Directionally Spread Surface Wavepackets subject to an Abrupt Depth Transition (ADT)

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Motivation and background

This project's aim was to extend ongoing research assessing the role of Abrupt Depth Transitions (ADTs) on the formation of rogue waves. Recent experimental, numerical, and theoretical work has shed new light on this rogue wave formation mechanism. The results have significant consequences for the extreme loads on offshore structures and, hence, the design and installation of offshore renewable energy systems. This understanding, however, has been limited to two-dimensional long-crested waves normally incident to the depth transition. Real waves are directionally spread with varying mean directions and hence, through new experiments at Manchester, this project's focus was on extending our understanding to these more realistic cases.

Phase 1: construction of the false floor

The first phase of the project was on the design, construction, and installation of a large false floor in the Manchester Wide Flume (5 m × 18 m). The floor was designed out of marine ply to be 5 m × 12 m × 0.22 m and was ballasted with 3.2 tonnes of gravel. During this phase we also designed and built 10 new wave gauges and an improved wave gauge calibration system in order to obtain the spatial coverage of measurements required. Figure 1 shows the floor installation, gauge construction and final experimental set-up.

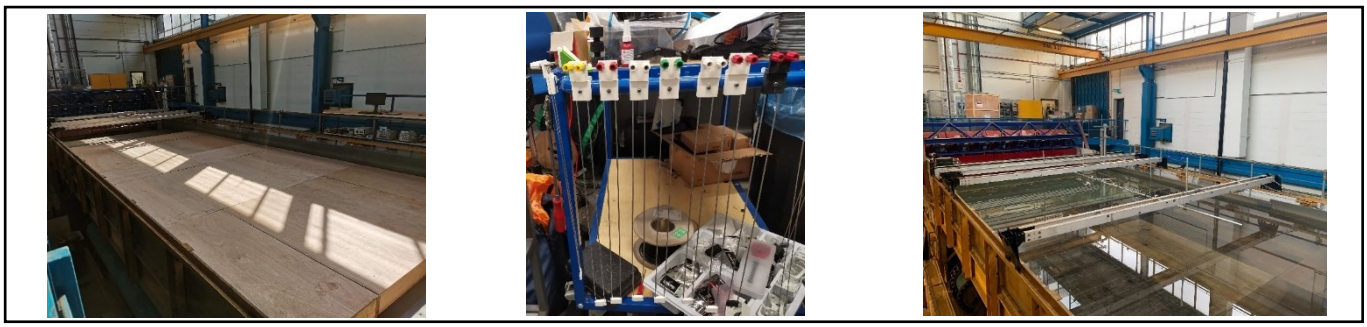

Figure 1: Images of the floor construction (left), new wave gauges (centre) and final experimental set-up (right)

Phase 2: experimental testing

Testing was split into several phases to target different areas of understanding, namely:

1. Wavepackets of increasing amplitude: to understand the nature and role of higher harmonics
2. Directionally spread and oblique wavepackets: to understand the effect of directionality on the free-bound interaction
3. Directionally spread irregular waves: to quantify the difference in (extreme) wave statistics in directional conditions

Preliminary results

Experimental analysis is still ongoing, in parallel with numerical modelling and theoretical work to enhance our understanding. Preliminary experimental results of the effect of directionality on the reduction of maximum crest amplitudes and the amplitudes of harmonics are presented in Figure 2.

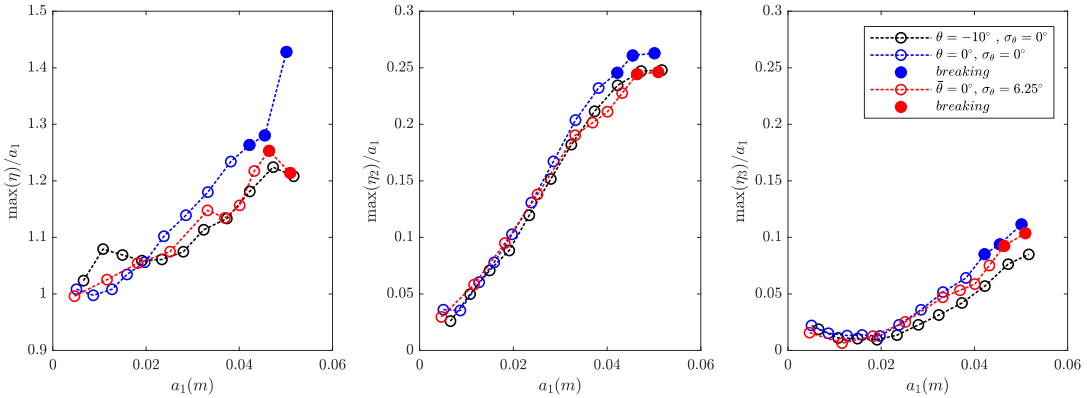

Figure 2: Peak values of surface elevation (left), second (centre) and third (right) harmonics as a function of amplitude