Numerical analysis of a dual WEC system in a breakwater

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ABSTRACT

Sea ports are infrastructures with substantial energy needs leading to air pollution and other environmental impacts. Thus, the integration of Wave Energy Converters (WECs) at ports will put these infrastructures on the right track for their commitment to sustainable and environmentally friendly development and operations. The breakwaters are designed to withstand wave action and promote the dissipation of wave energy, creating sheltered conditions for port activities. The high potential of these structures for the integration of WECs, due to their high exposure to ocean waves, triggered the SE@PORTS project (OCEANERA/0003/2016). The main objective of the SE@PORTS project is to access existing WEC's suitability to be integrated in port infrastructure and bring the selected concepts to the next TRL.

The present work describes the numerical analysis, validated by means of experimental tests, developed for the integration of a combined WEC on a vertical breakwater based on the combination of two state-of-the-art technologies, the Oscillating Water Column (OWC; Mutriku in Spain, 2008) and the Overtopping Wave Energy Converter (OWEC; Naples, 2013).

Since two energy converter devices are going to be analysed together (OWC and OBREC), a first individual analysis is performed for each WEC. The OWC design has been performed following two approaches. First an analytical approach was done, where different OWC chamber geometries and their resonance frequencies were analysed. Secondly a numerical analysis using NEMOH model, which is an open source software that computes the hydrodynamic coefficients, added mass, damping and excitation forces, of a floating body using the Boundary Element Method (BEM) was conducted. For the OBREC design, a numerical analysis was performed using IH2VOF model (http://ih2vof.ihcantabria.com), which is an extensively tested and validated 2DV RANS model, which uses the VOF method to track the free surface developed at IHCantabria. To set up the simulations, a new boundary condition was implemented in the model, consisting in taking flow from the reservoir as a function of the hydraulic head. Finally, to perform the final design of the caisson considering both technologies integrated on it, a hybrid modelling methodology (combining physical and 2D/3D numerical modelling) was followed, which will be presented in this work. For the 3D numerical analysis, IHFOAM tools implemented in OpenFOAM (https://ihfoam.ihcantabria.com/) was used. This model solves the three-dimensional RANS equations for two incompressible phases using a finite volume discretization and the VOF method. Within this hybrid methodology, physical model results were then used to calibrate (and also validate) the numerical model, and based on that the final innovative caisson was defined. During the presentation, the potential implementation in Lal Palmas (Canary Island, Spain) will be shown.