Modeling macro roughness with a porous media, example of the Artha breakwater

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INTRODUCTION

Regarding the wave climate and urbanisation in the bask country, several coastal structure in that area are submitted to extreme wave conditions that can be destructive. In the lineage of experiments by De Rouville (1938) and Bullock (2007), a set of pressure sensors have been installed in the wall of the Artha breakwater in St-Jean Luz, bay of Biscay. A first analysis of impact pressure by Larroque (2018) showed the difficulty to predict the most critical impacts from offshore statistics only and calls for finer investigations on wave dynamics near the breakwater. While wave transformation over low to mild sloping beaches have been widely studied, shoaling, breaking, reflection and dissipation over steep and very rough slopes are much less documented, Van der Meer (1992) and Dodet et al. (2018). With slightly different values some coral reef present similar slopes and roughness and have been the object of several in-situ and numerical studies Buckley(2015), Sous (2020).

Figure 1 – Wave impact on the Artha breakwater during a winter storm event

DESCRIPTION OF THE EXPERIMENT

During fall 2018 a measurement campaign was conducted close to the Artha breakwater. Offshore spectral parameters were measured at a directional wave buoy in 20 m water depth. A directional currentmeter was installed at the foot of the block armor unit at 15m deep while five pressure sensors were attached directly on the concrete blocks to obtain a complete cross-shore survey of wave transformation over the armor. In addition, high frequency impact pressure measurements are carried out on the dike wall together with punctual video recordings of wave impacts. The whole setup therefore provides a unique comprehensive in-situ dataset of wave transformation over a coastal breakwater.

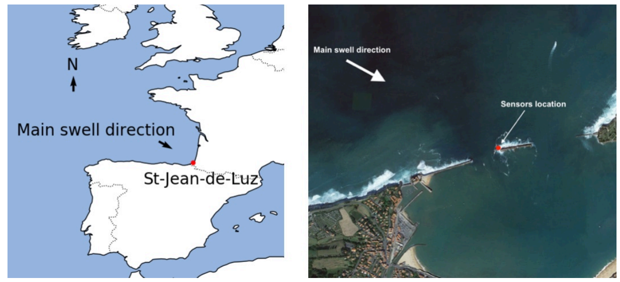

Figure 1 – Situation of the experiment at the Artha breakwater.

METHOD AND RESULTS

The three probes method applied to the transect of pressure sensor gives an estimation of the incident and reflected wave field entering and exiting the block armor. To gain a better understanding of the energy balance in this area a 2D SWASH model representing the block armor made of 50 tonnes concrete blocks by a porous media. The numerical model is validated on the pressure and velocity measurements, the profile of significant wave height, setup, velocity at the currentmeter and the number of wave impact or submersion of the sensors on the vertical wall of the breakwater. The block armor is made of 50 tonnes concrete blocks. This area presenting macro-roughness is assimilated to a porous media in the SWASH model.

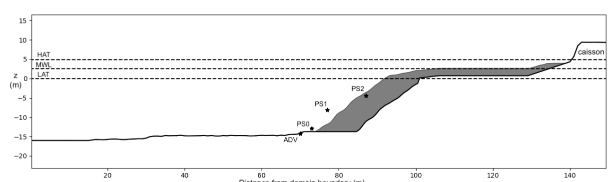

Figure 2 – Numerical domain for SWASH simulation

The model ability to reproduce the observed significant wave height and mean sea level is investigated with regard to the bottom dissipation function. The overall RMSE is fairly low and show that the model is able to reproduce the main feature of wave transformation in this type of environnement over a wide range of conditions. Once the model validated, the incident transmitted and reflected wave field is estimated based on three probes and PUV methods. An estimation of the block armor ability to dissipate wave energy in different conditions and the identification of different modes of action of the breakwater are proposed thanks to the model.

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