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# Numerical Simulation of Floating Bodies in Extreme Free Surface Waves

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A task of the EPSRC funded research project "Extreme Wave loading on Offshore Wave Energy Devices: a Hierarchical Team Approach" is to investigate the survivability of two wave energy converter (WEC) devices Pelamis and the Manchester Bobber using different CFD approaches. Both devices float on the water surface, generating the electricity from the motion of the waves.

In this paper, we describe developments of the AMAZON-SC 3D numerical wave tank (NWT) to study extreme wave loading of a fixed or floating (in Heave motion) structure. The extreme wave formulation as an inlet condition is due to Dalzell (1999) and Ning *et. al.* (2009) in which a first or second-order Stokes focused wave can be prescribed. The AMAZON-SC 3D code (see e.g. Hu *et al*. (2009)) uses a cell centred finite volume method of the Godunov-type for the space discretization of the Euler and Navier Stokes equations. The computational domain includes both air and water regions with the air/water boundary captured as a discontinuity in the density field thereby admitting the break up and recombination of the free surface. Temporal discretisation uses the artificial compressibility method and a dual time stepping strategy to maintain a divergence free velocity field. Cartesian cut cells are used to provide a fully boundary-fitted gridding capability on an regular background Cartesian grid. Solid objects are cut out of the background mesh leaving a set of irregularly shaped cells fitted to the boundary. The advantages of the cut cell approach have been outlined previously by Causon *et al*. (2000, 2001) including its flexibility for dealing with complex geometries whether stationary or in relative motion. The field grid does not need to be recomputed globally or even locally for moving body cases; all that is necessary is to update the local cut cell data at the body contour for as long as the motion continues. The handing of numerical wave paddles and device motion in a NWT is therefore straightforward and efficient.

Firstly, extreme design wave conditions are generated in an empty NWT and compared with physical experiments as a precursor to calculations to investigate the survivability of the Bobber device operating in a challenging wave climate. Secondly, we consider a bench-mark test case involving in a first order regular wave maker acting on a fixed cylinder and Pelamis. Finally, a floating Bobber has been simulated under extreme wave conditions. These results will be reported at the meeting.

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