PhD Open Days

Air entrainment in wave breaking: Experimental analysis and numerical modeling

H2DOC Doctoral Programme

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Introduction

The work performed on the PhD thesis has been developed under the H2DOC doctoral programme with the purpose of studying the influence of air entrainment in the energy dissipation associated with the wave breaking process, by using numerical and physical modelling.

Motivation

Regarding coastal protection, it is of the utmost importance to model correctly the wave breaking phenomenon since it is responsible for wave energy dissipation. However, wave breaking is a very complex problem where turbulence and entrained air play an important role in the wave attenuation. Numerical tools and physical modelling are needed to understand this complex phenomenon and to simulate it.

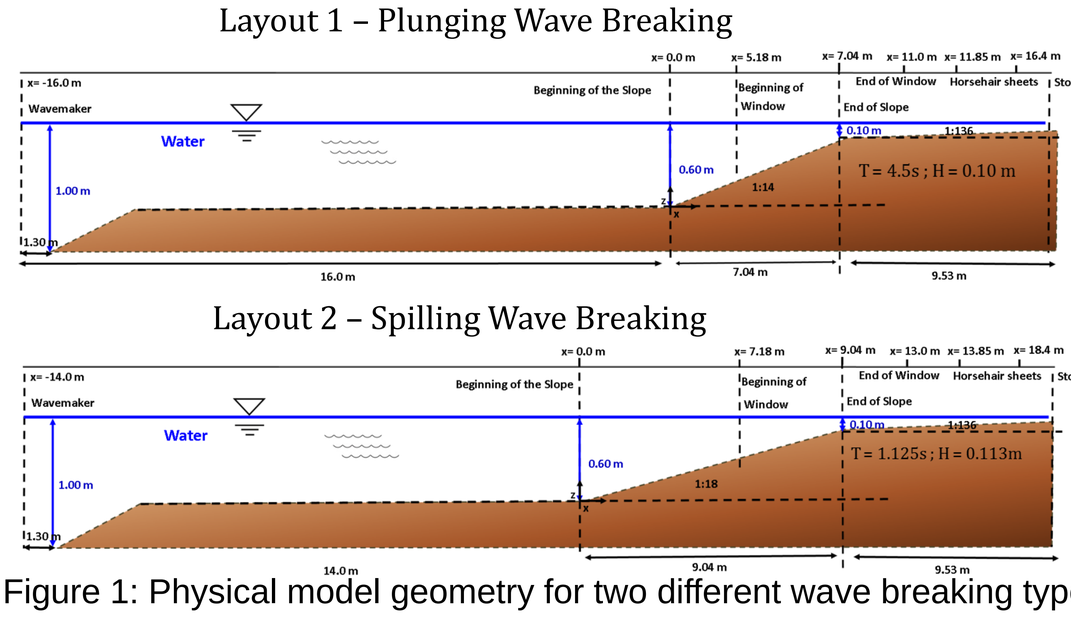

Figure 1: Physical model geometry for two different wave breaking types

Figure 2: Experiments for Plunging (left) and Spilling (right) wave breaking

Figure 3: Image analysis for air concentration

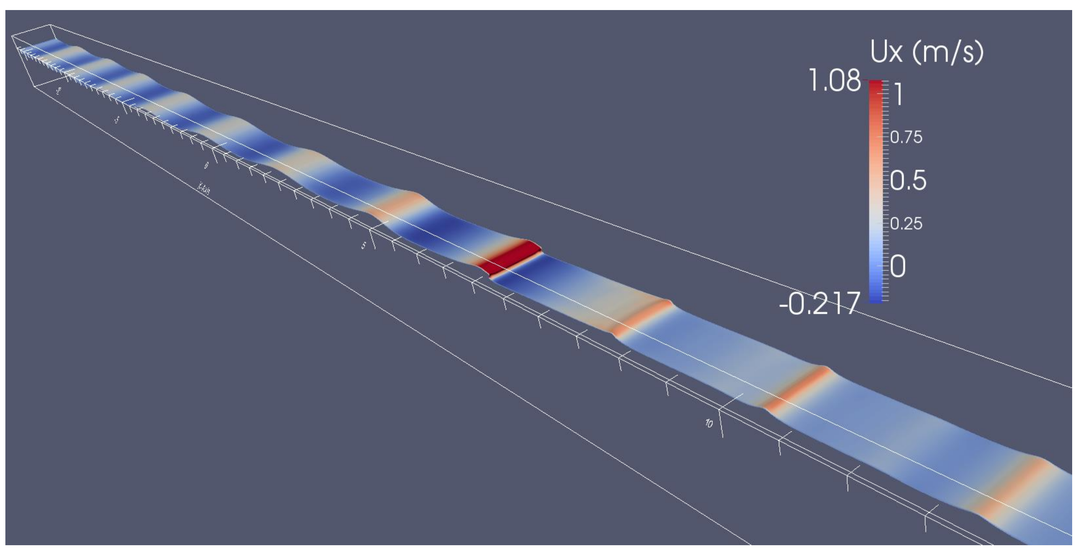

Figure 4: 3D Numerical modelling with OpenFOAM

