PhD Thesis A: **Numerical simulation of three-dimensional turbulent flow induced by breaking waves in the coastal surf zone**

A method named Large Wave Simulation is presented, for the study of turbulent flow that develops during wave breaking (spilling breakers) over a constant-slope bed. According to LWS method, large scales of velocity field and free-surface elevation are numerically resolved, whereas the corresponding subgrid scale (SGS) effects are accounted for by a SGS stress model, equivalent to the ones used in Large Eddy Simulation (LES) method. Spilling breaking is simulated by a SGS stress field that creates an eddy breaker and produces spanwise vorticity at the breaking wave front. LWS method is used in conjuction with the Euler equation and the corresponding nonlinear boundary conditions. Moreover, as a reference, a surface roller (SR) model is used for the simulation of spilling breaking, which necessitates empirical parameters, for the calculation of the eddy breaker effect. The SR model is adapted for two-dimensional, inviscid but rotational free-surface flow, by use of appropriately modified boundary conditions. Results of two-dimensional flow during breaking waves, propagating perpendicularly to the shoreline, are presented, as well as results of three-dimensional flow during breaking waves, propagating perpendicularly and obliquely to the shoreline. In the case of waves breaking perpendicularly to the shoreline over a constant slope (1/35) bed, free-surface elevation and velocities results are in accordance with existing experimental data. However, despite of the flow being weakly dependent to the cross-shore direction, due to the fact that the eddy breaker is three-dimensional, LWS method performs better when combined with a three-dimensional flow field. Finally, oblique wave propagation ($42,45^o$ at deep water) and breaking over a constant-slope (1/35) bed is simulated. Wave crestlines break gradually and the effect of the SGS stress field produces spanwise (long-shore) and streamwise (cross-shore) vorticity. The eddy breaker develops along the breaking wave front and its orientation follows the shape of the breaking crestlines.