Numerical design of floating Oscillating Water Column moored to the seabed

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GOBIERNO DE ESPAÑA · MINISTERIO DE ECONOMÍA Y COMPETITIVIDAD

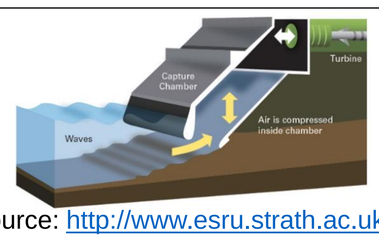
WELCOME: Numerical design of floating Wave Energy COnverter MEchanisms: efficiency and survivability
ENE2016-75074-C2-1-R. January 2017 – December 2019

Institutions working on the project: Universidade de Vigo · UNIVERSITEIT GENT · tecnalia Inspiring Business

Institutions supporting the project: The University of Manchester · TÉCNICO LISBOA · OCEANTEC · wavepower · VICINAY marine innovación · ABENGOA

OBJECTIVE

This project aims to develop a **numerical tool to study wave energy converters**.
In particular, floating OWC (Oscillating Water Column) moored to the seabed will be studied.
This software will be used to optimize the design of the devices by analyzing its **efficiency** under different wave conditions, chamber dimensions and PTO systems (Power Take-Off). Secondly, the **survivability** of the floating device will also be studied under extreme sea conditions, obtaining the optimum mooring layout to increase the lifetime of OWC, in high energy coasts.



Source: http://www.esru.strath.ac.uk/

NUMERICAL MODELLING: DUALSPHYSICS

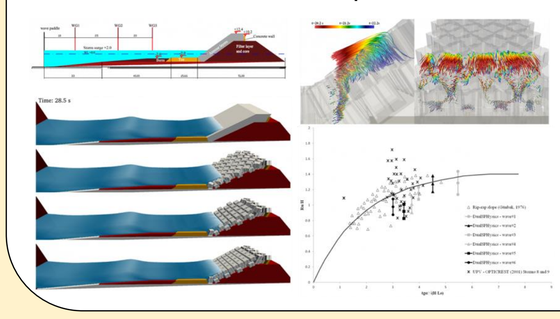
Smoothed Particle Hydrodynamics (SPH) describes a fluid by replacing its continuum properties with locally smoothed quantities at discrete Lagrangian locations named particles. Each particle is a nodal point where physical quantities are computed as an interpolation of the values of the neighbouring particles solving the Navier-Stokes equations. Hence, the domain can be multiply-connected with no special treatment of the free surface, making it ideal for examining complicated flow situations. The **DualSPHysics** code is here applied to simulate the interaction between sea waves and OWC.

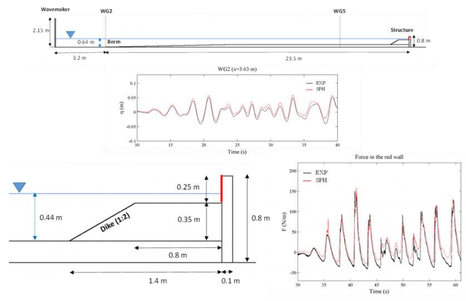
cpu gpu DualSPHysics

FUNCTIONALITIES OF DUALSPHYSICS

Fluid-structure interaction

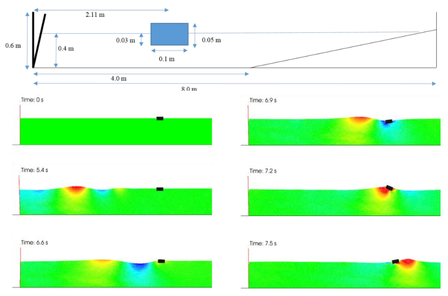
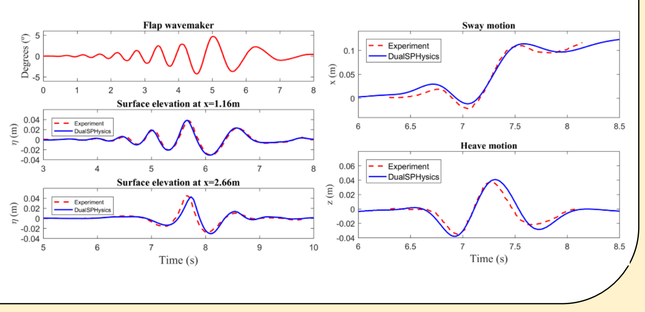
DualSPHysics has been already validated and applied to:
- Study of the run-up on an existing armour block breakwater.
- Estimation of wave impact on coastal structures.





