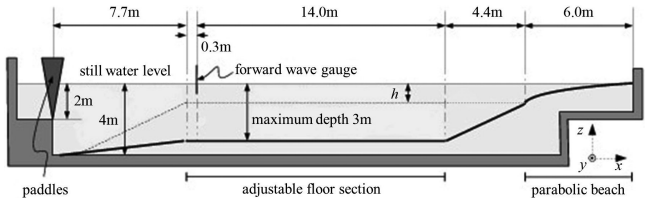

Fig. 1 COAST Laboratory Ocean Basin dimensions (CCP-WSI, 2019)

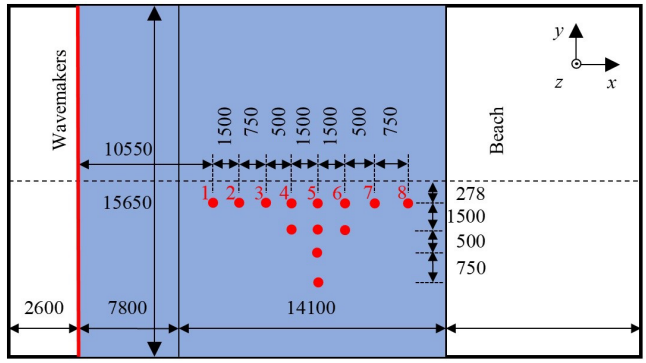

Fig. 2 Wave probe layout (Unit: mm) (CCP-WSI, 2019)