Numerical Experiment on Effect of Sand Grain Size and Wave Reflection for Tsunami Deposits Compared with Experimental Hydraulic Data

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The underestimation of the 2011 Tohoku tsunami caused severe damage in coastal areas. A re-evaluation of tsunami estimates is needed, which requires information on paleo-tsunamis. Historical records on large tsunamis are limited, because they occur infrequently. The study of paleo-tsunamis focuses on tsunami deposits, because they may contain several tsunami records. However, analysis of tsunami deposits cannot provide estimates of the tsunami source and its magnitude. Takahashi et al. (2000) proposed a model of movable bed conditions to simulate tsunami sediment transport. This model was applied to Kesennuma Bay using data from the 1960 Chilean tsunami; however, the amount of sand transportation was underestimated. Yamamoto et al. (2016) carried out a hydraulic experiment that measured accurate flow velocity and the amount of sand deposited under several wave and sand conditions in the tsunami run-up. This experiment used six types of uniform sand and mixed sand. The results showed that the deposition range varied with the sand grain size and based on the wave conditions. Furthermore, based on these data, Yamamoto et al. (2017) improved the validation accuracy of the Takahashi et al. (2000) model. However, it was not able to reproduce the sand deposition distribution of each grain size, or to solve the underestimation of the amount of sand transport. In addition, this validation focused on uniform sand conditions only.

To reproduce a more accurate distribution of sediment transport, Takahashi et al. (2011) proposed another model that focused on sand grain size. They carried out a hydraulic experiment using three types of sand and proposed different coefficients of motion equation depending on grain size. However, this model was limited to three grain sizes and specific flow conditions. Therefore, this current study calculated the Takahashi et al. (2011) model for various grain sizes and mixed sand conditions, and compared the results with the experimental hydraulic data of Yamamoto et al. (2017). In addition, we studied the effect of the cut-off wall that produces a reflected wave. The results showed that the amount of sand deposited generally corresponds with the hydraulic experiment, although the local-scale distribution differed in several places. The amount of sand deposits was underestimated near the shore. Conversely, the amount of sand deposits was overestimated near the run-up front. The sand deposit peak moved toward the run-up front compared with the hydraulic experiment.

Keywords: Numerical experiment, Hydraulic experiment, Uniform sand, Mixed sand

