APPLICABILITY OF THE VERTICAL TELESCOPIC BREAKWATER USING THE PAST TYPHOON IN TOKYO BAY

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INTRODUCTION

The vertical telescopic breakwater(VTB), which is a new breakwater that permits the navigation of ships, remain at the bottom of the sea during calm and rise to the surface during tsunamis or storm surges. Kawai et al. (2017) and Arikawa et al. (2019) found that it is effective not only for swell waves, but also for long-period waves simulating tsunamis and storm surges by previous experiments and numerical analyses. However, there have been few studies on the performance of VTB by numerical calculations in actual ports using actual typhoons. In addition, sea levels and changes in characteristics of typhoon due to climate change are predicted to occur; hence, we are concerned about the damage in all quarters caused by storm surge inundation, especially at Tokyo. Therefore, in this study, we used hypothetical typhoons under worst-case scenarios and quantitatively evaluated the protection performance of VTB against hypothetical typhoons with different aperture rates of VTB in Tokyo Bay by the numerical simulation.

NUMERICAL SIMULATION

For the numerical simulation, we used STOC-ML (Storm surge and Tsunami simulator in Oceans and Coastal areas) which is based on multi-layered nonlinear shallow water longwave equations (Tomita et al., 2005). STOC-ML is the quasi-3D model consisting of a momentum conservation equation and the continuity equation considering the porous.

CALCULATION CONDITION

Table 1 shows the conditions for the hypothetical typhoons. These conditions are based on the study by Yasuda et al. (2009) and actual typhoons that approached Tokyo. We created under multiple conditions with various central pressures, radius of maximum wind and typhoon track (only longitude) assuming future climate. Original is based on the observation parameters of previous typhoons, and the values represent the differences between them. An empirical typhoon model was used to reproduce the typhoon.

CONCLUSION

As a result, it was found that the maximum storm surge was reduced as aperture rate VTB was reduced. Fig. 1 shows that the maximum storm surge without VTB is the largest, which is the result of the worst-case scenario. The lowest aperture rate of 0.01, the maximum storm surge was reduced by two-thirds compared to the case without VTB. Even at the case of aperture rate of 0.1, it was reduced by 20% compared to the case without VTB. Moreover, not only the maximum storm surge was decreased, but also the water level fluctuations after the passing of the typhoon were reduced and the calmness of the water level in the harbor is effective. We need to evaluate the damage reduction effect of VTB in the future.

Previous typhoon	FAXAI, HAGIBIS
Track difference (Longitude)	-0.6°, -0.4°, -0.2°, original, +0.2°
Radius of maximum wind	original, 0.8 times
Central pressure	original, -5hPa
Computation time (UTC)	FAXAI : 2019/09/07 15:00 – 2019/09/09 21:00 HAGIBIS : 2019/10/11 09:00 – 2019/10/13 15:00

Table 1 - Hypothetical typhoon model

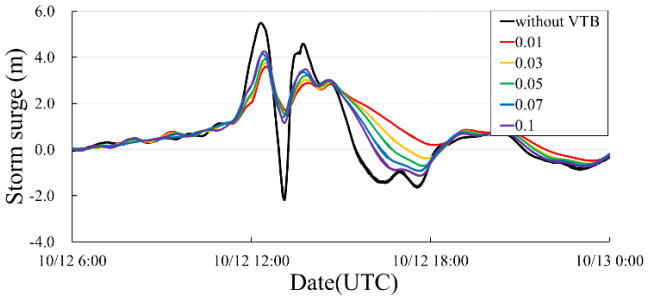

Figure 1 - Comparison of storm surge with aperture rates of VTB

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