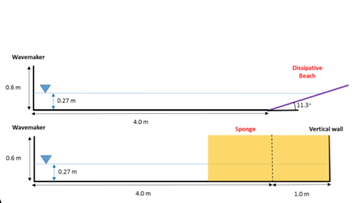
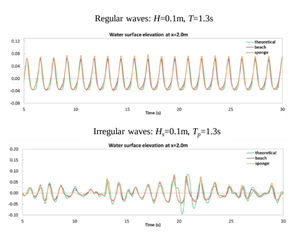
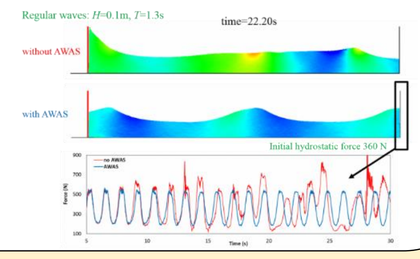
Wave interaction with floating bodies

Buoyancy has been already validated in DualSPHysics. The study of a floating body subjected to a wave packet has been validated with experimental data.

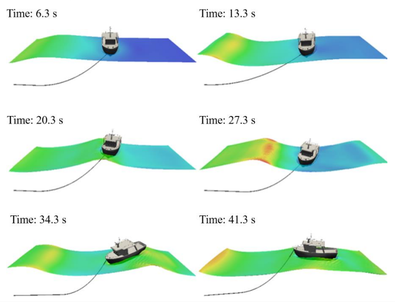
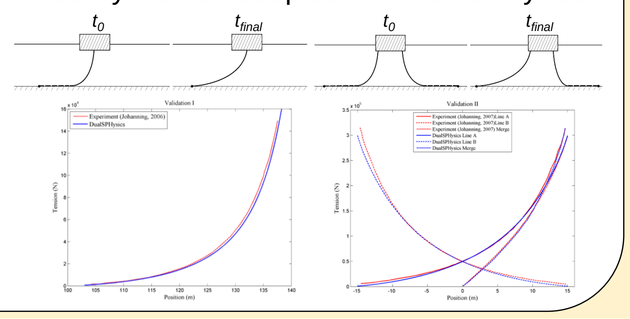
Wave propagation, passive & active wave absorption

DualSPHysics mimics physical wave facilities:
- Long-crested wave generation for regular, random and solitary waves.
- Passive absorption is implemented using a damping zone.
- Active wave absorption is also implemented, based on time-domain filters.

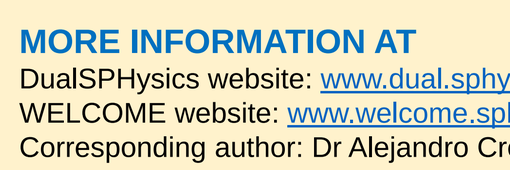
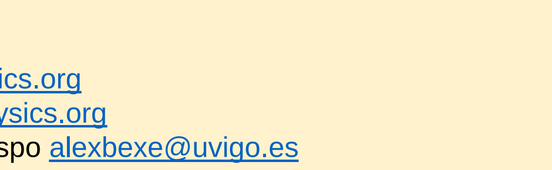
Mooring lines

MoorDyn (http://www.matt-hall.ca/moordyn/) is an open-source dynamic mooring line model that uses a lumped-mass formulation for modelling axial elasticity, hydrodynamics, and bottom contact. MoorDyn is now coupled with DualSPHysics.

SIMULATION OF OSCILLATING WATER COLUMN

FIXED OWC (laboratory scale):
The model was first validated with a laboratory test that consists of a fixed OWC with an open chamber (IHCANTABRIA).

Mutriku plant (real scale):
The model was then applied to predict water surface oscillations inside the chamber of a real OWC (located in Mutriku, Spain) using the prevalent wave conditions in the area.

FLOATING OFFSHORE OWC:
The new capabilities of DualSPHysics are shown by simulating the effect of mooring systems on a floating offshore OWC in the open ocean. The geometry and size of the floating OWC have been chosen for computational demonstration purposes but using the geometry and size of a realistic device. Regular no-breaking waves (*H=1.8 m, T=9.0 s, d=10 m*) are simulated in order to obtain preliminary results of i) water surface oscillations inside the chamber, ii) motions of the floating OWC. Maximum values of 75 tons are achieved for the numerical tensions at the four mooring lines.

FUTURE WORK

The future work will be focused on the implementation of a new version that considers water-air phases.
A new version of DualSPHysics will be released as open source including documentation and a new user friendly interface.

MORE INFORMATION AT

DualSPHysics website: www.dual.sphysics.org
WELCOME website: www.welcome.sphysics.org
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