Title of Diploma Thesis

Wave Energy Exploitation at the Port of Heraklion

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ABSTRACT

In recent years, there is an extensive interest in exploiting efficiently renewable enegy sources, attributed to the increase of energy demands, the lack of fossil fuels and climate change effects. Wave energy presents an abundant renewable energy source and is considered by many investigators as a major and promising resource.

Motivated by this, the present thesis focuses on the exploitation of wave energy by utilizing a floating, heaving Wave Energy Converter (WEC) in the leeward side of a vertical breakwater. Specifically, considering the inefficient application at a pilot stage, of a floating cylindrical heaving WEC placed at the port of Heraklion, in Crete, in the leeward side of the existing vertical breakwater, in this thesis: (a) the aforementioned WEC (WEC 1) is numerically modeled and its performance (hydrodynamic behavior and energy production) is investigated and assessed, aiming at identifying the causes of its ineffective implementation and (b) the deployment of another floating, cylindrical WEC of different dimensions (WEC 2) is proposed for the efficient exploitation of the available wave potential in this area and its performance is numerically investigated and assessed.

For both WECs (WEC1, WEC2), their performance is, initially, investigated and assessed under the action of regular waves. Each WEC is considered to be placed in front of the leeward side of the existing vertical breakwater (in full agreement with the physical problem) and to oscillate freely along their vertical axis (heave motion). Moreover, wave energy is absorbed through a linear Power Take Off (PTO) mechanism, which is actuated from the heave motion of each WEC. Emphasis is given on the affect of the distance between the WEC and the breakwater and the incident wave direction on the hydrodynamic behavior and energy production of the WEC.

The implementation of all the above is achieved through the numerical analysis of the examined WECs in frequency domain by applying an appropriate numerical model (WAMIT). The model enables the calculation of all quantities, describing the hydrodynamic behavior of the two WECs, as well as the calculation of the finally formed wave field.

Finally, based on the wave characteristics of the area, where the WECs are installed and by utilizing the TMA spectrum (modified JONSWAP spectrum for accounting depth effects on the spectral density), the energy absorption of the two WECs is calculated and compared for irregular waves.

Keywords: Wave Energy, Floating Heaving Cylinder, Vertical Wall, Hydrodynamic Coefficients, TMA Spectrum.