Particle Simulation considering the Sand-Scale-Effect for Scour behind the Breakwater due to Tsunami with Hydraulic Experiment

Naoki Tsuruta [1], †*Kojiro Suzuki[2], and Tsukasa Kita[4]

[1,2,3] Coastal and Ocean Engineering Research Division, PORT & AIRPORT RESEARCH INSTITUTE, Japan.

*Presenting author: Suzuki_k@pari.go.jp
†Corresponding author: Suzuki_k@pari.go.jp

Abstract

In Japan, the design concept of breakwaters have been changed from the 2011 off the Pacific coast of Tohoku earthquake with subsequent huge tsunami. To buy time for evacuation of people, the coastal structures requires the resilience against even huge tsunamis. Regarding the suffering process, scouring behind the caissons by the overflow is one of the main cause of their failure. Therefore, for effective design of the coastal structures against tsunamis, accurate evaluations of the scouring is essential. However, it is difficult to implement many hydraulic experiments due to cost, labour, time and other factors. Consequently, the numerical simulation is expected to be a substitute for the experiments. Huge tsunamis include violent flows, good robustness should be kept in the numerical model. As a numerical wave flume, particle method is a widely applied to practical engineering problems. The particle method is a fully Lagrangian method, and thus, it can avoid the numerical diffusion thanks to its numerical process with omission of the advection term. As a result, it has a good robustness for tracking violent flows including a large deformation of free surface, such as breaking waves. Although the particle method originally had a problem pressure noises, the numerical stability and accuracy has been enhanced by development of the so-called accurate particle methods. Additionally, since the particle method is based on the Lagrangian tracking through the moving particles, it is easy to implement the scouring simulation, which consists of moving boundaries. Herewith, the particle simulation is implemented to examine the scouring process under the overflow by huge tsunamis. To verify the performance, hydraulic experiments are also performed. As for numerical model, here, the CISPH-HS-HL-ECS is applied. In the particle simulation, bigger sand particles are used to save the numerical cost. In order to keep the consistency of the behavior of the suspended sediment between the numerical simulation and the experiment, this study considers the scale effect of sand using Ruby's falling speed equation.

Fig.1 Scour experiment

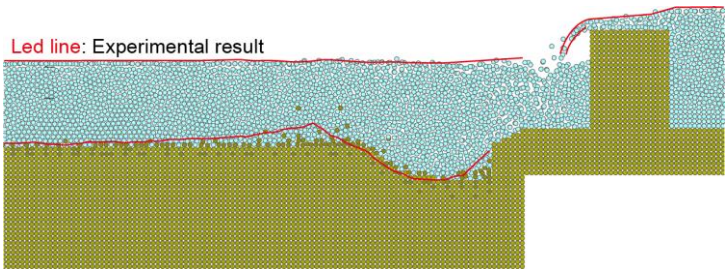

Fig.2 Particle simulation of Scour due to a Tsunami

References

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