Imperial College London

**Rizwan Sheikh**

# Wave Scattering from Vertical Surface-Piercing Cylinders

**Period of Study: 2002-2005**

**Supervisor:** Professor C. Swan

## Abstract

This thesis describes new laboratory observations concerning the interaction between a series of steep incident waves and vertical, surface piercing, cylinders. The motivation for the study arose as a result of wave impact damage sustained to the undersides of several concrete gravity-based structures in the northern North Sea. Earlier work, Swan et al., (1997), demonstrated that in the case of multiple column structures, the individual diameters of which lie outside the typical (linear) diffraction regime, there exists a new and previously unexpected mechanism leading to the scattering of high-frequency waves. Although the implications of this effect were carefully documented, not least because it explained the occurrence of wave impacts in relatively moderate seas, its physical origins remained unclear. In particular, it was uncertain whether this type of scattering would be observed in the case of a single column, or whether it results from the transmission of wave models trapped between the legs of a multiple column structure.

In the case of a single column, if the diameter, $D$, is such that the flow lies within the drag-inertia regime, $D/\lambda < 0.2$, where $\lambda$ is the corresponding wave length, linear diffraction theory suggests there will be little or no scattered wave energy. The present laboratory observations demonstrate that this is not, in fact, the case. If the incident waves are steep, a strong and apparently localised interaction is clearly observed at the water surface. This, in turn, leads to the scattering of high-frequency waves. Although these waves are relatively small in amplitude, their subsequent interaction with other steep incident waves takes the form of a classic long-wave short-wave interaction and can produce a significant increase in the maximum crest elevation relative to those recorded in the absence of the structure. The present dissertation will demonstrate that the scattering of these high-frequency waves, and their subsequent nonlinear interaction with other incident waves, has significant implications for the specification of an effective air-gap and hence for the setting of deck elevations on real offshore structures.