AN EXPERIMENTAL STUDY ON WAVE RUNUP ON QUAY TOP AND ITS REPRODUCTION BY USING A BOUSSINESQ-TYPE WAVE MODEL

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INTRODUCTION

Ports and coastal industrial and commercial regions in Osaka bay were inundated with water due to storm wave overtopping during Typhoon Jebi passing through on September 4, 2018. Although the large storm surge was observed at the end of the bay, the sea level rarely rises over seawalls which prevent sea water from intruding onto residential areas, fortunately. Therefore, in this study, the characteristics of wave runup over the gap between berthing depth and quay top in high, normal and middle tide condition are investigated with vertical 2D model experiments. Moreover, numerical simulations are conducted by using a Boussinesq-type wave model, which can be also applied to wave overtopping and inundation in horizontal 2D computational region, to reproduce the results of model experiments.

MODEL EXPERIMENTS IN A FLUME

Fig. 1 shows the quay model of which length is 3m, height from the flume bottom is 0.60m and top floor gradient is 1/10. The sea levels are set at the same to quay top (middle) and 0.08m below (normal) and above (high), respectively. The model scale is assumed as 1/25. Table 1 shows the offshore wave conditions which consists of 4 kinds of wave steepness H_0'/L_0 and 3 kinds of wave period T_0, estimated with Froude similarity rule. Here, H_0' is an equivalent offshore wave height. The wave runup on quay top is measured by a capacity-type wave gauge which is set along the top floor.

REPRODUCTION BY USING A BOUSSINESQ MODEL

Nowadays, updated several numerical codes based on Boussinesq equation: FUNWAVE, COULWAVE, etc. are applicable to calculation of wave runup. NOWT-PARI, which is applied to reproduce the results of these model experiments, is similar to them. Especially, the improved version which equips not only wave overtopping model on quay wall (Hirayama, 2013) but also a “step boundary technique” to keep numerical stability over the gap bathymetry during quay wall being submerged is adopted.

RESULTS AND DISCUSSIONS

Fig. 2 shows the comparison of maximum and significant relative wave runup heights on quay top: R_{max}, $R_{1/3}$ to H_0' between the estimated results of Mase (1992)'s formula for a simple slope and the measured results of model experiment. Although the measured R_{max}/H_0' and $R_{1/3}/H_0'$ can be nearly estimated by the formula while the quay wall is submerged, in lower sea levels, their plots are scattered because wave overtopping effects on the quay wall are not considered. According to Fig. 3, the improved NOWT-PARI underestimates the measured wave runups because the wave overtopping fluxes may be not enough, though the step boundary technique is effective on stable calculation beyond the bathymetry gap in higher tides.

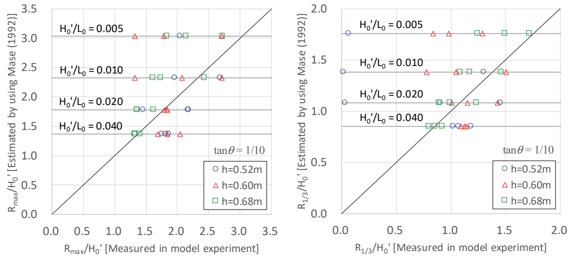

Figure 2 Comparison between experimental and estimated relative runup heights on quay in sea levels (Circles: h=0.52m, Triangles: h=0.60m, Squares: h=0.68m)

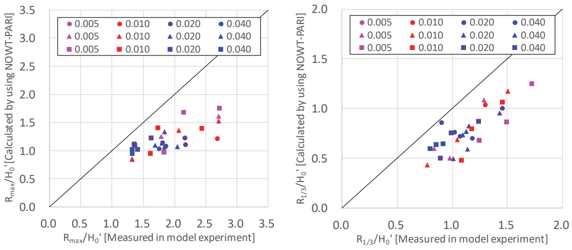

Figure 3 Comparison with calculated relative runup heights (Circles: h=0.52m, Triangles: h=0.60m, Squares: h=0.68m)

FUTURE WORKS

The inundation due to wave overtopping on a port area will be reproduced by using the improved NOWT-PARI.

REFERENCES

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Mase, H. (1992): Random wave runup height on gentle slope, J. Wtrwy., Port, Coast. and Ocean engrg., ASCE, Vol.118, No.5, pp.534-550.

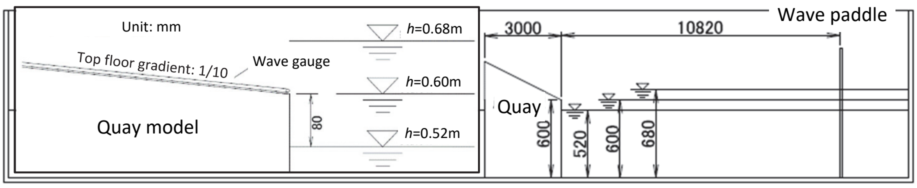

Figure 1 Quay model installed in a flume and sea levels during wave runup on quay top

Table 1 Offshore wave conditions

T_0 [s]	1.2	1.5	1.7	2.4
L_0 [m]	2.2	3.5	4.5	9.0
H_0' [m]	H_0'/L_0			
0.011	0.005			
0.022	0.010		0.005	
0.045	0.020		0.010	0.005
0.090	0.040		0.020	0.010
0.140		0.040		
0.180			0.040	0.020