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EVALUATION OF THE ACCURACY OF THE GENERATED WAVE FIELDS IN THE COASTAL & OCEAN BASIN (COB)

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INTRODUCTION

The Coastal & Ocean Basin (COB) wave tank facility is located in the Flanders Maritime Laboratory at the Ostend Science Park, Belgium. The COB and its associated testing services are designed (Troch et al. 2016) to facilitate the needs of the offshore renewable energy sector, coastal and offshore engineering community and offer the opportunity to academia, companies and government agencies, to test scale models under combined action of waves and currents in any relative direction, to develop innovative designs. The exploitation is managed by the consortium Ghent University, KU Leuven and Flanders Hydraulics. The COB is operational since March 2023 and has since then successfully completed its first projects on wave energy converters (WECFarm), wave diffraction study around a monopile (PhairywinD) and floating offshore photovoltaic islands (MarineSpots).

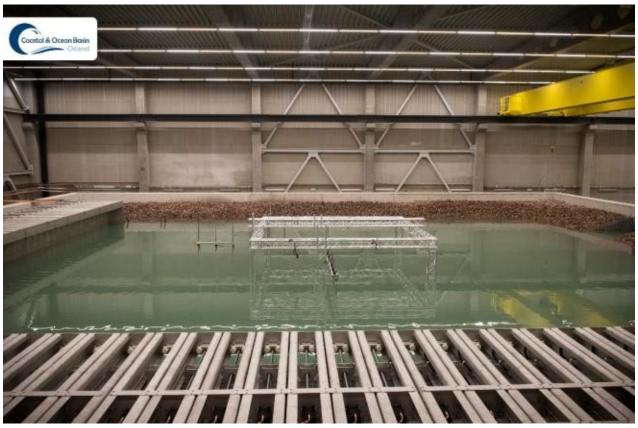

Figure 1. Flanders Maritime Laboratory (left) and wave measurement set-up in the Coastal & Ocean Basin (right).

WAVE FIELD GENERATION

The wave fields in COB are generated by an L-shaped, piston type and wet-back wave generator spanning two full sides of the basin, in combination with a parabolic double-layer rubble mound passive absorber. The wave generator features generation of 1st and 2nd order, regular waves and irregular sea-states, as well as short-crested wave fields and extra's such as cnoidal, bichromatic, focused and solitary waves for a range of operational water depths between 0.3 and 1.4 m. A maximum wave height of 0.55 m can be generated for the design water depth of 1.1 m, together with wave periods physically limited by wave steepness and machine stroke. The wave generator is equipped with active absorption.

Along the other two sides of the wave tank, a passive absorber is installed. A rubble mound passive absorber, with parabolic shape, decreasing porosity towards its core and sharp-edged stones with low chalk contents is selected, to increase the wave dissipation rate and limit the amount of reflected waves from the boundaries ,thereby increasing the quality of the waves in the measurement volume. The design of the passive absorber is based on the comprehensive overview by Ouellet et al. (1986) and fine-tuned based on experimental pre-studies carried out in a wave flume facility.

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QUALITY OF THE GENERATED WAVE FIELD

The quality of the generated wave field and the assessment of wave tank specific uncertainties related to model effects are key to interpreting the measurements from a laboratory facility (Hughes, 1993). Designers rely heavily on the outcome of wave tank tests and the prediction ability of design guidelines, such as EurOtop (2018) or testing standards for wave conversion systems (e.g. Holmes, 2009) or the ITTC is typically based on wave parameters derived from scale model testing and therefore strongly dependant on an accurate and reproducible representation of the wave field within a defined error margin. Hence, two dedicated experimental campaigns have been carried out in COB, in March 2023 and in October 2023, to assess the quality of the generated wave field, by mapping the basin with resistive wave probes (accuracy 0.1% FS) and measuring the obtained wave fields for the operational water depths and wave conditions. The results will be presented at the conference.

First, the performance of the COB in terms of wave generation capabilities is described. This involves deriving steepness, water depth and stroke limitation curves for COB to encompass the possible generated wave fields. Further, to investigate the performance of the passive absorber by decomposing the generated wave fields into reflected and incident components. The accuracy assessment of the wave fields is then based on the comparison of regular wave time series and irregular wave spectral sea state representations to theoretical solutions. The homogeneity of the obtained wave accuracy across the basin and the stability of the wave crest are further investigated. Since the L-shaped wave generator set-up enables the generation of highly oblique waves with an operational direction of 45 ° (diagonal waves), the quality of these waves is assessed in terms of spurious wave content (Lykke Andersen et al., 2020). Finally, the effectiveness of the active absorption at the wave generator and the capability to generate short-crested waves are studied.

CONCLUSION

The capabilities and performance of the newly built wave generation and passive absorption system in the COB wave tank are discussed. Together, both systems are designed to achieve high-quality wave fields inside the measurementvolume of COB. An assessment of the accuracy of the generated wave fields is carried out based on measurements obtained during two experimental campaigns, and the results will be presented at the conference.

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