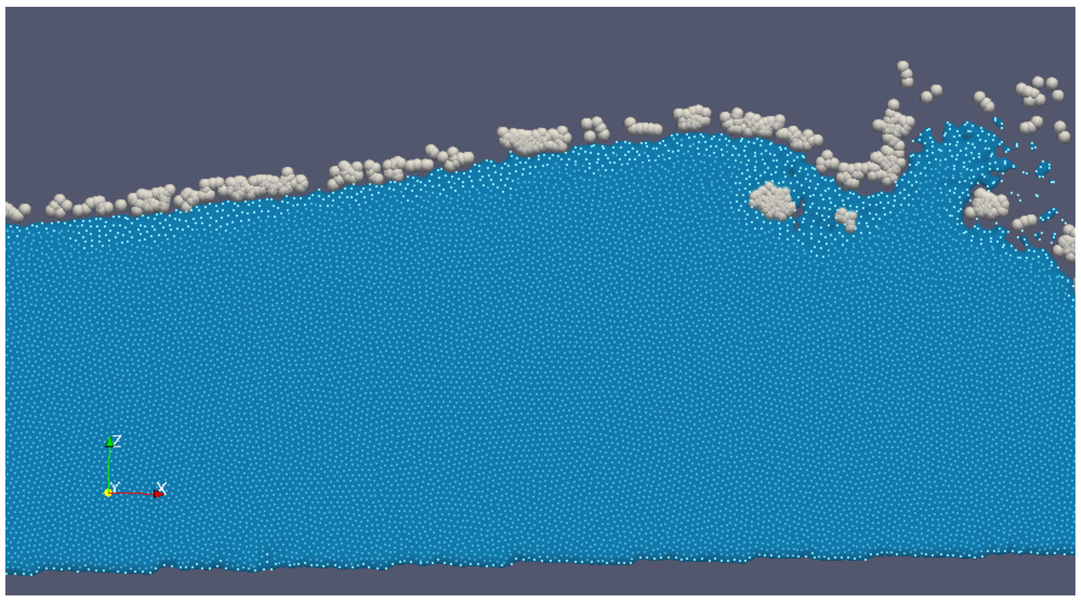

Figure 5: DualSPHysics numerical modelling of the air bubble entrainment

Methodology

- Experimental modelling in a wave flume at LNEC. Measurements of:
  - Free surface elevations.
  - Velocities (u,v,w).
  - Air Concentration.
- Numerical modelling using:
  - RANS model – OpenFOAM.
  - SPH model – DualSPHysics.

Results

- So far:
  - Both numerical models were validated.
  - The experimental tests at LNEC are almost finished.
  - New tool for image processing analysis has been developed and calibrated to measure the air concentration due to wave breaking.
  - Numerical tools were created to simulate air bubbles in both models.
  - The influence of the flume narrowing was assessed.
  - Several turbulence models were tested for the RANS model.
- Goals:
  - To quantify the influence of the air entrainment in the energy dissipation associated with the wave breaking process.
  - Development, application and validation of numerical models for the wave breaking dynamics and for the air entrainment quantification.

TÉCNICO LISBOA

Supervisors: António Pires Silva, Conceição Fortes and Jorge Matos

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