DualSPHysics: a numerical tool to simulate real breakwaters

Feng ZHANG[†1], Shaoping SHANG[1], Alejandro CRESPO[2], José DOMÍNGUEZ[2], Moncho GÓMEZ-GESTEIRA[2], Corrado ALTOMARE[3], and Andrea MARZEDDU[4]
[1]Xiamen University, China
[2]Universidade de Vigo, Spain
[3]Flanders Hydraulic Research & Ghent University, Belgium
[4]Universitat Politècnica de Catalunya, Spain
zhangfeng@stu.xmu.edu.cn[†]

Abstract: DualSPHysics [1] is an SPH-based model conceived to be an efficient and user-friendly numerical technique for a wide range of application in the field of hydraulic, naval and coastal engineering. The model is open source and can be freely downloaded from `http://www.dual.sphysics.org`. Thanks to the power of GPUs (graphics cards with powerful parallel computing), real engineering problems can be simulated with DualSPHysics using high resolution at a reasonable time. When applied to coastal engineering, the model has been demonstrated to accurately reproduce wave propagation and transformation and wave-structure interaction phenomena. The code is devised to mimic an experimental facility (wave flume or wave basin) and therefore implements automatic wave generation and integrated active wave absorption (AWAS) techniques [2]. Moving boundaries are used to mimic the displacement of the wavemaker used in a physical facility. In the present study, a piston-type wavemaker that moves with a pre-imposed displacement is considered to generate regular wave trains. Â The main objectives of the work are:

1. To validate DualSPHysics in terms of wave run-up on a breakwater with a two layer cubic blocks armor. The numerical results are compared with experimental data of a smooth dike (Figure 1) and a dike with 2 layers of cubic blocks (Figure 2).
2. To apply the validated SPH model to study the run-up on a dike using the real dimensions, bathymetry and waves conditions from the coast of Chongwu (China).

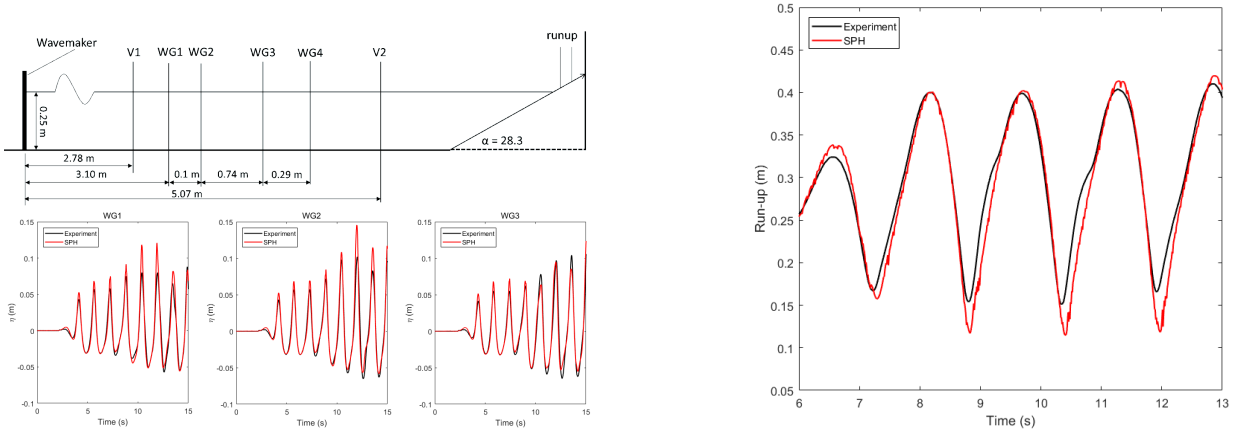

Figure 1: Validation of DualSPHysics comparing with experiments of the smooth dike and waves of $H = 0.1$ m, $T = 1.56$ s, $d = 0.25$ m.

As first **novelty**, a proper validation of run-up is here performed since we have compared the numerical and experimental time series of water surface elevation and time series of wave run-up. Previous work [3] presented a validation for run-up, but only a maximum value for different incoming waves was compared with experimental and literature data. The time series of the experimental wavemaker is assigned to the numerical one. Figure 1 and 2 shows the result of the validation with experiments using the smooth and the porous dike, respectively. Note that run-up for the armor block dike is numerically computed at 52 different positions along the width of the channel to catch the three-dimensional behavior. Several different wave conditions are simulated and overall **good accuracy** is obtained for both wave surface elevation and time series of the run-up.

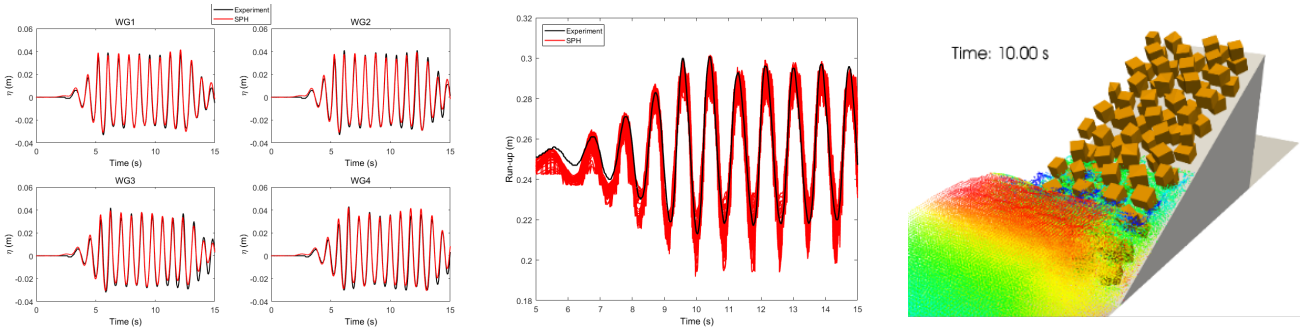

Figure 2: Validation of DualSPHysics comparing with experiments of the breakwater with a two layer cubic blocks armor and waves of $H = 0.08$ m, $T = 0.87$ s, $d = 0.25$ m.

The second **novelty** is the application of the SPH model to a real problem using the dimensions of a dike in China. In this case wave conditions are imposed based on real wave condition in situ and AWAS [2] is employed to compensate the wave reflection at the numerical wavemaker. This is mandatory to mimic the real open sea. Therefore, once the model has been properly validated with experiments **it can be applied to study real situations** in the coast of Chongwu.

References

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