

Extreme Wave Impact on a Moored Buoy

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Introduction

As part of the SuperGen UKCMER project entitled 'Survivability of wave energy converter (WEC) and mooring coupled system' this work concerns the numerical and physical modelling of an extreme wave impact on a simplified model of a moored WEC.

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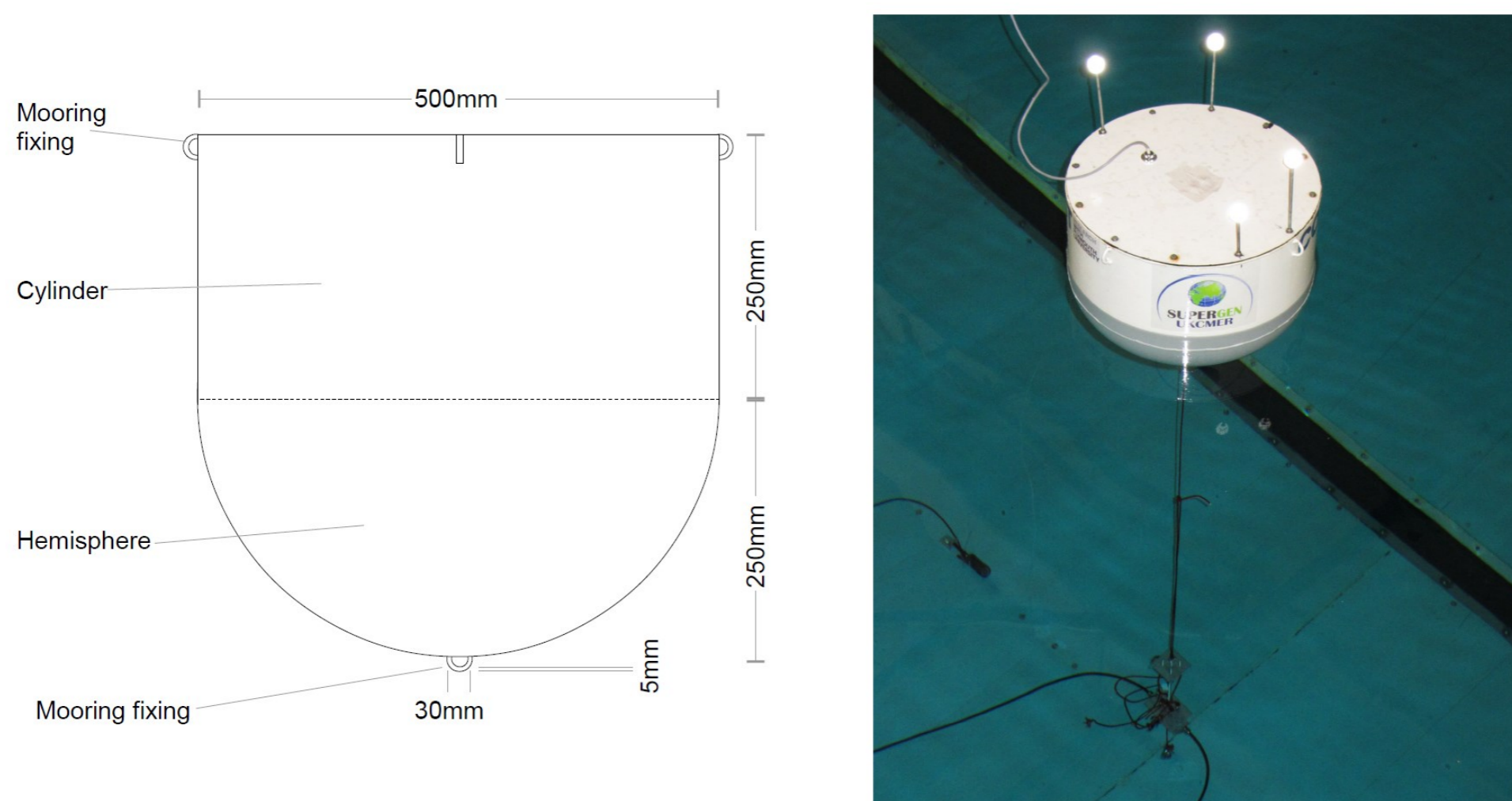


Figure 1: Dimensions of the hemispherical-bottomed, cylindrical buoy (left), and; a photograph from the COAST laboratory (right) showing the single-point, linear mooring and experimental setup.

