

# EPSRC Marine Wave Energy Programme Mooring analysis and design for offshore WEC survivability and fatigue (MoorWEC)

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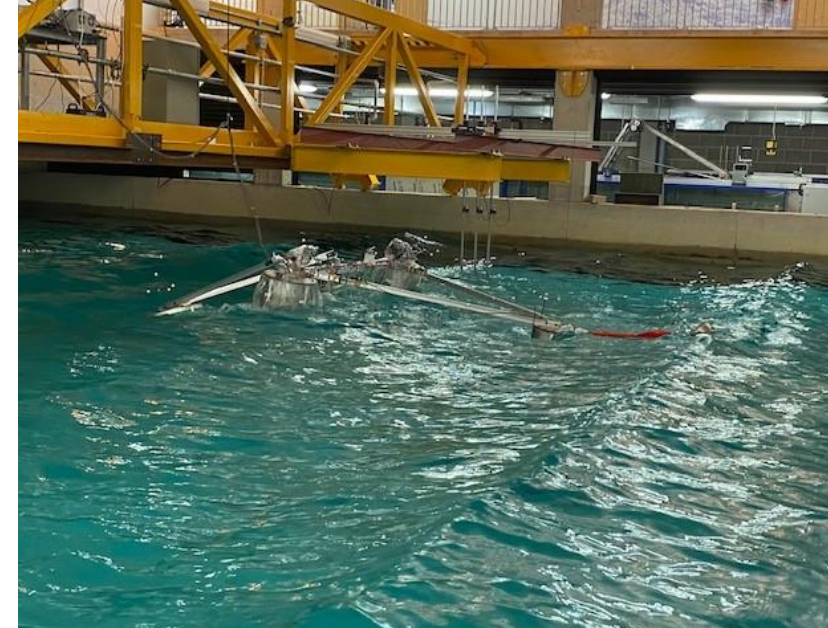
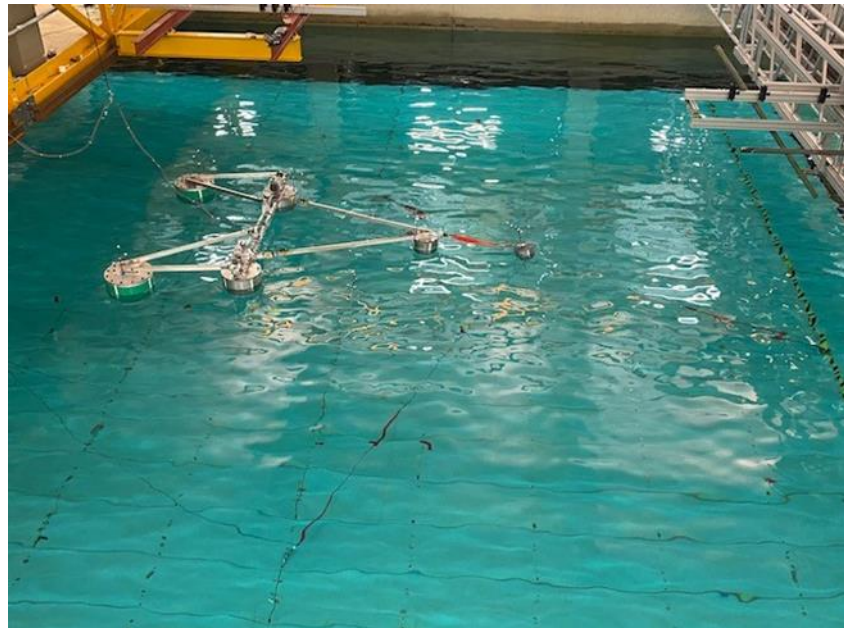
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# Summary April 2024 contents

- Wave basin testing and wave modelling
- System identification of mooring forces
- Hydrodynamic wave-body-mooring modelling – OREGEN
- Hydrodynamic wave-body-mooring modelling – Orcaflex
- With 15 papers listed

## M4 122 configuration in Plymouth COAST basin



# Wave basin testing and wave alone modelling

The wave basin tests have been completed: 3 weeks in COAST, Plymouth and 1 week at FloWave.

Wave modelling by OceanWave3D, UpenFOAM and DualSPHysics is being written up, probably the first comparisons for irregular wave conditions.

Data provided basis for system identification modelling of mooring force from wave conditions, a new approach.

Single float has been modelled , and models for multi-float M4 to be validated.

