Validation tests of a wave generation toolbox for OpenFOAM® CFD library

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Introduction

This poster focusses on the evaluation of an open-source CFD environment for simulating the behaviour of moored wave energy converters (WECs). This forms part of the SuperGen UKCMER project entitled 'Survivability of wave energy converter and mooring coupled system'. We report on progress made using the waves2FOAM toolbox [1] to create a numerical wavetank (NWT) within OpenFOAM® prior to study of moored floating bodies. We show initial convergence testing and comparisons with literature.

Methodology

OpenFOAM® offers a method for solving the Reynolds averaged Navier-Stokes equations for free surface flows of Newtonian fluids using the volume of fluid method. The waves2Foam toolbox extends this, allowing for generic wave generation and absorption.

The classic case of a propagating solitary wave running up on a vertical wall forms the basis of the convergence tests. The computational domain used (shown in figure 1) mimics that seen in the literature [2].

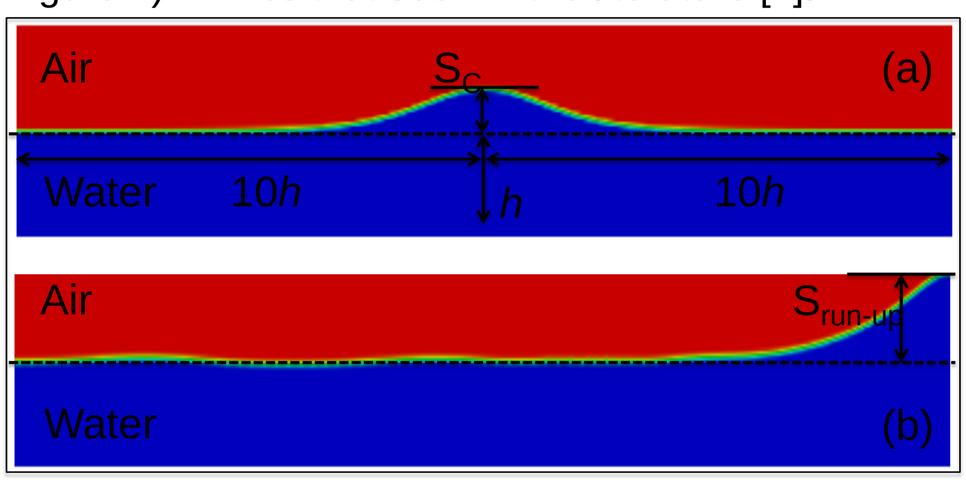
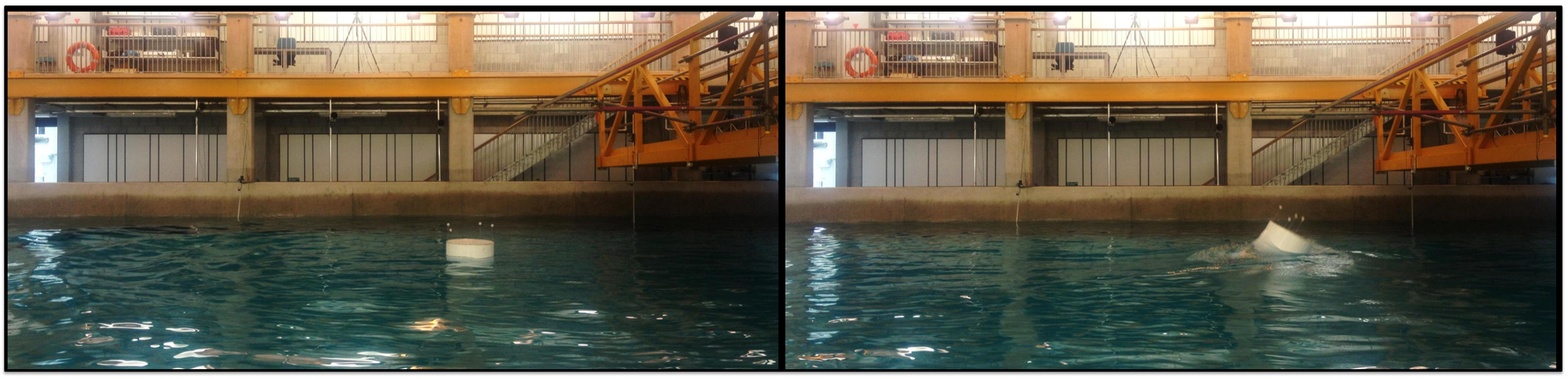


Figure 1: The computational domain used in the initial convergence tests. This example is for a soliton with initial height S_C = 0.4h at time = 0s [(a)] and at the point of maximum run-up [(b)]. *Not to Scale (compressed horizontally).*

Figure 4: Directionally focussed wave impact on a taut-moored, cylindrical buoy with hemispherical bottom. Before focussing event (left) and during (right).



