TWO-DIMENSIONAL WAVE OVERTOPPING CALCULATION OVER A DIKE IN SHALLOW FORESHORE BY SWASH

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INTRODUCTION

For the actual designs such as construction of storm walls and implementation of beach nourishment, an appropriate estimation of wave transformation and wave overtopping is necessary.

It is desirable to have a numerical model which is capable to calculate wave overtopping directly from offshore. For the calculation of the low-frequency waves, phase-resolving wave models seem to be suitable since they are capable to deal with wave-wave interaction directly. Still, to conduct such a calculation, the model should be computationally not too demanding and stable. Recently a phase-resolving wave propagation model, SWASH (Zijlema et al., 2011), based on the non-linear shallow water equations with a non-hydrostatic pressure model has been developed at the Delft University of Technology. The model is a depth integrated model, thus the computational cost is not very high. Furthermore, its parallel computation makes it possible to calculate relatively long time duration to obtain statistically significant value for wave height and wave overtopping. Suzuki et al. (2011) has already demonstrated that this model produces satisfactory results for both wave transformation and wave overtopping in shallow foreshore in their one-dimensional calculation. In this study, we extend these studies to a two-dimensional wave overtopping calculation over a dike in a shallow foreshore.

VALIDATION

Field measurement data from Petten sea dike in the Netherlands is used for the validation for the SWASH 2D calculation.

Figure 1 shows wave spectrum at 15 m depth and toe of the dike. Blue, red, black lines show SWASH calculation of 0 degree directional spreading, 15 degree directional spreading and measurement, respectively. 0 degree calculation is conducted to see the effect of directional spreading. As can be seen in the figure, the wave spectrum of 15 degree shows a good correspondence with the measurement. On the other hand, the wave spectrum of 0 degree shows a different trend: most of the energy shift to low-frequency (>30 s). However, the measurement has a cut-off in the frequency at 30 s, therefore, there is still uncertainty for the low-frequency waves.

Mean wave overtopping discharge is also calculated from layer thickness h(t) and layer speed u(t) behind the dike. The calculated overtopping discharges are 25.3 l/s/m and 2.1 l/s/m for 0 degree and 15 degree, respectively. The measured overtopping is 0.9 l/s/m. The accuracy of the simulated overtopping of the directional spreading 15 degree can be qualified as good, considering that the total overtopping is relatively small in this case. The overestimation of wave overtopping of 0 degree can be due to the overestimation of low-frequency waves.

CONCLUSIONS

The SWASH numerical model has been applied to the two-dimensional wave overtopping calculation over a dike in shallow foreshore. The model is validated with the field measurement data from Petten sea dike, the Netherlands. The calculated model shows a good agreement in terms of wave transformation and wave overtopping. Furthermore, the results show that the directional spreading effect is not negligible: it influences the wave overtopping discharge significantly in the shallow foreshore case.

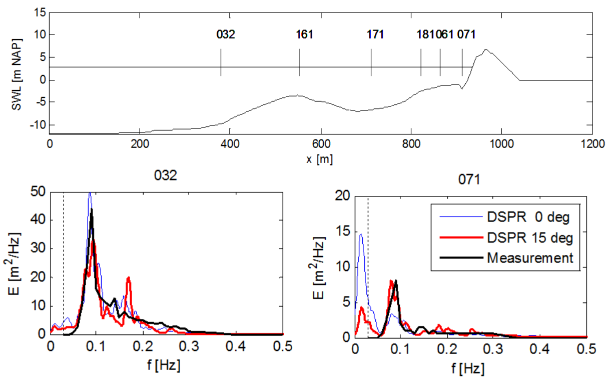

Figure 1 - Comparison of the wave spectrum for different directional spreading

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