VERIFICATION OF IMPULSIVE WAVE PRESSURE DUE TO SOLITARY WAVES BASED ON TWO-PHASE FLOW SIMULATOR

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INTRODUCTION

One of the effective protection facility against a huge tsunami is a seawall. The wave force of tsunami acting on such a seawall has been studied by many researchers so far. According to Takahashi et al. (1983), it is important to consider the following two factor for prediction of impulsive wave pressure. One is the angle between the wave front and the wall, and the other is compressibility of air. On the other hand, establishment of prediction method using numerical simulation has been attempted. As mentioned above, it is important to calculate the angle between the wave front and the wall, and in order to predict impulsive wave pressure accurately, a computational model which can treat complex interface deformation is necessary.

In this study, we analyze wave pressure of solitary waves using gas-liquid two-phase simulator and examine its applicability. And also, we examine computational efficiency and speed of its simulator.

NUMERICAL MODEL

We used CADMAS-SURF/3D-2F developed by Arikawa et al. (2009). In this simulator, the density of the cell at the interface between liquid phase and gas phase is expressed as mixed density. Mixed density represented by volume fraction of fluid and density of each fluid. The governing equations are the continuity equation and the Navier-Stokes equations. The terms are added to each equation in consideration of the temporal change of gas phase density. For comparison, we used the result of hydraulic model experiment conducted by Arikawa (2015) and CADMAS-SURF/3D which is liquid single-phase simulator. Calculation area and measurement points are shown in Figure 1. In numerical calculation, the same lattice condition is used for both simulators.

NUMERICAL RESULTS

Figure 3 and 4 show time series of water level (WG2, WG8). They are in good agreement with experimental data both single-phase and two-phase simulator. The time series of wave pressure is shown in Figure 6 (PG1). Both simulators can reproduce impulsive pressure. Moreover, continuous pressure after impulsive pressure occurs can be reproduced by two-phase simulator. The reason why continuous pressure could not be reproduced by single phase simulator is that it cannot treat the influence of air trapping as shown in Figure 2.

CONCLUSIONS

Conclusions are as follows:

(1) Both of single-phase and two-phase simulator could reproduce impulsive wave pressure;
(2) In two-phase simulator, it was possible to confirm improvement of computational accuracy by applying upwind difference to gas phase region and difference scheme corresponding to the volume fraction of the fluid of each cell to the gas-liquid mixing region.

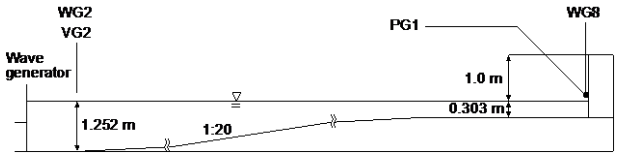

Figure 1 - Calculation area and measurement points


Figure 2 - Trapped air between wave front and wall

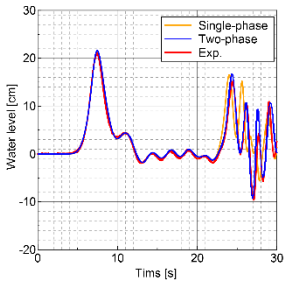

Figure 3 - WG2

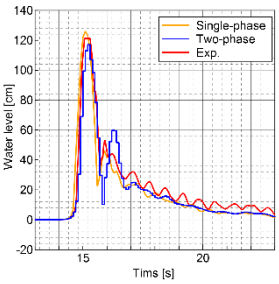

Figure 4 - WG8

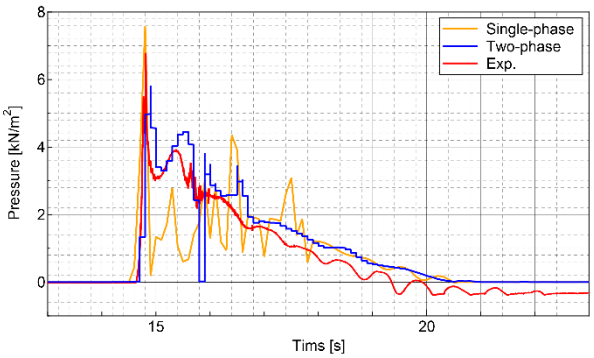

Figure 5 - PG1

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