The aim is to investigate the effect of directionality on wave-structure interaction and wave scattering. A range of focused wave groups were generated to interact with three FPSO models of different lengths.

Models of 1:100 scale were fixed to the gantry in the Plymouth University Ocean Basin for the first scenario. Further tests were carried out in heave motion only, heave & pitch and in full 6 degrees of freedom (6 DOF) floating scenarios.

Various wave conditions were generated as focused wave groups using NewWave theory. The wave conditions include unidirectional, cross-unidirectional and multidirectional focused wave groups with an underlying JONSWAP spectrum.

A numerical wave tank using the QALE-FEM method based on fully nonlinear potential flow theory with self-correction and self-adaptive wavemaker techniques can reproduce the waves in the physical wave basin very well.

The active adaptive wavemaker has been developed and demonstrated to work well in steep waves with strong nonlinearity, nonlinear irregular waves and focused wave groups. It can significantly reduce the length of the numerical wave flume.

Impact in Aerated Water

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The FROTH project is a close collaboration between five universities (Plymouth University, Manchester Metropolitan University, City University, Oxford University and University of Bath) with significant input from the Industrial Management Group (Saipem, Bureau Veritas, DNV-GL, Lloyds Register, Trinity House).

The aim is to investigate the detailed physics of violent hydrodynamic impact loading on rigid and elastic structures through a carefully integrated programme of numerical modelling and physical experiments at large scale. Open source numerical code is being developed to simulate laboratory experiments carried out in the COAST Laboratory at Plymouth University, with the ultimate aim of providing improved guidance to the designers of offshore, marine and coastal structures, both fixed and floating.

The Project Objectives are:
1. Investigate the role of aeration in hydrodynamic impact loading.
2. Investigate the effect of hydroelasticity during hydrodynamic impact.
3. Investigate the effect of directionality of local wave impact for a floating structure (short crested oblique waves, multiple directional wave groups and their induced motion and loads).
4. Characterise wave impact pressure for a series of wave structure interaction experiments with increasing wave steepness and investigate reliability of wave impact pressure prediction and limits of variability.
5. Make recommendations to improve empirical formula for practical design purposes.
6. Build a modular open source numerical tool to investigate all aspects of the problem.

The aim is to investigate the effect of aeration on impact by means of dropping a flat plate onto pure and aerated water surfaces. Tests were carried out with different drop plate masses, different impact velocities and different levels of aeration. Impact pressure and force were measured using pressure transducers and a load cell installed on the impact plate.

Numerical simulation using the compressible fluid flow code AMAZON-CW has reproduced the impact plate experiment in pure and aerated water.

Wave impact on both a rigid and elastic wall is investigated in both pure and aerated water to investigate hydroelastic and aeration effects. The truncated vertical wall is a flat plate connected to a rigid wall by four springs. The spring system can incorporate springs of different stiffness and can also be locked to create a rigid wall.

A focusing technique was applied to generate different types of wave impact by changing the focal location. Focused wave groups were defined using NewWave theory with an underlying JONSWAP spectrum.

Numerical simulations using OpenFOAM of focused wave impact on the truncated wall agree well with the experiment.

A compressible multiphase flow solver based on OpenFOAM has simulated breaking wave impact on a vertical wall and air-pocket and flip through wave impacts have been produced.