FIELD MEASUREMENTS AND SWASH PARAMETERIZATION ON BEACHES

Paula Gomes da Silva, Environmental Hydraulics Institute "IHCantabria", silvapgomes@gmail.com
Raúl Medina, Environmental Hydraulics Institute "IHCantabria", raul.medina@unican.es
Mauricio González, Environmental Hydraulics Institute "IHCantabria", mauricio.gonzalez@unican.es
Roland Garnier, Environmental Hydraulics Institute "IHCantabria", roland.garnier@unican.es

INTRODUCTION

The wave runup, defined as the vertical oscillation of the water edge at the coast, is commonly used as criterion for coastal design projects and flooding/erosion risk analysis. Due to the complexity of nearshore wave processes, most runup studies are based on empirical approaches which directly relate these oscillations to the beach and offshore wave characteristics. However, there is still considerable debate about just how runup is related to these environmental parameters, as well as about the range of application of empirical models due to site specific conditions. Recent works emphasized the importance of including site specific conditions to reduce the scatter in available parameterizations. Parameters related to beach characteristics like the sediment size, the amount of reflection, wave spectral shape and morphodynamic beach state may improve runup predictions (Poate et al., 2016, Guza and Feddersen, 2012).

This work is centered on the time-varying component of the runup (swash - S). Based on measured data obtained during a field campaign carried in the North of Spain on September 2017, the processes involved in swash oscillations were analyzed; the parameterizations proposed in previous works to predict the infragravity (ig: 0.004 Hz - 0.05 Hz) and incident (inc: 0.05 Hz - 0.1 Hz) swash were tested and, finally, the role of the reflection of random waves on swash values was assessed.

FIELD DATA AND PARAMETERIZATION ANALYSIS

Wave, current, runup, topography and bathymetry data were measured during a field experiment carried out in Somo beach (North Spain) from 19th to 21st September 2017. Taking the empirical formulas proposed in previous works as a starting point (*i.e.* Guza et al,1984; Ruggiero et al. 2001 and Stockdon et al. 2006; Gomes da Silva et al., 2018), the available dataset was used to assess the empirical parameterization of incident and infragravity swash on beaches.

RESULTS

Infragravity swash

Some of the previous parameterizations for calculating the infragravity swash on beaches did not show a relation between the swash zone oscillations and beach characteristics, like the foreshore slope and sediment size. In those cases, the calculated infragravity swash is calculated based only on wave conditions, usually through the parameter $(H_0L_0)^{0.5}$. This means that, under the same wave conditions, the low frequency swash would be the same in a beach composed by gravel and on a beach composed by fine sediment. Other works could find a relation to the square roots of the foreshore slope through the parameter $(tan\beta H_0L_0)^{0.5}$ (Ruggiero et al, 2001).

Recently, Gomes da Silva et al (2018), proposed a parameterization to predict the infragravity swash on beaches based on dataset measured on Somo beach on May 2016 (Gomes da Silva et al, 2017) and on data available from previous works. According to that work, the horizontal cross-shore infragravity swash - S_{igH} - is related to the parameter $(H_0L_0/tan\beta)^{0.5}$ as shown in eq. 1:

$$S_{igH} = K(H_0L_0/tan\beta)^{0.5} \qquad [1]$$

where H_0 and L_0 are the wave height and length deshoaled to a depth of 80 m and $tan\beta$ is the foreshore slope. The correlation with $tan\beta^{-0.5}$ can be explained by the relation between standing wave amplitude and the swash of non-breaking waves, from standing waves solution (Guza et al., 1984). The slope of the regression, K, obtained for each experiment was interpreted as a function of the dimensionless fall velocity parameter (Ω^*) defined by Wright et al. (1985) (Figure 1). Ω^* represents the morphodynamic beach state, and consider not only the current wave and beach conditions, but also takes into account the previous sea states. High correlation was verified when using K as a function of Ω^* ($\rho^2 = 0.87$).

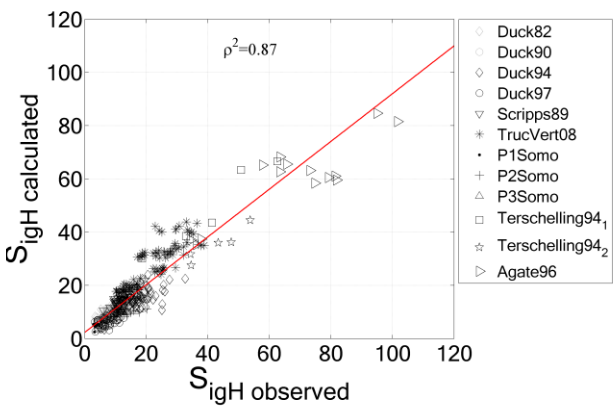

Figure 1 - Regression analysis between measured and calculated infragravity swash using eq. 1. (Image from Gomes da Silva et al., 2018)

The first part of this works was dedicated to verify the validity of the parameterization proposed by Gomes da Silva et al. (2018) when applied to the new Somo dataset. The calculated S_{igH} showed good agreement with the measured values, if compared to previous formulas (*i.e.* Ruggiero et al, 2001 and Stockdon et al 2006).

Incident swash

The dataset measured on Somo beach indicated the presence of a partial standing wave within the incident frequency, and a typical cross-shore nodal structure was verified across the surf zone. The presence of a standing wave can lead to amplification of the swash excursion at the coast affecting swash predictions. Previous works have already reported a relation between the standing wave amplitude and the amplitude of the swash oscillations (Suhayda, 1974; Guza and Bowen, 1976). According to those works, when the wave steepness is low, the evolution of the waves across the surf zone can be described by linear wave theory and the excursion of the waves on the swash zone can be related to the amplitude of the standing wave in the vicinity of the shoreline. The amplification of the standing wave at the most shoreward position, is determined, among other factors, by the amount of reflection at the beach.

Guza et al (1984) studied monochromatic waves over a beach in laboratory and demonstrated that the wave runup can be described by three regimes. Under very reflective conditions, the wave runup can be predicted by the standing wave solution. During fully breaking conditions, the wave runup is saturated and no relation to the offshore wave height is expected. Finally, a transitional regime exists, where partial reflection is observed.

The application of the standing wave solution (Guza et al, 1984) to the swash of random waves measured at Somo beach was verified. The results indicated good agreement when the transition regime relationship was applied to the incident swash (S_{inc}). The solution proposed by Guza et al (1984) showed higher correlation coefficients if compared to those obtained from the comparison of other parameterizations.

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