Title of Diploma Thesis

3D Experimental and Numerical Investigation of the Performance of a Floating Breakwater

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ABSTRACT

Floating Breakwaters (FBs) are nowadays considered as a technologically modern and environmental friendly alternative solution to conventional, bottom mounted breakwaters. The most typical configuration of FBs consists of an array of floating individual modules of trapezoidal longitudinal cross section, which are connected to each other with flexible connectors and are moored to the seabed with inelastic mooring lines (made of chain).

In the present thesis, the dynamic/structural behavior and the effectiveness of a FB are investigated numerically and experimentally in three dimensions under the action of perpendicular and oblique regular waves. The examined configuration of the FB consists of three identical modules of trapezoidal longitudinal cross section, which are connected to each other with hinges (flexible structural system) and are moored with inelastic mooring lines made of chain. The objectives of the present thesis are as follows: (a) validation of the applied numerical models and methodologies that have been developed from other researchers and enable the numerical modeling of floating structures similar to the examined configuration of the FB and (b) investigation of the effect of the incident wave characteristics on physical quantities describing the dynamic/structural behavior and the effectiveness of the examined FB, through the combined use of numerical and experimental models.

The numerical modeling is implemented through the application of WAMIT and MOORSIM-FREQ 96. WAMIT is a radiation/diffraction panel program developed for the linear frequency domain analysis of the interaction of surface waves with offshore floating structures. The objective of the MOORSIM-FREQ 96 numerical code is the static and the frequency domain dynamic analysis of the mooring lines of the examined FB. This code enables the calculation of all the physical quantities that describe the mooring lines' behavior. The two aforementioned numerical models are coupled using an appropriate iterative procedure until convergence is achieved in terms of specific convergence criteria. As far as the experimental modeling of the examined FB, the experimental data are obtained from corresponding 3D experiments (scale 1:20) that were conducted by the supervisor of the thesis in a 3D basin at the Technical University of Istanbul. Appropriate processing and analysis of the above data are implemented in the present thesis in order to calculate the statistical quantities describing the dynamic/structural behavior and the effectiveness of the examined FB.

The validation of the applied numerical models and of their coupling procedure is implemented through comparison of experimental results (mooring lines' tensions, wave field at specific positions in the leeward side of the FB) with the corresponding numerical results obtained in the present thesis. Moreover, the numerical results (including also the hydroelastic response of the FB) are compared with experimental results corresponding to a FB's configuration, where the floating modules are connected to each other with flexible connectors. Based on this comparison, the applicability of the present numerical models in the case of flexible connectors' consideration is investigated. Finally, through the combined use of the aforementioned numerical and physical models, the effect of the incident wave characteristics (wave period, wave height, wave angle) on appropriately selected physical quantities is investigated and highlighted. These quantities describe the dynamic behavior (generalized dynamic response in the various degrees of freedom, hydroelastic response), the structural behavior (mooring lines' tensions) and the effectiveness of the FB (wave field in the leeward side of the FB).

Keywords: Floating breakwaters, 3D numerical modeling, 3D experimental modeling, Numerical model's validation, Dynamic/structural behavior.