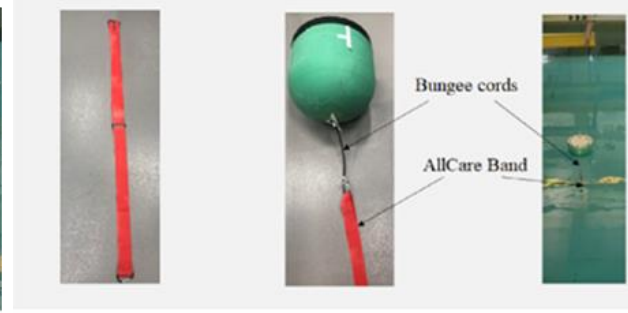
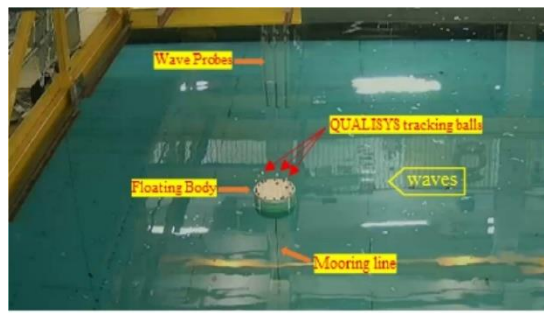
- P. Stansby, S. Draycott, Gangqiang Li, Chenyu Zhao, E. Carpintero Moreno, Ajit Pillai, L. Johanning, 2022 Experimental study of mooring forces on the multi-float WEC M4 in large waves with buoy and elastic cables, Ocean Engineering, 266, 113049
- S. Draycott, P. K. Stansby, M. L. McAllister, T. Davey, L. Jordan, T. Tosdevind , M. Hann 2022 The numerical re-creation of experimentally generated nonlinear irregular wave fields using a time-reversal approach, Applied Ocean Research, 129, 103397
- S. Draycott, P. Stansby, Gangqiang Li 2023 An Experimental Assessment of the Effect of Directional Spreading on Mooring Line Loads for the Multi-float M4 WEC, ISOPE International Ocean and Polar Engineering Conference, Ottawa, ISOPE-I-23-110
- Sam Draycott, P Stansby, Gangqiang Li 2023 Experimental measurements of two elastic taut-slack mooring configurations for the multi-float M4 WEC, Proc. European Wave and Tidal Energy Conference, Lisbon 15
- P. Stansby, S. Draycott 2024 M4 WEC development and wave basin Froude testing, European Journal of Mechanics-B/Fluids 104, 182-193
- S. Draycott et al 2024 Modelling nonlinear wave fields: a comparison between numerical models, in preparation

# System identification of mooring forces

This is a completely novel approach led by Long Zhang for prediction of highly nonlinear mooring forces. The models are based on physical data (laboratory or ocean) or hydrodynamic modelling if not available for design. Models based on limited data may predict force statistics for unseen wave states. The method is now being generalised for design optimisation of mooring systems

- X Wang, D Liang, M Li, P Stansby, L Zhang 2023 Data-Driven System Identification Modelling for Multi-Float M4 Wave Energy Converter with Elastic Bed-Buoy-Bow Float Mooring, Proc. European Wave and Tidal Energy Conference, Lisbon
- L Zhang, S Draycott, P Stansby 2024 System identification and generalisation of elastic mooring line forces on a multi-float wave energy converter platform in steep irregular waves, Mechanical Systems and Signal Processing 214, 111259
- L Zhang, P. Stansby, S, Draycott 2024 Data driven design optimisation of the mooring system for a multi-float wave energy converter using system identification techniques, to be submitted

# OREGEN modelling



OREGEN code has been set up as a consistent framework comprising OREGEN\_BEM (hydrodynamic coefficients), OREGEN\_TIME (nonlinear wave input and excitation with implicit time stepping), OREGEN\_MOOR (moorings). This has been validated for a single float with nonlinear elastic moorings including steep waves. Catenary moorings are being validated with Plymouth data for the Voltun wind platform. The multi-float M4 with hinge constraints comparisons will follow. Efficient methods for second-order surge are being developed in a parallel project HydroMore in Norway.

- Gangqiang Li, P.Stansby 2022 A general computing platform for offshore renewable energy systems (OREGEN), Trends in Renewable Energies Offshore, 807-815
- Gangqiang Li, P.Stansby 2023 Software Framework to Accelerate BEM Linear Wave Load Program Using OpenMP (OREGEN-BEM), ISOPE International Ocean and Polar Engineering Conference, ISOPE-I-23-323
- Gangqiang Li, P. Stansby, S. Draycott 2024 General formulation for floating body with elastic mooring in irregular waves: A hybrid linear and nonlinear framework and validation, Marine Structures 96, 103623
- D.Lande-Sudall, P.Stansby 2024 Efficient Modeling of Extreme Second-Order Surge Response with Spar Substructure Test Case, Available at SSRN 4746880

# Orcaflex modelling

This is being undertaken by Chenyu Zhao and Lars Johanning, now at Plymouth. Limitations of prediction in steep waves are shown but results are otherwise generally satisfactory.

Orcaflex and the linked Orcawave software have validated some hydrodynamic inputs for new OREGEN codes.

- C Zhao, L Johanning, G Li, P Stansby 2022 Comparison of the full dynamic simulation and wave basin test of a multi-float WEC, Trends in Renewable Energies Offshore, 293-298
- C Zhao, P Stansby, L Johanning 2023 OrcaFlex predictions for a multi-float hinged WEC with nonlinear mooring systems: elastic mooring force and dynamic motion, Ocean Eng, 286, 115504