A coupling methodology for modeling near-field and far-field wave effects of floating structures and wave energy devices

Vicky Stratigaki[1], Peter Troch[1]
[1]Civil Engineering, Ghent University, Technologiepark 60, 9052, Ghent, Belgium
E-mails: vicky.stratigaki@ugent.be, peter.troch@ugent.be

This research focuses on the numerical modelling of wave fields around (oscillating) structures such as wave energy converters (WECs), to study both near and far field WEC effects. As a result of the interaction between oscillating WECs and the incident wave field, additional wave fields are generated: the radiated and the diffracted wave field around each WEC. These additional wave fields, together with the incident wave field, make up the perturbed wave field.

Several numerical methods are employed to analyse these wave fields around WECs. For example, for investigating wave-structure (wave-WEC) interactions, wave energy absorption and near field effects, the commonly used and most suitable models are based on Boundary Element Methods for solving the potential flow formulation, or models based on the Navier-Stokes equations, often referred to as 'wave-structure interaction solvers'. On the other hand, for investigating far field effects of WEC farms in large areas, 'wave propagation models' are most suitable and commonly employed.

However, all these models suffer from a common problem; they cannot be used to model simultaneously both near and far field effects due to limitations. In this research, we developed a generic coupling methodology to combine the advantages of the above two approaches; (a) the approach of wave-structure interaction solvers, which are used to investigate near field effects because they can more correctly model wave energy absorption and the resulting wave fields induced by oscillating WECs or WEC farms. These solvers suffer from high computational cost and thus are mainly used for limited: (i) areas around WECs; (ii) number of WECs, and (b) the approach of wave propagation models, which are used for predicting far field effects and which can model the effect of WEC farms on the wave field and the shoreline in a cost-effective manner, but usually cannot deliver high-fidelity results on wave energy absorption by the WECs. In addition, in our research we developed a wave generation technique for generating the perturbed wave field induced by an oscillating WEC, in a wave propagation model. The results obtained from the proposed coupling methodology and wave generation technique along a circle have been validated ([1], [2]) and show very good agreement.

This research is situated in the topics of "Working Group 1: Numerical hydrodynamic modelling for WECs, WEC arrays/farms and wave energy resources" of WECANet.

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References

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