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Editorial

Special issue on experimental investigations of fluid mechanics problems in large ocean research laboratories

Over the past few decades, rapid developments have taken place in fisheries, offshore oil and gas extraction, offshore renewable energy conversion, port activities, and floating offshore platforms. However, extreme ocean climate events, such as strong winds and waves, the rising sea level, and shrinking areas of sea ice, all threaten marine structures. Therefore, researchers are focused on understanding the behavior of ocean and coastal structures in situ to ensure their long-term safe operation and survival.

Advanced laboratory tests play a crucial role in ocean and coastal engineering. Marine tanks and basins provide parameterized experimental environments that can simulate representative sea states involving waves, winds, currents, and tides. Laboratory tests enable naval architects and maritime engineers to understand the behavior and performance of structures in the ocean, and hence evaluate the stability and reliability of such structures in extreme sea states. In coastal engineering, tank and basin tests are used to optimize the design of seawalls and breakwaters and hence mitigate against coastal erosion and inundation. Laboratory tests are also used to check the feasibility of different renewable energy generation options for wave, tidal, and offshore wind power generation.

To ensure measured data are widely applicable, there is an ongoing trend in ocean and coastal engineering towards large-scale physical model tests. Large-scale tank and basin experiments are particularly well suited to the simulation of extreme sea conditions and enable the behavior of ocean and coastal structures to be investigated in such sea states. Large-scale models, even close to full-size models, can be used in modern tanks and basins to reduce scale effects and improve the reliability of experimental results. Nowadays, with the development of artificial intelligence, data assimilation techniques and machine learning also play crucial roles in large-scale laboratory experiments. Engineers use machine learning to optimize experimental parameters and improve experimental efficiency and reliability. Data assimilation techniques comprehensively integrate data from multiple sources, improving predictive accuracy. This special issue presents four papers exploring the use of large-scale laboratory test facilities in ocean and coastal engineering, as follows.

The first paper, entitled “Floating hydroelastic circular plate in regular and irregular waves” by Michele et al. [1], describes the results of physical model experiments performed in a 15.5 m long, 9.0 m wide, 1.9 m deep wave basin in the Coastal, Ocean, and Sediment Transport (COAST) laboratory at the University of Plymouth. This work investigates the response of a floating hydroelastic disk in regular and irregular waves and determines the response amplitude operator. The authors quantify the effects of water depth and plate thickness on the overall dynamic behavior of the circular disk. The paper presents synchronous and subharmonic nonlinear responses for regular waves and displacement spectra for irregular waves.

The second paper, entitled “M4 WEC development and wave basin Froude testing” by Stansby and Draycott [2], introduces the M4 wave energy converter, a moored, multi-float, multi-PTO (power takeoff), multi-mode, attenuator-type system. The paper describes wave basin tests that were performed in a medium-scale basin at the University of Manchester and in the larger-scale basin in the COAST Laboratory at the University of Plymouth to investigate the global characteristics of response, power capture, and mooring loads, and validate a linear diffraction-radiation model. The authors also report wave basin testing of a new mooring design and comment on the limitations of wave basins in controlling wave (and current) conditions and the consequences for related measurements. The authors discuss future wave basin designs aimed at improving laboratory tests essential for the successful deployment of wave energy converters, which would include the effects of beaches, currents, and associated turbulence.

The third paper, entitled “Spatial estimation of unidirectional wave evolution based on ensemble data assimilation” by Zhang et al. [3], discusses the sensitivity of numerical simulations to initial conditions, which has invariably limited the application of the nonlinear Schrödinger equation in wave forecasting. This paper develops a data assimilation framework for wave spatial evolution estimation, which couples Kalman filtering, a data assimilation technique, with the modified nonlinear Schrödinger equation. Unidirectional random wave experiments were performed in the large-scale 300 m long, 16 m wide, 7.5 m deep multifunctional wave tank at Shanghai Jiao Tong University to evaluate the performance of the coupling framework developed by the authors. The paper provides a methodology for enhancing the noise resistance of nonlinear fluctuation models used in predicting the spatial evolution of waves, and thus improves the overall accuracy of model predictions.

The fourth paper, entitled “Experimental and numerical investigation of breakwater-integrated heaving point absorber device under irregular waves” by Aiswaria et al. [4], investigates the performance of a spherical wave energy converter integrated with a chamber breakwater in irregular waves suitable for sea states off the West Coast of India. The paper reports on tests performed on a 1:30 scale model in irregular waves produced in a 50 m long, 1 m wide, 1 m deep wave flume at the Ocean Engineering Laboratory, Indian Institute of Technology, Bombay, India. Two typical scenarios are considered: one where the wave energy converter is restricted to heave, and the other where the wave energy converter is integrated with a chamber breakwater. The authors

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determine the power absorbed by the model and hence assess the effect of integrating wave energy converters with breakwaters. It is demonstrated that the combined system has twin benefits for coastal protection and wave energy conversion.

The foregoing papers cover experiments in large-scale physical test facilities on the hydroelastic characteristics of plates, the hydrodynamic response of a novel wave energy converter, enhanced wave evolution models, and the coupling of heave-type point energy devices with offshore breakwaters. These works provide a snapshot of current developments in physical model tests addressing contemporary fluid mechanics problems using advanced experiments in large-scale ocean tank and basin facilities.

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References

[1] S. Michele, S. Zheng, F. Buriani, A.G.L. Borthwick, D.M. Greaves, Floating hydroelastic circular plate in regular and irregular waves, Eur. J. Mech. – B/Fluids 99 (2024) 148–162, https://doi.org/10.1016/j.euromechflu.2023.01.008.

[2] P.K. Stansby, S. Draycott, M4 WEC development and wave basin Froude testing, Eur. J. Mech. – B/Fluids 104 (2024) 182–193, https://doi.org/10.1016/j.euromechflu.2023.12.007.

[3] Z. Zhang, T. Tang, Y. Li, Spatial estimation of unidirectional wave evolution based on ensemble data assimilation, Eur. J. Mech. – B/Fluids 106 (2024) 1–12, https://doi.org/10.1016/j.euromechflu.2024.02.006.

[4] K. Aiswaria, R. Balaji, P. Krishnendu, Experimental and numerical investigation of breakwater-integrated heaving point absorber device under irregular waves, Eur. J. Mech. – B/Fluids 107 (2024) 40–51, https://doi.org/10.1016/j.euromechflu.2024.04.014.

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