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Evaluation Method of Tsunami Wave Pressure Using 2D Depth-Integrated Flow Simulation

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Abstract

To design and construct land structures resistive to tsunami force, it is most essential to evaluate tsunami pressure quantitatively. As for the design of buildings against tsunami force, the guidelines for tsunami evacuation buildings are the unique technical information at present. In the guidelines, the tsunami force is considered to be equivalent static water pressure of 3 times of the inundation depth without building. In case that tsunami run-up simulation considering individual buildings is conducted, it is also necessary to calculate inundation depth without building in order to estimate tsunami force by using the existing hydrostatic formula. This study aims at proposal of estimation method of tsunami wave pressure using inundation depth and horizontal velocity at the front of the structure.

Hydraulic experiments were conducted to estimate tsunami wave pressure acting on several different types of land structures and examine the influence of a seawall in front of the structure on tsunami wave pressure. The experiment was carried out in a flume measuring 18.0m in length, 0.5m in width and 0.5m in height. A gate was installed near the upstream section of the flume in order to impound a specified depth of water. Tsunami was generated by lifting the gate. As the wall at the downstream end of the flume is removed, flows can pass through there without accompanying any reflecting phenomena. In the flume, the sea bottom model and land model were installed. The land model consisted of upright seawall and flat land. Land structure was placed alone at 1.0m or 2.0m downstream from the seawall. Wave pressures were measured at some points on the structure. A capacity-type wave gage and a propeller-type current meter were used to measure inundation depth and flow velocity, respectively. The existing hydrostatic formula, in general, tended to underestimate tsunami wave pressure under the condition of inundation flow with large Froude number.

Estimation method of tsunami pressure acting on a land structure was proposed using inundation depth and horizontal velocity at the front of the structure, which were calculated employing a 2D depth-integrated flow model based on the unstructured grid system. The comparison between the numerical and experimental results revealed that the proposed method could reasonably reproduce the vertical distribution of the maximum tsunami pressure as well as the time variation of the tsunami pressure exerting on the structure.