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Numerical Study on Damage of Tsunami Evacuation Building under Tidal Wave and Debris Impact

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Robustness of a tsunami evacuation building is one of the most important problems in protecting lives and properties against tsunami. To ensure robustness, it is necessary to design with consideration of strict external forces, including dynamic fluid force and debris impact force, caused by tsunami.

In this research, we numerically simulate behaviour of a tsunami evacuation building under tidal wave and debris impact to investigate trend of the forces due to tsunami. Partitioned fluid-structure interaction analysis scheme coupled with stabilized ISPH (Incompressible Smoothed Particle Hydrodynamics) method [1] and ASI (Adaptive Shifted Integration)-Gauss method [2] is applied for the simulation. The ISPH method is a semi-implicit particle method and suitable for free surface flow problem such as tsunami. The ASI-Gauss method is a finite element method using linear Timoshenko beam elements and can express a plastic hinge at any position in an element by shifting a numerical integration point. Besides, improved ERP (Explicitly Represented Polygon) wall boundary model is used as interface modelling between fluid and structure domain. This model accurately satisfies boundary conditions on solid walls and can directly calculate fluid force exerted on the walls.

As validation of the proposed FSI coupling scheme, we solved free fall problem of a beam member and dam break problem with an elastic obstacle. Results of these analysis showed that the coupling scheme can obtain precise solution. Furthermore, we conducted a simulation of a tsunami evacuation building under tsunami and debris. Specification of the building was determined according to current tsunami evacuation building design standard in Japan [3]. Based on the results, damage of the building caused by tidal wave and debris impact was verified.

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