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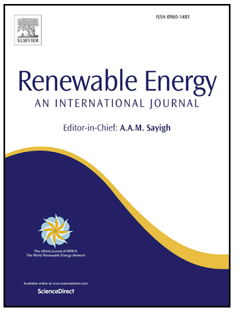

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On Survivability Of Asymmetric Wave-Energy Converters In Extreme Waves

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Abstract

To provide guidance for improving the survivability of asymmetrical wave-energy converters (AWECs), the forces experienced by them in breaking-waves condition were analyzed and reported. "The Berkeley Wedge" (TBW), a highly efficient wave-energy converter and floating breakwater, was used as a canonical study. The forces were obtained by computation using the Weakly Compressible Smoothed Particle Hydrodynamics (WCSPH) method and by model-scale experiments. Breaking waves were first generated upstream for both physical and computational modeling by developing appropriate time histories of a wavemaker. Plunging breakers and wave forces from the computational model were verified by experiments for different drafts. To increase the survivability, while retaining the same operational draft of TBW, pressure-relief channel (PRC), a novel scheme that allowed water to flow through TBW was modeled and its effectiveness in extreme-waves was demonstrated computationally. A design was proposed to operate the PRCs so as to increase the survivability of such AWECs.

Keywords: Wave Energy, Asymmetric Wave-Energy Converter, Survivability in Waves, Wave-Structure Interaction, Extreme-Wave Loads

1. Introduction

The negative effects of fossil fuels consumptions are becoming more and more apparent on the environment and our daily lives. Parallel to this, many movements and research projects have been initiated to increase the efficiency and reliability of the means of harnessing renewable energy resources [1]. Solar, wind, geothermal, ocean waves, etc., are abundant sources of energy and can be used in combinations to overcome the energy crisis [2] and to reduce fossil fuel consumption. One of the resources with high potential, availability, and predictability is ocean waves [3, 4]. Many devices have been proposed or implemented for harvesting wave energy [5]. However, ocean is an unforgiving environment and wave energy converters (WEC) face multiple destructive forces such as corrosion, fatigue, and large forces caused by extreme waves.

A promising recent design of an asymmetric WEC (AWEC) called "The Berkeley Wedge" (TBW) [6], was shown to have a wave energy extraction efficiency of more than 90%. TBW is a one-degree of freedom system consisting of an asymmetric heaving floater (AF), a power-take-off system (PTO), and a mounting structure. This specific AF is designed so that it experiences a small viscous effect. It has been shown, both in theory and by experiment that TBW can act as a nearly perfect AWEC, and concurrently as a breakwater at resonance when the damping of the PTO is matched with the radiation damping of the AF. In those analyses, incident waves were assumed to be linear and time-harmonic. Furthermore, the heaving motion of the AF was relative to a fixed mounting structure above the water surface. The mounting structure can be bottom mounted for nearshore installation or attached to the side of large floating platforms for deep-water usage [7]. The orientation of the mounting structure and AF allows the PTO electronics to be well above the water surface, hence reducing the chances of water damage. The PTO, as developed in

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