Title of Diploma Thesis

Optimum Layouts of an Array of Wave Energy Converters in front of Vertical Wall

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ABSTRACT

In this diploma thesis, the optimum, in terms of power absorption optimization, layouts of an array of five, semi-immersed, oblate spheroidal heaving Wave Energy Converters (WECs) situated in front of a bottom-mounted vertical wall of finite length under the action of regular waves is investigated. The optimum layouts are determined for a given incident wave frequency and incident wave direction and they satisfy spatial constraints related to: (a) the perpendicular distance of the WECs from the wall, (b) the WECs' in-between distances, (c) the length of the wall available for the WECs' placement and (d) symmetry considerations (for perpendicular to the wall waves).

The required diffraction/radiation problem is solved in the frequency domain by utilizing the conventional Boundary Integral Equation method, which is numerically realized using WAMIT software. For solving the constrained optimization problem, a Genetic Algorithm solver is developed and it is coupled with WAMIT in the MATLAB computational environment. The developed algorithm is validated by comparing its results with the parametric results of other investigators for the case of a linear WEC array.

Under the action of perpendicular to the wall waves with frequency equal to the WECs' heave natural frequency, the formation of the array's optimum layout depends upon the length of the wall available for the WECs' placement. When the total available length of the wall is utilized, an "arrow"-shaped optimum layout, situated at a large perpendicular distance from the wall, is formed. However, by exploiting part of the total available length of the wall, a "trapezoidal" optimum layout is realized. Under the action of perpendicular to the wall waves with frequency smaller than the WECs' heave natural frequency, the WECs are arranged as close as possible to the wall along a straight line parallel to the boundary regardless of the wall length utilized for the WECs' placement. Moreover, WECs are grouped into 2-body "clusters", which are situated close to the wall edges. The above optimum layouts satisfy symmetry considerations with respect to the incident wave direction, which enhance the array's power absorption ability compared to the case of a totally random WECs' placement. Finally, the action of oblique incident waves leads to optimum layouts that show a significantly decreased power absorption ability compared to the layouts obtained for perpendicular to the wall waves.

Keywords: Wave energy, Wave energy converters, Wall, Optimum layouts, Genetic Algorithm, Power absorption.