Large transient waves in shallow water

Susan Frances Smith

The present investigation is concerned with the description of transient, nonlinear waves in shallow water, and considers the extend to which the recent conceptual changes in the description of a “design wave” in deep water (for ocean engineering purposes) are equally applicable to the intermediate and shallow water depths which are typical of most coastal environments.

Large 2-D transient waves, produced by frequency dispersion and wave focussing, are generated numerically in deep, intermediate and shallow water depths, suing a fully nonlinear time-stepping boundary integral model. The model has been validated against experimental measurements for highly nonlinear focused wave groups. Calculations of the water surface elevation and the underlying water particle kinematics are present. The nature of the resulting nonlinearity is shown to be highly dependent on the water depth. Furthermore, the results show that in shallow water the nonlinearity may disrupt the focusing process. If the underlying spectrum is sufficiently narrow-banded, then the focusing process may in fact be completely destroyed. In such cases, the large wave event is not characterised by a symmetric surface profile in which all the wave components are brought into phase at one position in space and time.

An assessment has been made of the successes of two recently developed wave theories (a global Fourier method and a local Fourier method) to model the water particle kinematics arising beneath large transient waves. The results suggest that the nature of the nonlinear interactions have important implications for the accuracy of the kinematics predictions. However, both these models will typically provide an improved description of the water particle kinematics when compared to the existing design solutions.

Since most shallow water locations incorporate a gradually sloping bed, the influence of such a bottom boundary on the behaviour of nonlinear transient waves has also been considered. This has been achieved using a newly developed nonlinear model.