Optimization of an oscillating wave surge converter

Summary

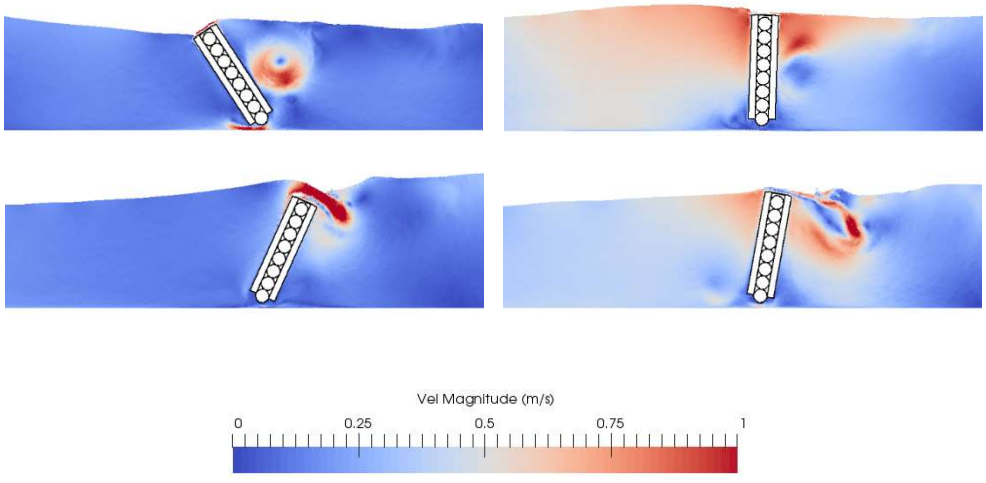
This PhD dissertation is aimed at advancing the design of an Oscillating Wave Surge Converter (OWSC). The specific objectives of this thesis are: (i) adapt/implement a Smoothed Particle Hydrodynamics (SPH) numerical model of OWSC considering the hydrodynamic interaction of the wave with the flap and the hydraulic power take-off (PTO) system; (ii) plan, prepare and do numerical model tests of OWSC, envisaging the maximization of its efficiency for several configurations; (iii) plan, prepare and do physical model tests of an OWSC; and (iv) validate the numerical model using the new experimental data in the specific conditions of the Uruguayan coast.

A new robust numerical model was developed to provide an integrated framework to model complex fluid-structure-structure systems. This model is based on implementation of Project Chrono's library under DualSPHysics code. The SPH model of DualSPHysics is used to model the fluid and structure interaction and Project Chrono's library implementation is used to describe the mechanical systems. Its DVI implementation allows for the straightforward definition of complex mechanical systems such as contacts, constraints, joints and sliders. To validate the dynamic behaviour of PTO system and the hydrodynamic characteristics of OWSC two groups of physical model tests were carried out. In the first group, different magnitudes of regular and irregular excitation forces were applied to the PTO system. In the second group, a 1:10 scale OWSC model with above PTO system was driven by regular and irregular waves. These tests provide new data for the validation of numerical models, including free surface elevation, pressure in the PTO system, rotation angle and angular velocity of the flap, velocity fields, as well as Reynolds stresses and turbulent kinetic energy.

The comparison between experimental and numerical results show that the numerical model can predict, with a satisfactory accuracy, most of dynamic behaviours of PTO system and hydrodynamic characteristics of OWSC.

Keywords

Numerical modelling, laboratory experiments, oscillating wave surge converter (OWSC), meshless methods, Smoothed Particle Hydrodynamics (SPH), DualSPHysics, Project Chrono, fluid-structure-structure interactions, hydraulic power take-off (PTO) system.



Different instants of the simulation with regular waves interacting with the OWSC.

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