Results

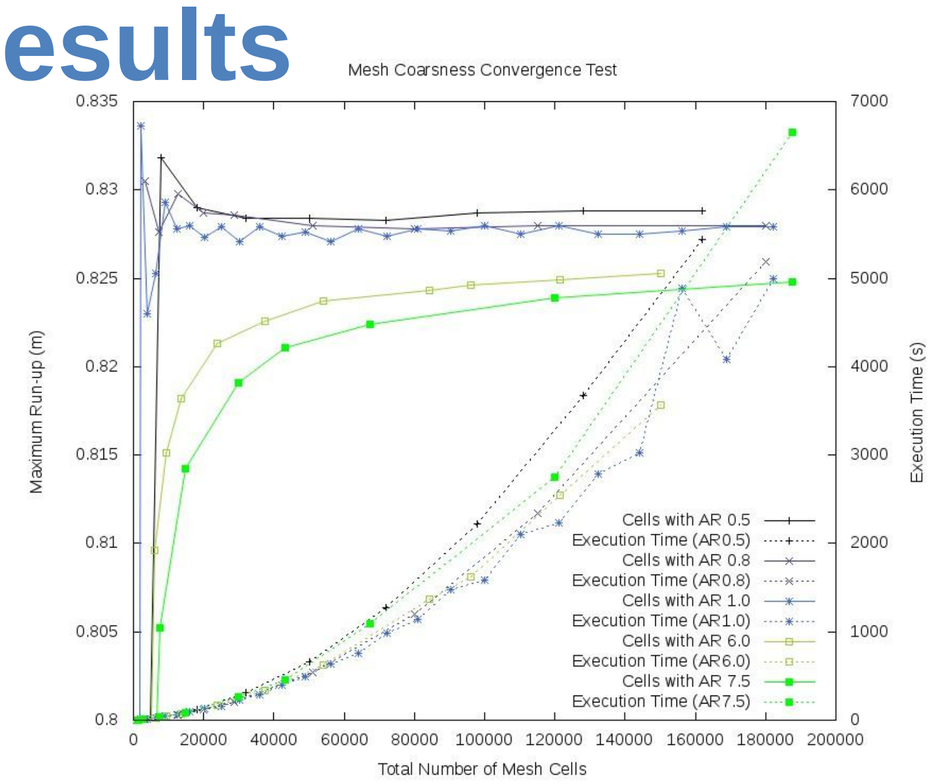


Figure 2: The maximum run-up of a solitary wave (S_C = 0.4h) for a range of mesh coarseness and cell aspect ratios and the execution time for each.

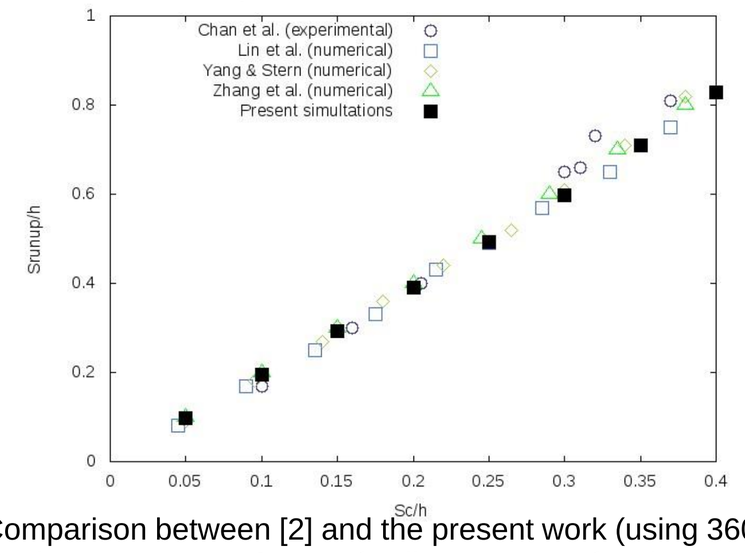


Figure 3: Comparison between [2] and the present work (using 36000 square grid cells) for the max run-up, S_{runup}, of solitary waves of various heights, S_C.

Conclusions

The present work and [1] shows promise in OpenFOAM® and waves2Foam's ability to simulate waves successfully.

The next stage in this project is to generate focused waves in a NWT, introduce a coupled, moored structure and provide experimental validation using Plymouth University's COAST lab (figure 4).

References

1. NG Jacobsen, DR Fuhrman, J Fredsøe (2011) "A wave generation toolbox for the open-source CFD library: OpenFoam®", *Int. J. Numer. Meth. Fluids*, 70(9): 1073-1088.
2. Y Zhang, Q Zou, D Greaves (2009) "Numerical simulation of free-surface flow using the level-set method with global mass correction", *Int. J. Numer. Meth. Fluids*, .63(6): 651-680.