Modelling of Extreme Water Waves

This project aims to contribute to a better understanding of extreme waves, including those waves which are designated as “freak” due to their unusual height and steepness given the underlying sea-state. By developing a 3-D numerical model based on the Boundary Element Method (BEM), these events can be simulated without the limitations of existing models, e.g. the need to assume periodicity of the wave motion when applying Fourier based methods. Using this BEM model, the project will investigate two fundamental questions regarding extreme waves. Firstly, given an extreme wave event, what are the kinematics under the crest? Improving the accuracy of kinematics predictions would lead directly to an improvement in the calculations of loading on structures during events such as wave slamming (of relevance to the offshore industry), overtopping (of interest to coastal engineering), wave-vessel interactions in general and so-called “green water” inundation (relevant to naval architecture). Secondly, how do extreme waves evolve? The fact that instances have been reported where extreme waves have arisen within relatively moderate sea states in areas with no prevalent current or particular variation in local bathymetry would suggest that wave focussing is likely to play a major role in the evolution of an extreme wave. Whilst much recent research has been carried out into unidirectional wave focussing, the role of directionality in the focussing of waves is less well understood, but of high importance since real sea-states are inherently three dimensional. Therefore, this project will investigate the effect of directionality on the focussing process.