ACCURATE PREDICTION OF TSUNAMI FORCE FOR EFFECTIVE DESIGN OF BREAKWATER

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INTRODUCTION

In 2011, the off the Pacific coast of Tohoku earthquake with subsequent huge tsunami caused serious damages to many breakwaters. The damage process mainly comprises their slide or toppling over by the overflowing tsunami, whose typical cases can be seen in *Soma* and *Kamaishi* ports. In order to save the people as long as possible, it is necessary to design breakwaters effectively with keeping their resilience particularly against such an overflow of a huge tsunami. As the first step to the goal, the pressure force of the overflowing tsunamis should be predicted accurately, however, its feature remains unknown due to its complicated mechanisms. Regarding *the Japan guideline of breakwater against tsunami*, it introduces an estimation formula based on the static pressure with compensating coefficients α_f and α_r for the foreside and backside of the target breakwater, respectively, as shown in Figure 1. The compensating coefficients are set with semi-empirical values as α_f=1.1 and α_r=0.9. However, in recent years, it was found that the coefficient α_r randomly varies depending on the hydraulic conditions (Arikawa et al., 2013), and to make matters worse, the variation appears more significant by changing the structure of the target breakwater, i.e. the condition of the mound under the caisson and the parapets above the caisson (Miyata et al., 2014). Therefore, improvement of the estimation method should be required as an urgent subject. In order to resolve this problem, this study performs hydraulic experiments targeting breakwaters under tsunami-overflows with focusing on the effect of the property of the mound, which has insufficient studies. From the results, an effective estimation method for the compensating coefficient α_r is newly proposed by reconsidering the coefficient as a dynamic parameter covering the various boundary conditions.

EXPERIMENT AND PROPOSED METHOD

The experiments are implemented by using a flume with 105m in length and 0.8m in width (2.2m in width for a sub-flume). The target tsunamis are reproduced by uniform flows, which are circulated by a pump through the main and sub flumes. Here, plural breakwaters are prepared in order to consider the changeable property of the tsunami force by the structures as: i) impermeable mound, ii) permeable mound, iii) permeable mound with additional permeable mound, respectively. Figure 2(a) shows a relation between a traditional arranged-parameter d^* (=d'/d), which was proposed by Arikawa et al. (2013), and the coefficient α_r. In similar to the existing studies, it is shown that the coefficient α_r varies dispersively in a wide range as the arranged parameter d^* goes larger. The arranged-parameter d^* is composed of a water level d_2 behind the target structure, which is

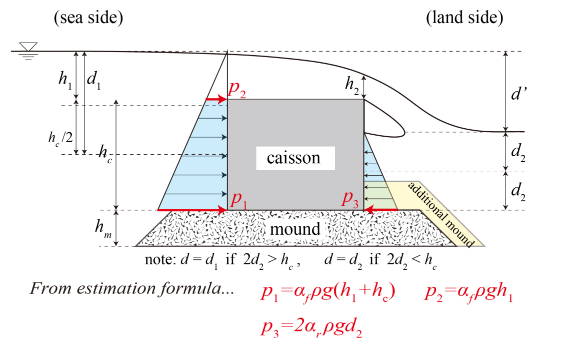

Figure 1 - Presented formula of overflowing tsunami force.

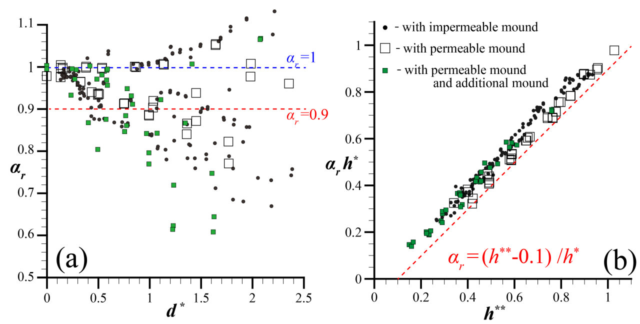

Figure 2 - Arrangement of coefficient α_r.

generally defined by a water height at a position apart from the landing-point of the overflow on the water. In fact, the water level easily perturbates by the overflows particularly around the vicinity of the structure. Therefore, the effect of the overflow should be considered for enhancement of accuracy of estimating the coefficient α_r. Here, we introduces a new arranged-parameter h^{**} so that it comprises an argument related to the landing-point of the overflow. Figure 2(b) shows a relation of the proposed arranged-parameter h^{**} and the coefficient α_r. It can be recognized that the scattering of the plots is effectively suppressed for all the cases i), ii) and iii). And from an asymptote of the plots, a unified approximation of the dynamic coefficient α_r is gotten as shown in Figure. 2(b).

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