

Large scale experiments on farms of heaving wave energy converters

Stratigaki Vasiliki and Peter Troch

Department of Civil Engineering, Ghent University, Technologiepark 904,
B-9052 Zwijnaarde, Belgium
E-mails: vasiliki.stratigaki@ugent.be ; peter.troch@ugent.be

The shrinking reserves of fossil fuels in combination with the increasing energy demand have enhanced the interest in sustainable and renewable energy sources, including wave energy. In order to extract a considerable amount of wave power, large numbers of Wave Energy Converters (WECs) will have to be arranged in arrays or farms using a particular geometrical layout. The operational behaviour of a single device may have a positive or negative effect on the power absorption of the neighbouring WECs in the farm (so-called near-field effects). As a result of the interaction between the WECs within a farm, the overall power absorption is affected. Finally, the wave height behind a large farm of WECs is reduced (Troch *et al.*, 2010; Stratigaki *et al.*, 2011) and this reduction may influence neighbouring farms, other users in the sea or even the coastline (so-called far-field effects).

Several numerical methods have been employed to analyse the response of WECs. Boundary Element Methods (BEM) based on potential flow have been used intensively to study the hydrodynamic interaction of multiple oscillating bodies (near-field effects) for small computational domains. To study far-field effects, a much larger computational domain is required. In this case, wave propagation models are generally employed (e.g. MILDwave (Troch, 1998)).

In contrast to the quantity of numerical analysis of WEC arrays and the large body of experimental work concerning individual or pair of WECs (e.g. Babarit *et al.*, 2009), only a very limited number of experimental studies of WEC arrays have been published. In the last decade, a few experimental measurements of the response and power output of small arrays of closely-spaced heaving floats were reported, e.g. in (Stallard *et al.*, 2008), Supergen programme etc.

Experimental studies concerning wake effects of large WEC-farms (near-field and far-field effects) are not available in literature. Within the HYDRALAB IV European programme, access to the Shallow Water Wave Basin of DHI (Denmark) has been granted for the present research. The objective of those innovative experiments is to cover the gap of experimental studies in the literature and to determine near-field and far-field effects from large farms of Wave Energy Converters. In this research project, the wake effects by farms composed of devices of the oscillating type (point absorbers) are investigated for several farm configurations and various wave conditions.

The main objective of this research is to improve the understanding of wake effects and the modification of wave conditions due to energy extraction by WEC farms. Knowledge of both the behaviour of a single WEC affecting its neighbours (near-field effects) and the shadow effects behind a large farm (far-field effects) including the measurement of the dimensions of the wakes, are important for the design of a WEC-farm.

Moreover, it is essential to understand the behaviour of a 'farm' of Wave Energy Converters under several wave conditions and to quantify the effect on power absorption by modifying: (i) the distances between the WECs in a farm, (ii) the number of the WECs in a farm and (iii) the farm geometrical layout.

Acknowledgements

This study is conducted within the frame of HYDRALAB IV, EU project. Moreover, the first author would like to acknowledge her Ph.D. funding grant by the Research Foundation – Flanders, Belgium ("Fonds voor Wetenschappelijk Onderzoek – Vlaanderen", FWO). The authors would also like to acknowledge FWO for funding the construction of the WECs.

References

- Babarit A., H. Mouslim, A. Clément and P. Laporte-Weywada. 2009. On the numerical modelling of the non-linear behaviour of a wave energy converter. 28th Int. Conf. Ocean, Offsh. & Arctic Engin., Hawaii.
- Stallard T., P.K. Stansby and A. Williamson. 2008. An experimental study of closely spaced point absorber arrays. Proc. 18th International Offshore & Polar Engineering Conference, Canada.

- Stratigaki V., P. Troch, L. Baelus and Y. Keppens. 2011. Introducing wave regeneration by wind in a mild-slope wave propagation model, MILDwave, to investigate the wake effects in the lee of a farm of wave energy converters. Proc. of the 30th OMAE 2011, Rotterdam.
- Troch P. 1998. A numerical model for propagation and transformation of linear water waves. Department of Civil Engineering, Ghent University.
- Troch P., C. Beels, J. De Rouck and G. De Backer. 2010. Wake effects behind a farm of wave energy converters for irregular long-crested and short-crested waves. 32nd International Conference on Coastal Engineering, Shanghai, China, ASCE. (in press).