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WAVE REFLECTION ANALYSES ON LASER SCAN DATA FROM A MODEL SALT MARSH

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1 INTRODUCTION

Physical or numerical models are common tools to investigate the interaction between waves and marine structures. The decomposition of the water level into incident and reflected wave components is often required, as most design variables (overtopping, run-up) are linked to the incoming wave characteristics. Also, an accurate solution can provide information on the distribution of energy in the wave spectrum and the spread of energy from the fundamental wave components to the lower and higher frequencies (Lin and Huang, 2004). Thus, utilizing an appropriate wave reflection analysis is critical in the analysis of such experiments.

2 METHODOLOGY

Experiments were carried out at the flume of the Hydraulic Engineering lab of the Delft University of technology, 0.80m wide, 1m high and 39m long. The setup consisted of a foreshore, a salt marsh with a vertical cliff at its edge and a dike, as shown in Figure 1. A meadow made of about 48.000 rubber shoots mimicking the species *Spartina Alteniflora* was constructed and fixed on the salt marsh platform. Several hydrodynamic states were ran for different combinations of water depth (0,10,25,40 cm above the salt marsh), wave height (H_s=8-16 cm) and wave steepness (s=3-5%). Six different experimental set-ups were investigated, composed of three different cliff heights (h_c=0,6,12cm) and the cases with and without meadow.

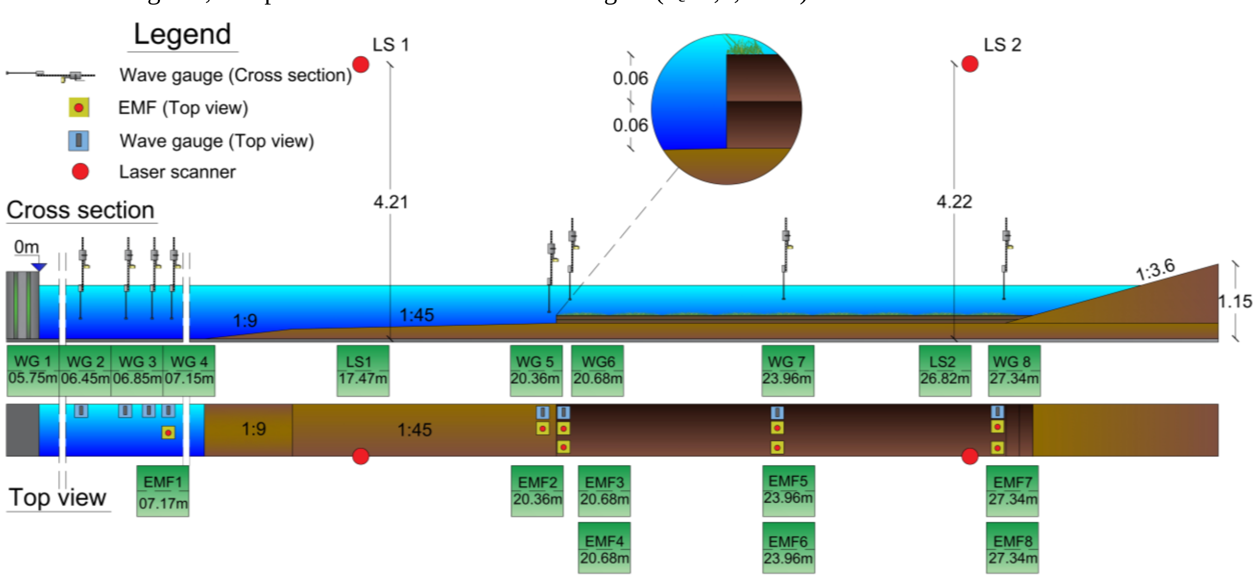

Figure 1. Laboratory set-up and instrumentation.

Two SICK LMS511 lidar laser scanners (LS) were used to record a dense grid of water levels along the wave flume (Oosterlo et al., 2021, Blenkinsopp et al. 2012, Hofland et al. 2015), resulting in an interpolated grid of dx=0.1m in space and dt=0.1s in time. 8 wave gauges were installed in order to validate the readings of the LS. Lastly, 3 electro magnetic flowmeters (EMF3, EMF5 and EMF7) were placed at the beginning, middle and final part of the salt marsh to record velocity 8cm above the bottom, while another 3 (EMF4, EMF6, EMF8) were installed in the same positions, recording in the middle of the water column.

