CALCULATION METHOD OF UPLIFT FORCES AT PIER BASED ON GAS-LIQUID PHASE FLOW MODEL

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INTRODUCTION

Seaside facilities such as pier are affected by uplift forces due to storm surge and waves caused by typhoons. Therefore, detailed knowledge of external force is required for designing the pier (Tanimoto et al., 1978). Previously, the elucidation of the uplift forces and the shock wave pressure has been a major issue. Indeed, it has been clarified by experiments. Bagnold (1939) conducted an experimental study for revealing the relationship between the air layer and the pressure value, and found that air, which is a compressible fluid, reduces the pressure value. Furthermore, air has the effect for prolonging the action time. Arikawa and Yamano (2009) conducted the numerical simulation of shock breaking wave pressure by considering the inclusion of gas, and it was shown that the shock wave pressure after breaking wave can be reproduced. However, there are few cases that numerical calculation is considered for phenomena such as lifting pressure that are greatly affected by air. In this research, reproduction calculation of experiment was performed using numerical calculation for incompressible fluid. In addition, we will make a hole in the slab for calculation and investigate how the uplift forces changes.

EXPERIMENT OUTLINE

we installed a model of a 1/40 scale jetty in a cross-section water tank of length 36 (m) × width 0.5 (m) × height 1 (m) for our experiment (Fig 1). There is a space of 5 cm between both ends of the waterway wall and the floor slab. The experiment was performed under the conditions that the incident wave height is 0.04 (m) and 0.08 (m), and its period is 0.96 (s).

CALCULATION MODEL

In this study, we used a gas-liquid phase flow model (CADMAS-SURF/3D-2F). The basic equations are extended from the continuous equation and Navier-Stokes equation for 3D incompressible viscous fluids based on the porous model. In addition, a function that can consider the compression effect of the gas phase is introduced. This model employs a hybrid scheme that includes two weighted average methods: Euler method and SMAC method. The calculation grid size was set to 1.0 cm in the z direction at the bottom of the floor slab, and 2.0 cm in the x.y.z direction at other locations.

CONCLUSION

By the numerical calculation that introduced the calculation flow of the difference scheme according to the fluid volume fraction, the reproduction calculation of the uplift forces in the hydraulic model experiment was performed. As a result, the reproducibility was insufficient in many cases. However, it was possible to grasp the change of the momentum of the fluid in the numerical calculation for the incompressible fluid. In addition, we were able to capture the change in uplift forces due to the holes in the floor slab. If reduction of calculation time can be realized, it can be applied in design practice. As future tasks, it is possible to further improve the reproducibility of the experimental results and to elucidate the mechanism for considering the influence of compressibility.

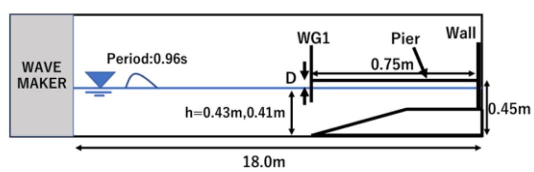

Figure-1 Overall view of the experiment

(WG1: Wave height meter, D: Clearance, h: Water level)

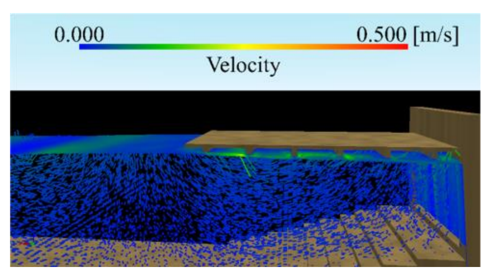

Figure-2 calculated flow velocity near the pier

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