The Evolution of Large Waves in Shallow Water

The motivation for this research lies in the results of a desk study by Swan & Chan (2002) of the wave conditions arising at Baja California, USA. At this coastal location, the water depth is 16.5m, and can be characterised as shallow or intermediate and the results which were generated by a fully nonlinear, numerical, wave evolution model (Bateman *et al.* (2001) and Bateman *et al.* (2002)) suggest that waves as large as the 1 in 500 year event will exist without breaking. These waves are highly asymmetric, with as much as 75% of their total wave height located above the mean water level. In this case, the maximum wave height was H_{max} = 14m and the maximum surface elevation η_{max} = 10.43m. Such waves cannot be modelled using an existing linear or nonlinear steady wave model. Furthermore, the application of a linear irregular wave model will also give misleading results.

This project is going to investigate if these results are real, whether they can be easily reproduced and what is the physics under-pinning their evolution; what is the form of the extreme event and if it is produced by focusing as in the case in deep water; also if the "NewWave model" (Tromans *et al.* (1991)) is applicable in intermediate and shallow water depths. Finally, if the commonly applied depth-limited breaking criteria are appropriate to these large wave events and whether they should be applied to wave fields involving a significant spread of energy in both frequency and direction.

The investigation will be both numerical and experimental. The experiments are going to be undertaken in the new hydrodynamics laboratory in the Civil Engineering Department at Imperial College. A new shallow-water wave flume or `coastal' flume is going to be used, and has been specifically designed for this purpose. The experiments concern unidirectional, focused wave groups in intermediate water depths, shallow water depths and wave groups propagating up a slope. The new wave basin is also going to be used in order to investigate directional wave groups. The purpose of this study is to investigate the influence of focusing, nonlinearity, directionality (in the wave basin) and resonance. Particularly, the aim of this study is to investigate the physical mechanisms responsible for the evolution of large waves in shallow water. The results will be compared to similar wave conditions generated in deep water. Simultaneously, the experimental cases will be examined thoroughly using numerical models. Particular attention will be paid to local changes in wave spectra, to the effects of directionality and to the possible significance of resonant interactions. The eventual goal of this project is to establish new breaking or limiting wave criteria for shallow and intermediate water depths.