The main aim of these experiments was to investigate the attenuation of wave energy over the salt marsh during extreme storm conditions. As a necessary intermediate step, we applied three different wave reflection analyses on the recorded data: the linear wave decomposition by Zelt and Skjelbreia (1993), which was applied through a 7 point moving window on the LS data grid; the method by Guza and Thornton (1985) which assumes shallow water conditions and for which we used the combined EMFs' velocity signals and the LS data; the Radon transform, for which we used the LS data grid (Almar et al., 2014).

3 RESULTS

At the conference, we will showcase our findings by comparing the results of the three wave reflection analyses, in terms of incoming and reflected wave characteristics, as well as spectrum transformation, for a range of hydrodynamic conditions and geometrical set-ups. Figure 2 shows an initial comparison of the root mean squared wave height (H_{rms}) for the incident wave field, calculated using the three methods. Finally, we will present the challenges and the adopted solutions associated with the use of laser scanners for measuring wave fields in clear laboratory water.

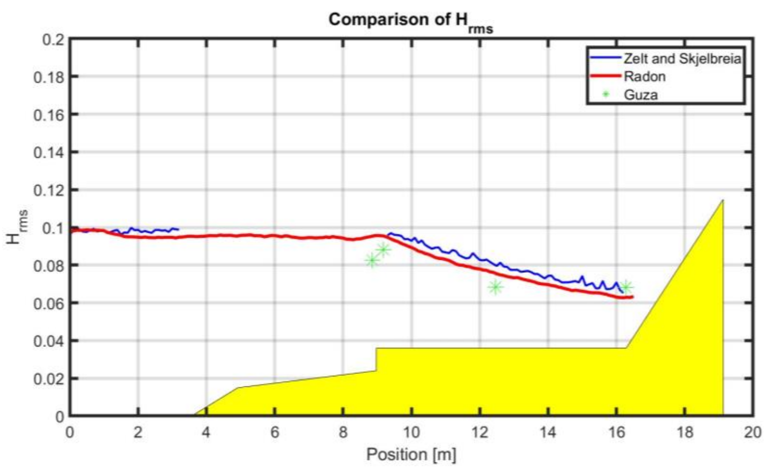

Figure 2. Calculation of H_{rms} from the incoming wave signal of the three decomposition analyses.

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REFERENCES

Oosterlo, P., Hofland, B., van der Meer, J.W., Overduin, M., Steendam, G.J., 2021. Calibration and preparation of field measurements of oblique wave run-up and overtopping on dikes using laser scanners. Coastal Engineering 167

Lin, C.Y. and Huang, C.J., 2004. Decomposition of incident and reflected higher harmonic waves using four wave gauges. Coastal engineering, 51(5-6), pp.395-406.

Zelt, J.A. and Skjelbreia, J.E., 1993. Estimating incident and reflected wave fields using an arbitrary number of wave gauges. In Coastal Engineering 1992 (pp. 777-789).

Guza, R.T., Thornton, E.B. and Holman, R.A., 1985. Swash on steep and shallow beaches. In Coastal Engineering 1984 (pp. 708-723).

Almar, R., Michallet, H., Cienfuegos, R., Bonneton, P., Tissier, M. and Ruessink, G., 2014. On the use of the Radon Transform in studying nearshore wave dynamics. Coastal Engineering, 92, pp.24-30.

Blenkinsopp, C.E., Turner, I.L., Allis, M.J., Peirson, W.L. and Garden, L.E., 2012. Application of LiDAR technology for measurement of time-varying free-surface profiles in a laboratory wave flume. Coastal Engineering, 68, pp.1-5.

Hofland, B., Diamantidou, E., van Steeg, P. and Meys, P., 2015. Wave runup and wave overtopping measurements using a laser scanner. Coastal engineering, 106, pp.20-29.