Wave flume-generated seiching analysis

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ABSTRACT
This paper describes the spectral analysis of waves based on a set of experiments undertaken at the Catalonia University of Technology in the large wave flume of the Maritime Engineering Laboratory. The scope of this study is to compare the effect of various wave regimes on very low frequencies generations. The influence of seiching related to the interpretation of the low-frequency for both cases studied erosive and accretive wave conditions was quantified.

KEY WORDS: Spectral analysis; Seiching; Low frequency; Wave grouping.

INTRODUCTION
Extreme storms may affect significantly the coastal environment, especially in terms of erosion and sediment transport and they can provoke disastrous consequences such as sediment transport beyond the surf zone to unusual depth (Budillon et al., 2006).

The total offshore sediment transport rates are shown to reduce, leading to the observed modification of the sandbar migration strictly related to the dynamic of the entire surf and swash zone as a whole (Masselink & Puleo, 2006; Brocchini & Baldock, 2008). Indeed, the hydro/morphodynamic processes of the surf zone and swash zone (SZ hereinafter), are strongly linked through feedback processes.

In SZ dynamics four different dynamics are considered: superficial SZ hydrodynamics, subsurface SZ hydrodynamic, sediment dynamic and co-related beachface morphodynamic (Brocchini & Baldock, 2008; Masselink & Puleo, 2006; Horn & Baldock, 2007; Ciavola et al., 2011).

Physical model tests were performed at the large wave flume of the Maritime Engineering Laboratory (LIM), Catalonia University of Technology (UPC), as part of the EU project Hydralab III SUSCO-Swash zone response Under grouping Storm Conditions (http://www.hydralab.eu/project_summary_report.asp?id=97&H=4).

During the tests the shoreline response and the SZ hydrodynamics were carefully monitored when grouping waves, able to generate free waves and energy in the high frequency part of the spectra, impact on the controlled area (Vicinanza et al., 2011; Baldock et al., 2011). The wave conditions were designed to investigate the differences in beach profile evolution for comparable energy flux of the incident short waves for two sets of wave conditions, erosive and accretive. Comparison between monochromatic conditions, monochromatic conditions perturbed with free long waves and wave conditions in which free and forced long waves are generated by wave groups were examined. The main aim of this study is to compare the effect of various wave regimes on very low frequencies generations. In particular, wave flume seiching is investigated as a potential source for low-frequency energy during the experiments.

In fact, wave generation in an enclosed flume will cause seiching owing to wave reflections or wave grouping effects that can transfer wave energy to low-frequencies (Haller et al., 2001). It is important, therefore, to quantify any influence of seiching on these experiments, especially in regard to the interpretation of the low-frequency for erosive and accretive wave conditions. The resonance occurs when the dominant frequencies of the external forcing match the Eigen frequencies of the flume (Rabinovich, 2009). Those frequencies are determined by the Eigen analysis. In addition, Merian’s formula can be used to estimate the periods of the dominant seiches in the wave flume, especially of the first Eigen mode.

A numerical solution, using measured data as input, additionally shows the influence of the low frequencies on the wave energy spectra.

EXPERIMENTAL SETUP
The large-scale wave flume has a length of 100 m, a width of 3 m and a depth of 5 m. The sandy dissipative profile consisted, from the wave paddle toward the shoreline, of an initial section (1:20 slope from x = 31 to 37 m) prior to a plane bed (from x = 37 to 42 m), followed by a 1:15 slope plane beach (Figure 1). Prior to running each wave condition, the bathymetry were performed by manual reshaping and then compacted by running a 10 minutes ‘smoothing’ wave condition in order to return the initial profile. This approach enable consistent comparison of the beach evolution.

The following instruments have been installed and used in the controlled SZ: 1 beach profiler, 6 Acoustic Doppler Velocimeter were also used to measure velocity fluxes (2 with z = 0.17 m from the sandy bottom, 2 with z = 0.04 and 0.09 m and 2 both located at 0.04 m from the bottom), 10 Resistant Wave Gauges, 8 Micro Acoustic Wave Gauges, 4 Acoustic Wave Gauges, 8 Optical Backscatter Sensor, 6 Electromagnetic Current Meters and 6 Pressure Sensors. ADVs were sampled at 100 Hz and all the other instruments were sampled at 20 Hz (Riefolo et al., 2014).