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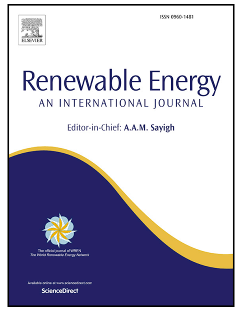

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Modelling an articulated raft wave energy converter

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Abstract

In this paper we develop an efficient mathematical solution method for an articulated raft wave energy converter. Representative of Pelamis and the Cockerell raft design, it is comprised of a series of floating pontoons connected via hinges. Power is generated through the relative motions of adjacent elements which are excited by the incident wave as it passes along the length of the device. Using an efficient semi-analytic solution we are able to generate results more quickly than would be possible using a panel-based numerical code such as WAMIT. This allows us to explore the parameter space quickly and thus to develop an understanding as to what elements of raft-type wave energy converter design allow it to generate power so successfully. We find that the capture factor increases proportionately to the number of pontoons, a focusing effect that allows the device to absorb far more power than that which is directly incident upon its frontage. Hinge position and device proportions are also significant with results favouring long, narrow rafts made up of pontoons of increasing length from fore to aft.

Keywords: hydrodynamic, wave energy converter, articulated raft, optimisation, mathematical model.

1. Introduction

Ocean waves have long been of interest as an abundant source of energy and a wide variety of devices has been conceived over the years with the intention of harnessing their potential. Indeed, in response to the oil shortage of the 1970's the UK government initiated a major Wave Energy programme. This attracted the attention of a wide range of scientists and engineers and many ideas for capturing wave energy were proposed. Of particular note is the seminal work of Stephen Salter [15], published in *Nature* in the mid 1970's it demonstrates that efficiencies up to 80% may be achieved by a cam-shaped cylindrical device called the Salter 'duck'. This was one of the earliest wave energy designs to gain funding from the programme along with the Bristol cylinder of Evans [3], the NEL oscillating water column [6] and the Cockerell raft of Sir Christopher Cockerell [2].

In general, wave energy device concepts fall into three main categories: terminators, attenuators and point absorbers. Terminators are oriented perpendicular to the incident wave direction to provide the maximum wave frontage of the device. Meanwhile, attenuators extend parallel to the incident wave direction with the intention of progressively extracting energy along the length of the device and point absorbers are small relative to the incident wavelength, generally being deployed in large arrays. All are designed with the intention of converting the oscillatory motion of sea waves into a usable form of renewable energy. An assessment of the performance of various wave energy device types can be found in [14], for example.

Early work was predominantly focused on terminator type devices, perhaps in part due to the extensive use of two-dimensional wave tank testing in which a device filled the entire width of the tank. Salter's 'duck', the Bristol Cylinder and the NEL are all terminator type devices and whilst Cockerell's raft was originally conceived as a longer attenuator type raft chain, early experiments were disappointing and the design quickly evolved into a terminator

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