**Nonlinear wave-current interactions**

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This dissertation presents an experimental and numerical investigation of two-dimensional waves interacting with both depth-uniform and depth-varying currents. Firstly, regular waves coexisting with a current are considered. The development of a numerical model which allows the interaction of a two-dimensional wave train and an arbitrary current is outlined. Then a theoretical investigation is presented which provides an assessment of the effects of the current's surface velocity and the current's near-surface vorticity on the wave-current interaction. To support this investigation, a detailed laboratory study is presented. In this study surface elevation, kinematic and pressure measurements are compared to both the existing solutions and the proposed numerical model.

Secondly, regular waves propagating from quiescent water onto a current are investigated. A numerical model is outlined which allows the wave height and wavelength changes to be calculated as waves propagate from quiescent water onto and arbitrary current. Then a theoretical investigation is presented which provides an assessment of the effects of the current's surface velocity and the current's near-surface velocity on the wave height and wavelength changes. Again, a laboratory study is presented and the results are compared to both the existing solutions and the proposed numerical model.

Finally, an experimental investigation is presented for random waves propagating onto a current. Both the change in the water surface elevation and the resulting kinematics are considered. The results are compared to the existing solutions and the proposed numerical models.

This study shows that as waves propagate from quiescent water onto a depth-uniform current, the wave height and wavelength changes, and the resulting flow field may be predicted by existing irrotational solutions. However, as waves propagate from quiescent water onto a depth-varying current (such as a wind-driven current), the wave height and wavelength changes, and the resulting flow field are strongly dependent upon the current's vorticity distribution. In such cases the existing irrotational solutions will provide incorrect predictions, and fully non-linear wave-current solutions such as the proposed numerical models are required.