Optimization of Overtopping Wave Energy Converters

Introduction

The general principle of overtopping wave energy converters is shown in Figure 1. It is based on wave run-up on a slope and overtopping into a reservoir that is emptied into the sea through a turbine.

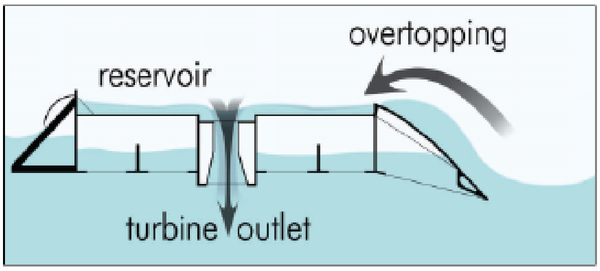

Figure 1 - Overtopping principle (Wave Dragon [1])

Figure 2 – Seawave Slot-Cone Generator SSG [2]

An overtopping device can be either a “fixed” construction (“on shore fixed structure”), e.g. the Seawave Slot-Cone Generator (SSG) developed by the Norwegian company WaveEnergy AS (Figure 2), or a floating construction in deeper water (“offshore floating structure”), e.g. the Wave Dragon developed by Wave Dragon ApS (Denmark) (Figure 1).

Optimization

It is clear that for this type of WEC the regulation of the amount of water in the reservoir(s) is a very important issue for a maximal absorption of the energy present in the waves and for an energy output that is as constant as possible. When the volume that overtops into the reservoir - wave by wave - is known, the turbine/control strategy can be adjusted accordingly to achieve an optimal efficiency of the device. This requires a time domain approach to predict the overtopping volumes wave by wave.

Big waves can occur one after the other or very well spread in time. This wave groupiness of the incoming waves has a big influence on the individual and average overtopping volumes. But also tide level and foreshore – for onshore fixed structures – and changing mass distribution due to water in the reservoir(s) and floating level – for off shore floating structures – are important parameters for the overtopping volumes that need further examination.

Focus of study

At the Civil Engineering Department of Ghent University, the hydrodynamic behavior of overtopping wave energy converters is investigated and optimized in a fundamentally experimental and numerical (integrated) study. A commercial solver for the Navier-Stokes flow equations using the Volume-Of-Fluid(VOF)-technique for the free surface configuration (FLOW3D) is used for the numerical part. Both 2D (wave flume) and 3D (wave tank) physical tests are used to validate the numerical study.

Some figures of the experimental and numerical study are shown below.

Figure 3 - Picture of test set-up in Aalborg, Denmark

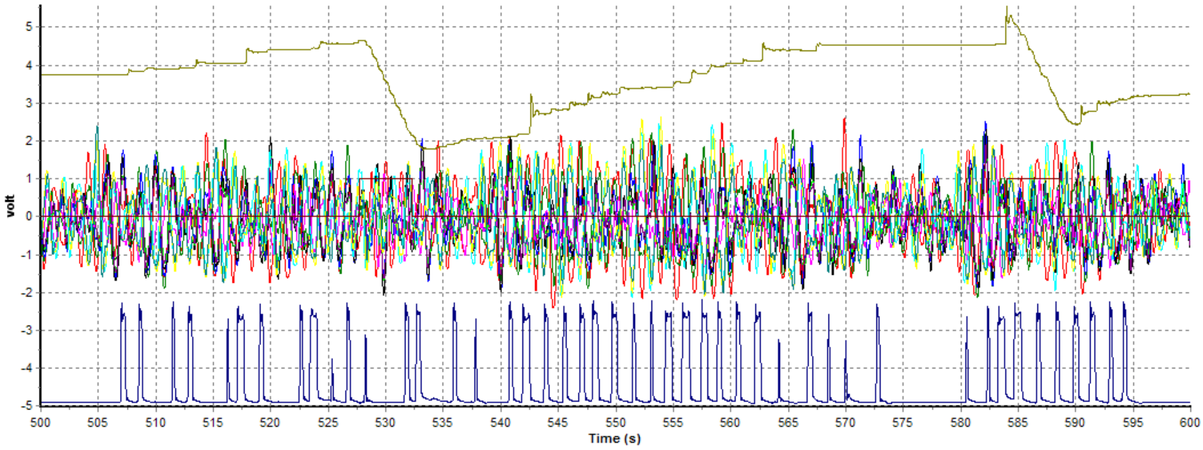

Figure 4 - Example of output test set-up Aalborg, Denmark (WaveLab®)

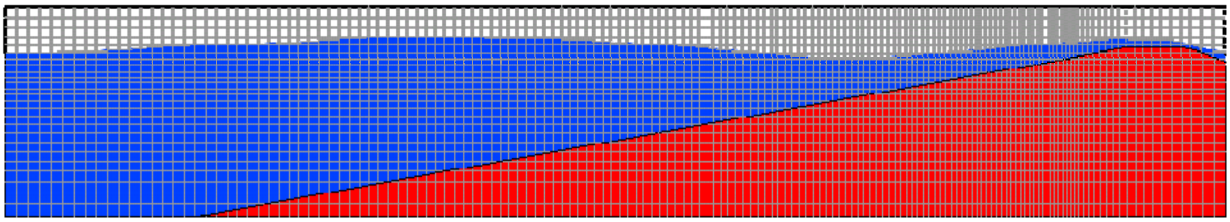

Figure 5 - Implementation of wave overtopping in FLOW3D®

[1] www.wavedragon.net
[2] www.waveenergy.no

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