Coupling methodology for modelling the near field and far field effects of an array of wave energy converters

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Wave Energy Converters (WECs) are devices used to capture ocean energy into useable electricity. In order to produce a large amount of electricity at a competitive cost, arrays composed of large numbers of WECs will need to be deployed in the ocean. Due to hydrodynamic interaction between the WECs (near field effects), the geometric layout of the array is a key parameter in maximizing the overall array power production and minimizing far field array effects on the surrounding area and wave field. Consequently, it is essential to model both the near field and far field effects of a WEC array. Modeling both effects by employing a single numerical model that offers the desired precision at a reasonable computational cost, is, however, still a great challenge.

Two types of models are mainly used to model WEC array effects: wave interaction solvers and wave propagation models. Wave interaction solvers can accurately model the physical processes of wave energy absorption by solving the body motion. They are accurate but their computational cost increases exponentially for large numbers of WECs in arrays and large domains and therefore when modelling far field effects. Wave propagation models can model the WEC array far field effects in large domains at a reasonable cost, however the simplifications when representing the WEC near field effects and absorption can lead to errors. The objective of this research is to present a coupling methodology that will combine the strengths of both types of models to model the entire spectrum of WEC array interaction.

The proposed coupling methodology is based on a one-way coupling between the wave interaction Boundary Element Method (BEM) solver, NEMOH, and the depth-averaged mild-slope wave propagation model, MILDwave. In a one-way coupling the wave field for each numerical model is calculated independently. In the presented cases, NEMOH is used to resolve the near field effects whilst MILDwave is used to resolve the far field effects.

The coupling methodology consists of the superposition of two different wave field simulations: an incident wave field and a radiated/diffracted wave field. The incident wave field is calculated intrinsically in MILDwave. The diffracted/radiated wave field is calculated around the WEC array in NEMOH and then propagated in MILDwave by imposing it on an internal wave generation boundary along a circle. The WEC type presented in this study is a heaving flat disk buoy, similar to the WECs currently planned for commercial array projects in the UK, Australia and Sweden.

Results are presented for different sets of conditions for regular waves with varying wave periods. In the immediate domain around the WECs (the near field), the resulting wave field is compared to the wave field provided by NEMOH, used to assess the accuracy of this coupling methodology. A good agreement is found between the NEMOH wave filed and the coupled wave field in MILDwave. The effects of varying the number of bodies, the incident wave period and the coupling radius are detailed. The advantages and disadvantages of the coupling methodology are also discussed when modelling WECs arrays.

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Keywords: WEC arrays; hydrodynamic interaction; wave propagation; coupling; MILDwave; boundary elements method

References

- LHEEA. Nemoh, open-source BEM linear wave solver. http://lheea.ec-nantes.fr/doku.php/emo/nemoh/start. 2014. [Accessed 21-12-2016]
- Troch, P., MILDwave – *A numerical model for propagation and transformation of linear water waves.* Internal Report, Dept. of Civil Engineering, Ghent University, 1998.