CFD Modeling of Fully Nonlinear Water Wave Tank

In this study, we use CFD simulations to model a fully nonlinear water wave tank. Firstly, for validation purpose, regular waveswith different wave steepness are simulated and the results are compared with the second-order potential flow solution for the free surface displacement time history at fixed locations, the instantaneous free surface spatial profiles, and the velocity and pressure fields under the free surface. It is shown that for small wavesteepness, the CFD solutions agree very well with the second-orderpotential flow solutions while for large wave steepness, apparent differences between these two solutions are observed. The validation and fully nonlinear feature of the CFD solutions are therefore demonstrated. Secondly,plunging breaking waves are simulated using the CFD wave tank by focusing a large number of linear wave components at a prescribed time and location. The time histories and normalized variance of free surface displacement at various locations along the tank are obtained from the CFD simulation and compared to the lab experiments. In particular, the CFD results predict reasonably well the wave breaking location and the loss of energy flux due to wave breaking. Finally, a vertical circular cylinderis placed in the CFD wave tank to simulate the breaking wave impact on a fixed structure. The pressure time histories at various points on the cylinder surface are obtained for several cylinder locations with respect to the prescribed wave breaking point. The CFD results are compared with previous experiments and discussed.

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