BREAKING AND WASH-UP OF SOLITARY WAVES ON A COMPOSITE BEACH

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INTRODUCTION

Hazardous events, such as landslides, rock slides, rock falls or avalanches often generate extreme, impulsive waves when entering water bodies (Fuchs & Hager, 2015). These waves are approximated by solitary waves and researchers investigate their damage potential when inundating built environment. Deepening the understanding of solitary waves running up a uniform beach slope and propagating over a subsequent horizontal plane can help to reduce and mitigate damage and the number of casualties caused by such a hazardous event. So far, few authors addressed this specific setting near-shore (Fuchs & Hager, 2015; Zelt & Raichlen, 1991).

In this study, large scale solitary waves propagate about 200 m in in the Large-Wave Flume (GWK, 307 m × 5 m × 7 m) at the Coastal Research Center in Hannover, Germany then they run up a beach slope and subsequently break, generating a bore which advances onto a subsequent, initially dry, horizontal surface. **Unlike previous studies, the generated solitary waves broke close to the edge between the beach slope and the horizontal plane section. The overall aim of this study is to investigate the characteristics of the broken waves' dynamics. In addition, their surge profile and front celerity are compared to those of the non-breaking solitary waves.** Subsequently, the differences between the velocity regimes along the bore propagation path are presented and linked to the fundamental physical processes behind.

EXPERIMENTAL SETUP

The experimental program performed in the Large-Wave Flume (GWK) employed a total of 18 breaking solitary waves. The freeboard between the horizontal plane section and the still water level was varied between 0.2 m (test No. 1-5), 0.1 m (test No. 6-11) and 0.0 m (test No. 12-18). Wave heights between 0.5 m and 1.1 m with periods of about 4 s were generated. Run-up and wash-up dynamics was measured by wave gauges consisting of a echosounder system and by line laser scanners. A dual video-camera system recorded the process. Flow velocities were measured by acoustic Doppler velocimetry (ADV) probes.

PRELIMINARY RESULTS

To investigate the wash-up, wave gauge data was evaluated to understand the transformation of the approaching solitary waves to the onshore composite geometry. Figure 1a displays water surface elevation time-histories of all of the 18 tests measured by ultrasonic sensor US_1. This sensor is located at the edge between the beach slope and the horizontal plane. In addition,

Figure 1b shows the water surface elevation time-histories of US_2, which was located 1.8 m downstream of the aforementioned edge. Some of the time histories of US_1, especially those of test No. 12-18 (zero freeboard), show spikes in the water surface as soon as the breaking solitary waves approached the sensor location. These were due to wave breaking and accompanying splash up. It can be seen in the subsequent time-histories of US_2, that these spikes increased in magnitude. Moreover, additional water surface peaks were measured by US_2 for the time series of test No. 1-5 (0.2 m freeboard). The medium height freeboard tests (No: 06-11) show no peaks, as all of those waves broke on the slope. Further analysis involving video observation revealed information as to how the breaking process unfolded. In addition, surface Particle Image Velocimetry (PIV) and automated bore front detection provided valuable information about the overall dynamics of breaking solitary waves on composite beaches.
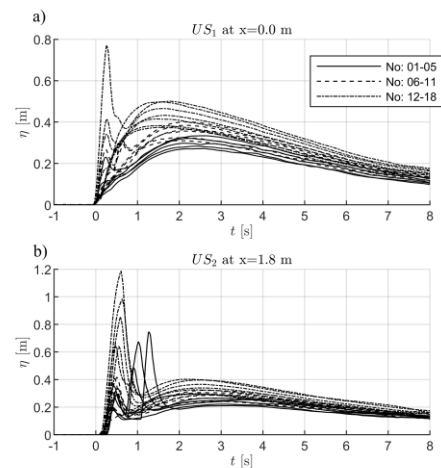

Figure 1 - Time series of all 18 tests evaluated in this study. a) time series of ultrasonic wave gauge 1, which is located at the edge between the beach slope and the horizontal section; b) time series of wave gauge 2, which is located 1.8 m downstream from wave gauge 1.

CONCLUSIONS

This study evaluated the propagation of a unique set of large scale solitary waves. The waves break on a beach slope followed by an adjacent horizontal section over which the subsequent bore propagated. **For the first time, insight into the process of the wash up evolution of broken solitary waves on composite beaches was investigated.**

REFERENCES

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