Facilitating coastal and ocean research in the laboratory

K. M. Collins†, P. Arber, D. Greaves, M. Hann, G. Iglesias, D. Simmonds, S. Stripling, A. Toffoli‡
School of Marine Science and Engineering, Plymouth University, Plymouth, UK

Introduction

For coastal scientists and engineers, physical modelling is an essential part of the process of research and this is especially true for marine energy technology development. The recently built Coastal, Ocean and Sediment Transport (COAST) laboratory at Plymouth University provides a versatile facility for studying engineering and ocean science problems.

Facilities

The flexibility of the laboratory stems from its multiple facilities: the 35 m long Ocean Basin with moveable floor can produce both regular and irregular waves at a range of water depths, and has 24 force absorbing wave paddles, mitigating reflections and allowing a quick experiment turnaround. In addition, currents can be run in two directions at the same time as the waves.

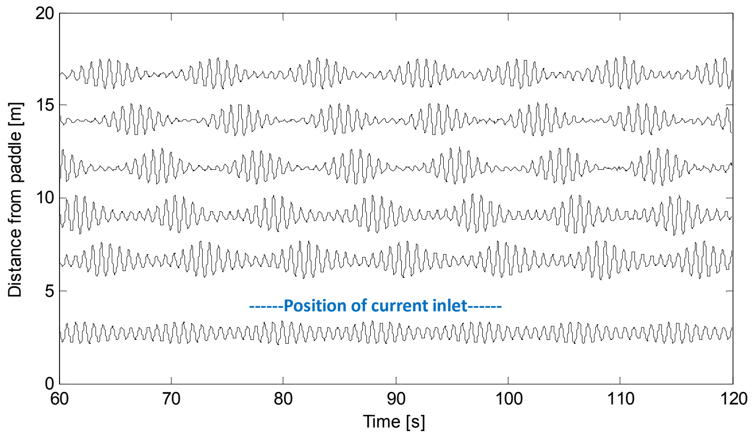
View of the Ocean Basin.

The smaller Coastal Basin is fitted with a 20 piston-type wave makers and the Sediment Wave Flume has one piston paddle. Both the Basin and the flume can be used with sediments and can provide recirculating currents in either direction.

Experiments

Creation of rogue waves

It is only recently that the formation of rogue waves has been studied numerically in terms of waves flowing into an opposing current [3]. To examine this, packets of waves were propagated along the Sediment Flume, first with no current then with an opposing current. In the presence of the opposing current, the wave packets were seen to deform as they travelled along the flume, shown in the figure below.



Wave gauges deployed along the tank showed that the amplitude increased as the wave packet propagated along the tank.

Coastal defences

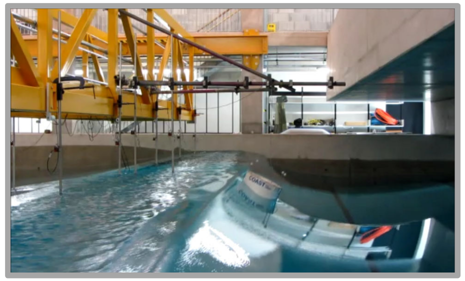
Long-crested waves encounter breakwaters in the Coastal Basin

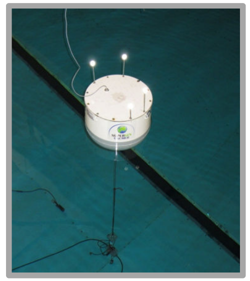
The Coastal Basin has been used for research and student projects, such as the study of sediment transport around coastal structures. The photo on the left shows waves being driven around armoured breakwaters. A laser scanner was used to map out the beach morphology after two different wave conditions: crests normal to and crests at 30° to the direction of travel.

Measuring extreme impacts

The X-MED project uses numerical modelling and experimentation to examine extreme wave impacts and their loads on moored devices. To generate the focussed wave packets required, the NewWave theory is used. NewWave uses linear or second order theory to determine the most probable highest wave for a given sea state [1,2].

To investigate impact loads, a buoy was secured in the Ocean Basin via a taut mooring and struck with wave packets with different amplitudes. As the amplitude increased, the buoy heave was greater, although this was limited by the mooring reaching its maximum extension.





The X-MED buoy moored in the Ocean Basin: being hit by a wave (left) and showing the retroreflective markers used for 3D motion tracking (right).

References

[1] Tromans, P. S., Anaturk, A. R. and Hegemeijer, P. (1991). A new model for the kinematics of large ocean waves - application as a design wave. In First International Offshore and Polar Engineering Conference, vol. III (ed. J. S. Chung). Edinburgh: The International Society of Offshore and Polar Engineers.

[2] Xu, L. and Barltrop, N. (2005). Wave slap loading on FPSO bows, Report 324 for the Health and Safety Executive.

[3] The excitation of rogue waves in a variable medium: an experimental study on the interaction of water waves and currents, A. Toffoli, T. Waseda, H. Hidetaka, T. Kinoshita, K. Collins, and M. Onorato, 2013, submitted for publication.

COAST LABORATORY WITH PLYMOUTH UNIVERSITY
COASTAL OCEAN & SEDIMENT TRANSPORT

† Corresponding author: keri.collins@plymouth.ac.uk
‡ Presenting author

0800 052 5600
coast@plymouth.ac.uk
www.plymouth.ac.uk/coast