Geophysical Research Abstracts
Vol. 18, EGU2016-8756-4, 2016
EGU General Assembly 2016

3D Numerical Simulation on the Sloshing Waves Excited by the Seismic Shacking

Lin Zhang and Tso-Ren Wu

Graduate Institute of Hydrological and Oceanic Sciences, National Central University, Taoyuan, Taiwan
(zhanglin09hk@gmail.com)

In the event of 2015 Nepal earthquake, a video clip broadcasted worldwide showed a violent water spilling in a hotel swimming pool. This sloshing phenomenon indicates a potential water loss in the sensitive facilities, e.g. the spent fuel pools in nuclear power plant, has to be taken into account carefully under the consideration of seismic-induced ground acceleration.
In the previous studies, the simulation of sloshing mainly focused on the pressure force on the structure by using a simplified Spring-Mass Method developed in the field of solid mechanics. However, restricted by the assumptions of plane water surface and limited wave height, significant error will be made in evaluating the amount of water loss in the tank.
In this paper, the computational fluid dynamical model, Splash3D, was adopted for studying the sloshing problem accurately. Splash3D solved 3D Navier-Stokes Equation directly with Large-Eddy Simulation (LES) turbulent closure. The Volume-of-fluid (VOF) method with piecewise linear interface calculation (PLIC) was used to track the complex breaking water surface. The time series acceleration of a design seismic was loaded to excite the water. With few restrictions from the assumptions, the accuracy of the simulation results were improved dramatically. A series model validations were conducted by compared to a 2D theoretical solution, and a 3D experimental data. Good comparisons can be seen. After the validation, we performed the simulation for considering a sloshing case in a rectangular water tank with a dimension of 12 m long, 8 m wide, 8 m deep, which contained water with 7 m in depth. The seismic movement was imported by considering time-series acceleration in three dimensions, which were about 0.5 g to 1.2 g in the horizontal directions, and 0.3 g to 1 g in the vertical direction. We focused the discussions on the kinematics of the water surface, wave breaking, velocity field, pressure field, water force on the side walls, and, most importantly, the amount of water loosed in the event. The simulated water movement excited by the seismic acceleration was visually similar to the video clip mentioned before. From the simulation results, we observed that the water was mainly leaked at the corner of the water tank with a nonlinear curve of the free-surface. This phenomenon can't be found in the conventional studies with acceleration in a sole direction. We also studied the effect from a porous body placed on the lower part of the tank. Detailed results and discussion will be presented in the full paper.

Keywords
Sloshing, Splash3D, LES, Breaking waves, VOF, spent fuel pool, Nuclear power plant