Methodology

A floating buoy and linear mooring arrangement (shown in Figure 1) was subjected to an extreme wave based on the 100 year return wave at the Wave Hub site. The NewWave formulation^[1] and a Pierson-Moskowitz spectrum with f_p of 0.356Hz were used to approximate the 14.4m wave at 1:50 scale. 6DoF motion and the load in the mooring were recorded in the experiment.

Using time series data from the experiments as the input boundary condition, a numerical simulation of the extreme wave impact was performed using the volume of fluid, Navier-Stokes solver provided with OpenFOAM® and the generic wave generation and absorption capabilities of the waves2Foam toolbox^[2].

Results

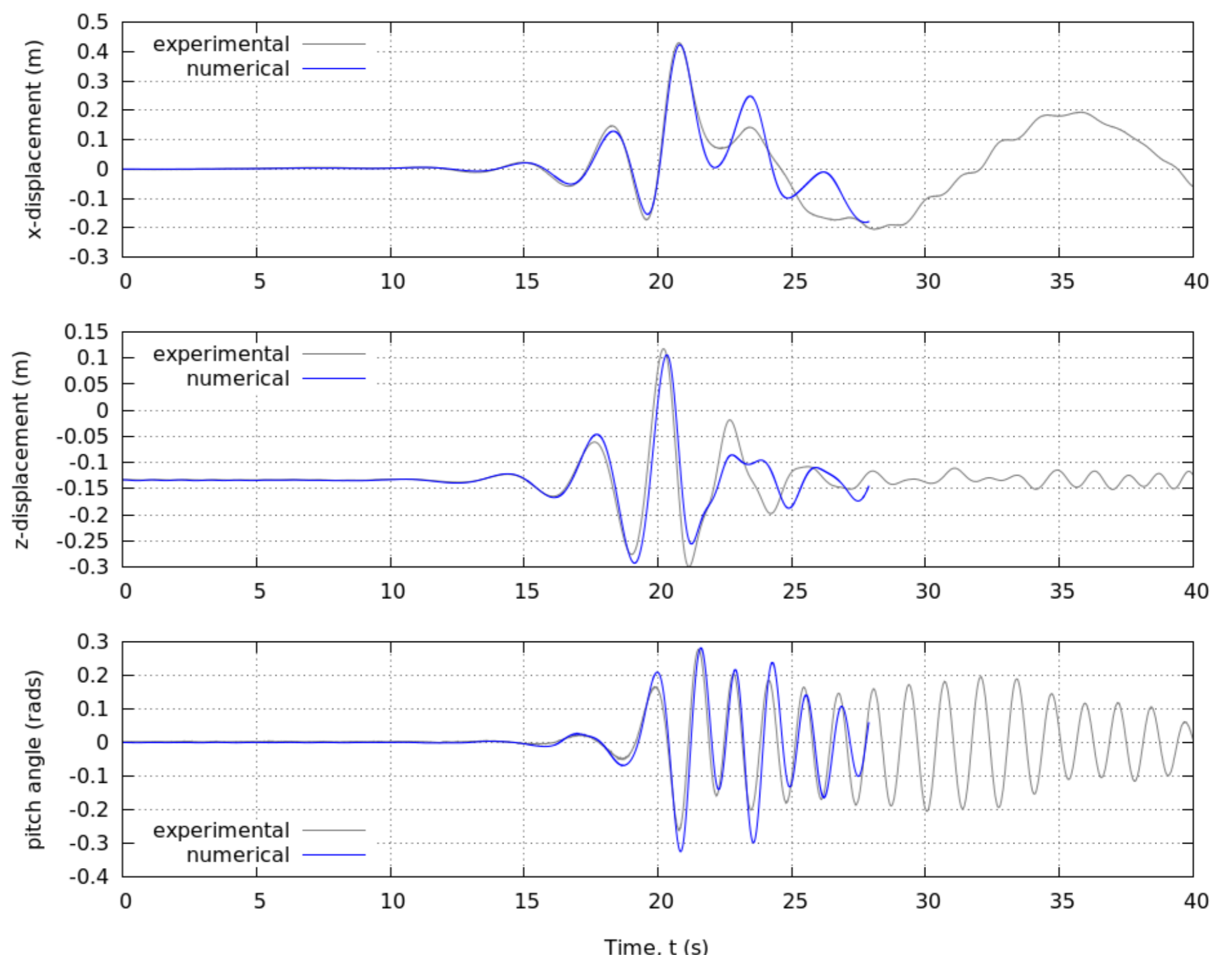


Figure 3: Comparison between numerical and physical results for x-displacement, z-displacement and pitch angle of the buoy when subject to an extreme wave event.

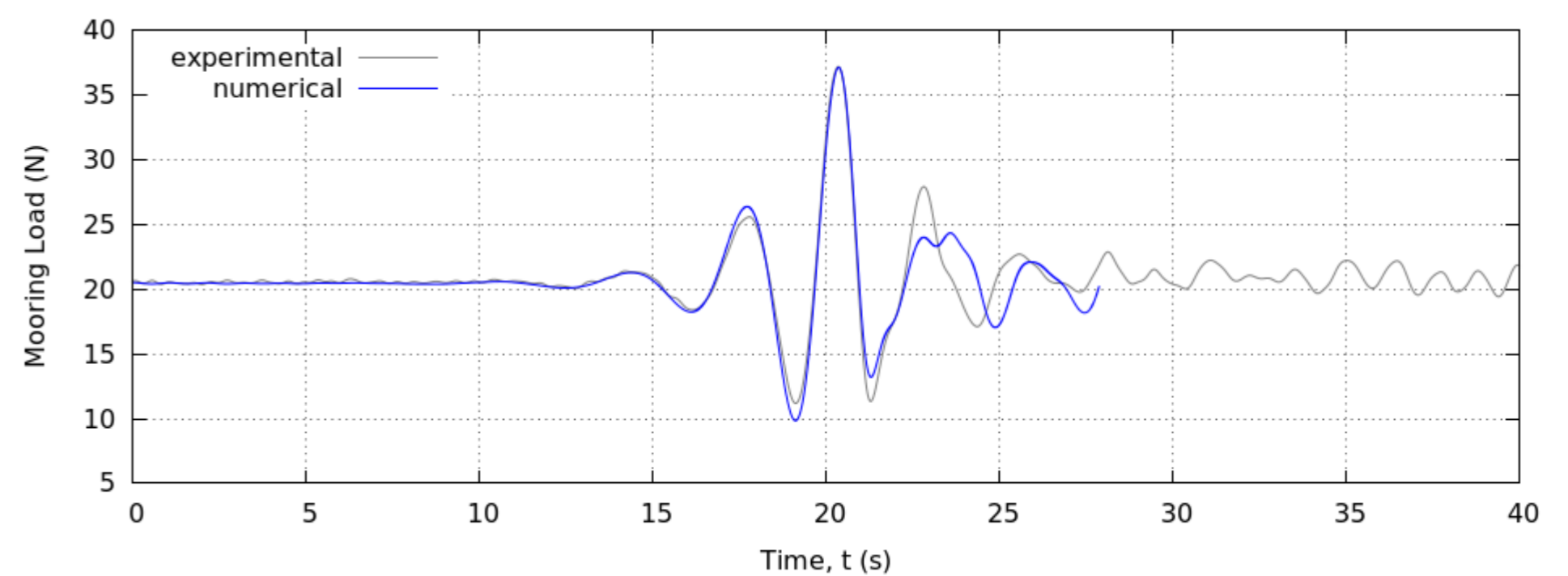


Figure 4: Numerical and physical results for the load in the mooring of the buoy when subject to an extreme wave event.

