AN INTERNAL WAVE GENERATION METHOD FOR THE NON-HYDROSTATIC MODEL SWASH

Panagiotis Vasarmidis, Ghent University, panagiotis.vasarmidis@ugent.be
Vasiliki Stratigaki, Ghent University, vicky.stratigaki@ugent.be
Tomohiro Suzuki, Flanders Hydraulics Research, tomohiro.suzuki@mow.vlaanderen.be
Marcel Zijlema, Delft University of Technology, m.zijlema@tudelft.nl
Peter Troch, Ghent University, peter.troch@ugent.be

INTRODUCTION

Numerical wave propagation models are commonly used as engineering tools for the study of wave transformation in coastal areas. In order to simulate waves in the nearshore zone correctly, the generation and absorption of waves at the boundaries of the models need to be modelled accurately. In numerical models, incident waves are usually generated by prescribing their horizontal velocity component at the boundary of the computational domain over the vertical direction. Additionally, in order to absorb and to prevent re-reflections in front of the numerical wave generator, a weakly reflective wave generation boundary condition is applied in which the total velocity signal is a superposition of the incident velocity signal and a velocity signal of the reflected waves. However, this method is based on the assumption that the reflected waves are small amplitude shallow water waves propagating perpendicular to the boundary of the computational domain and hence this method is weakly reflective for directional and dispersive waves.

Within the present study, an internal wave generation method combined with sponge layers is applied in the non-hydrostatic model SWASH, in order to more accurately generate waves and avoid re-reflections at the boundaries.

NUMERICAL MODEL AND IMPLEMENTATION

SWASH is an open source non-hydrostatic wave model (Zijlema et al., 2011). The governing equations of the model are based on the nonlinear shallow water equations with added non-hydrostatic effects, which are derived from the incompressible Navier-Stokes equations.

The implemented internal wave generation method is based on the technique proposed by Wei et al. (1999) who developed a source function method in Boussinesq models based on a spatially distributed source. For our case here, a source term in the form of mass is added to the continuity equation implemented in SWASH, and thus the spatially distributed source function is applied over an area. The principle is illustrated in Figure1.

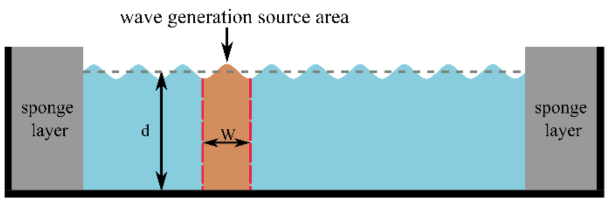

Figure 1 - Principle of spatially distributed source function method as implemented in SWASH for the present study

The source term is a function of a velocity that is called the energy velocity and for the system of SWASH equations has been mathematically derived by Vasarmidis et al. (2019) in case multiple vertical layers are implemented. It was also observed that by increasing the number of vertical layers, a better fit is achieved with the exact linear solution of the group velocity, which makes the method proposed here applicable even for highly dispersive waves.

VALIDATION

The implemented method is validated against analytical solutions and experimental data including water surface elevations, orbital velocities, frequency spectra and wave heights. As illustrated in Figure 2, the developed method is validated by comparing 3D model simulations with the results of the Berkhoff shoal experiment. The numerical results show a very good agreement with the analytical solution and the experimental data. More details of the validation results will be presented in the conference paper.

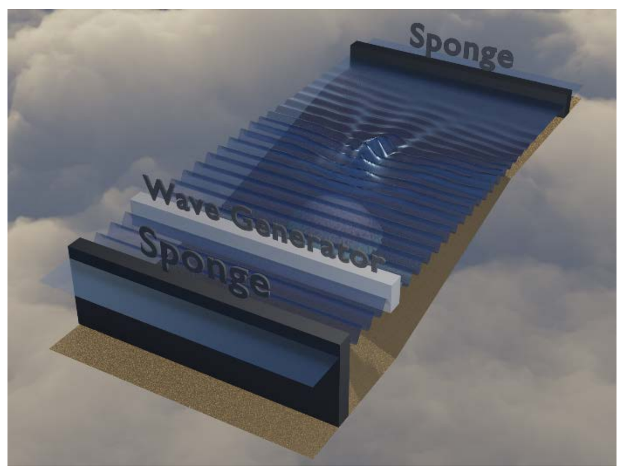

Figure 2 – Wave propagation over the Berkhoff shoal, showing the 3D SWASH results of water surface elevations

REFERENCES

Vasarmidis, Stratigaki, Suzuki, Zijlema, Troch (2019): Internal Wave Generation in a Non-Hydrostatic Wave Model, Water, vol 11, p. 986.

Wei, Kirby, Sinha (1999): Generation of waves in Boussinesq models using a source function method, Coastal Engineering, vol 36, pp. 271-299.

Zijlema, Stelling, Smit, (2011): SWASH: An operational public domain code for simulating wave fields and rapidly varied flows in coastal waters, Coastal Engineering, vol. 58, pp. 992-1012.