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SEAWAVE SLOT-CONE GENERATOR OVERTOPPING PERFORMANCE IN 3D CONDITIONS

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INTRODUCTION

This paper presents physical model tests results on wave overtopping on an innovative caisson breakwater for electricity production. The work reported here contributes to the European Union FP6 priority 6.1 (Sustainable Energy System). The design of the structure consists of three reservoirs one on the top of each other to optimize the storage of potential energy in the overtopping water (Sea wave Slot-cone Generator, SSG).

3D tank tests have been carried out at the Hydraulics and Coastal Engineering Laboratory of Aalborg University in order to measure the overtopping flow rates in the three reservoirs. The flow rates are directly related to the efficiency of the device based on the overtopping principle: the overtopping water is stored in different reservoirs depending on the wave height and on it way back to the swl passes through a turbine spinning it up and so generating electricity. The advantage of the converter consists on its simplicity and robustness. The Norwegian company WAVEenergy AS is constructing a pilot at the island of Kvitsøy, Norway.

OBJECTIVES

The effect of the wave height on the overtopping water for each reservoir has been studied as well as the influence of the period. Moreover a comparison between tests in 2D conditions has been done in order to separate and analyse the effects of bathymetry, spreading and directionality of the wave spectrum on the overtopping flow rates.

EXPERIMENTAL DATA

The model scale of the SSG wave energy converter pilot plant that has been tested is scale 1:60 under different 3D wave conditions. The model has been fixed to the scaled reproduction of the cliff of the location where it will be installed and the bathymetry of the area has been reproduced. The overtopping on the SSG model has been tested under 5 different significant wave heights and periods, 8 spreading conditions and 8 wave directions. The captured overtopping water was temporarily stored in small tank containers (one for each reservoir) equipped with pumps of know capacity that were pumping back the water in the basin. The total utilization of the pumps and the records of water levels inside each tank container have derived the overtopping flow rates for the singles reservoirs. Incoming 3D waves have been measured by 7 wave gauges in a trapezoidal configuration.

PRELIMINARY RESULTS

Preliminary analysis results are highlighting the influence of the wave period on the overtopping flow rate with respect to the relative crest freeboards. In particular a different behaviour is noticeable for the three reservoirs:

- For the 1st reservoir (Figure 1) results show a flow rate increasing due decreasing of wave length/period.
- For the 2nd reservoir, the flow rate also increases due to decreasing of wave length/period but the higher crest free board

- For the 3rd reservoir we assist to a different trend due to the fact that the higher reservoir is completely open.

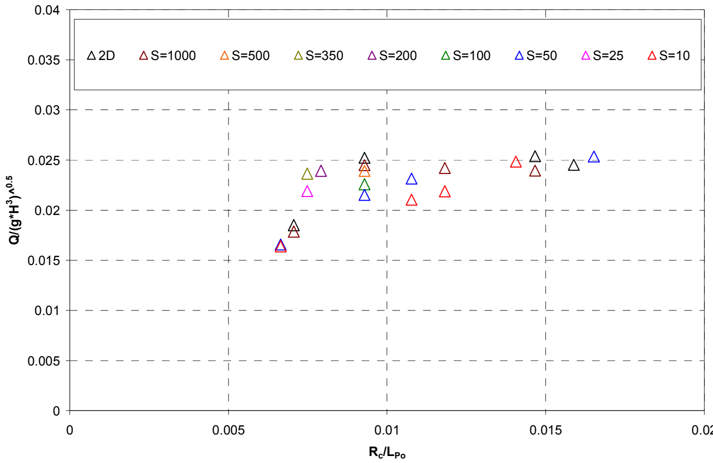

Figure 1. Wave period effects: dimensionless overtopping against relative freeboard for lower reservoir

Defining the hydraulic efficiency as the ratio between the stored overtopping power and the incoming wave power, it has been found that the effect of spreading, bathymetry and directionality is reducing the hydraulic efficiency of the SSG pilot plant by 50% with respect to a 2D head on wave's attack condition. The higher is the spreading and the higher is the module of the attack angle, the higher is the loss on stored overtopping water (e.i. stored overtopping power).

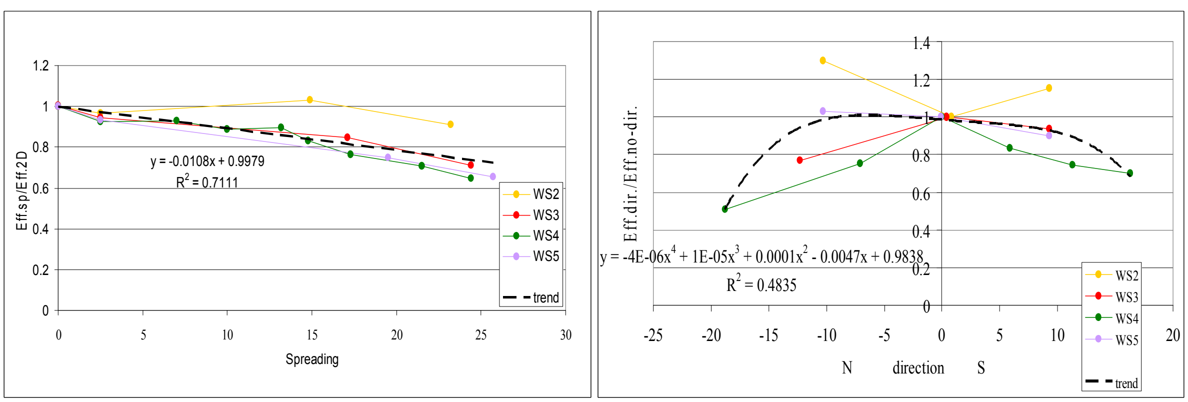

Figure 2. Effect of spreading and directionality on the hydraulic efficiency of the SSG Pilot Plant.

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