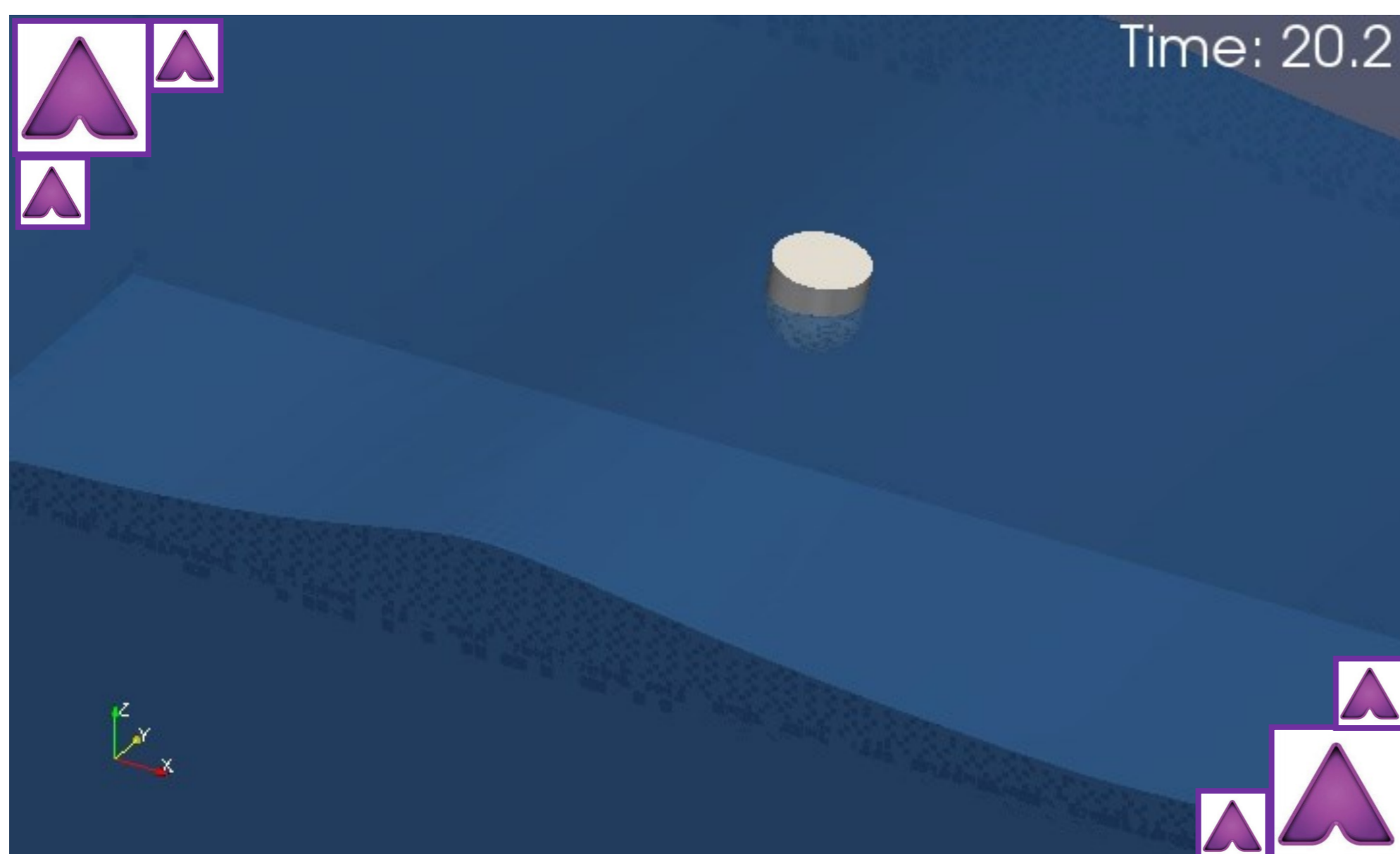


Figure 2: Screenshot as the main crest reaches the buoy. This image is tagged with augmented content (see note above).

Conclusion

In conclusion, the motion of the buoy and load in the mooring have been captured accurately by the numerical simulation. This provides confidence in the computational tool and allows progression toward more complicated WEC models including additional features such as power take-off systems and moving parts.

References

1. PS Tromans, A Anaturk, P Hagemeyer (1991) "A new model for the kinematics of large ocean waves – application as a design wave", in *Proceedings of the 1st International Offshore and Polar Engineering Conference, 1991*: Edinburgh, UK: 64-71.
2. NG Jacobsen, DR Fuhrman, J Fredsøe (2012) "A wave generation toolbox for the open-source CFD library: OpenFoam®", *Int. J. Numer. Meth. Fluids*, 70(9): 1073-1088.