Experimental Observations of Overwash Deposits on Berm Beach with Shoreface Nourishments

Wenbin Zhang, Chi Zhang, Yuan Li*, Dake Chen
College of Harbour, Coastal and Offshore Engineering, Hohai University.
Nanjing, Jiangsu Province, China
Weiqi Dai
Yellow River Institute of Hydraulic Research, Yellow River Conservancy Commission (YRCC).
Zhengzhou, Henan Province, China

ABSTRACT.

Coastal overwash occurs frequently on the crest of dunes or berms under hurricanes and storm surges. It is well recognized that the volume of overwash deposits depends on tidal level, setup induced by storms, wave setup, short wave runup, standing wave height and berm/dune shapes (i.e., crest level and foreshore slope). However, previous analysis was based on datasets collected on natural beaches, and there are hardly any studies focusing on overwash process with shoreface nourishments. Laboratory experiments regarding overwash deposits on berm beach with shoreface nourishment were conducted in a wave flume. Results showed a morphological coupling between overwash deposits and shoreface nourishment. The volume of overwash deposits decreased with the seaward slope and increased with the ratio of crest depth to the shoreface nourishment height.

KEY WORDS: shoreface nourishment; overwash; laboratory experiments; berm protection; morphological coupling

INTRODUCTION

Coastal areas are densely populated, economically developed and rich in tourism resources (e.g., Armstrong et al. 2016 and references herein). However, coastal disasters have been intensified due to sea-level rising, global climatic change and human interference (e.g., Luo et al. 2013). Overwash is one of the most common coastal disasters that occurs frequently on the crest of dunes or berms under hurricanes and storm surges (Wang and Horwitz 2006). Overwash is defined as the flow of water and sediment over the crest of the berm/dune that does not directly return to the water body where it originated. During overwash event, sands on the dune/berm are redistributed dramatically by the high wave energy, and the coastal structures and vegetations on low-lying areas could be destroyed. Beach nourishment is a kind of effective and ecofriendly coastal disaster mitigation method (Luo et al. 2013; Luo et al. 2015). By filling sands on the shoreface, an artificial sandbar is formed to trigger high waves breaking and reduce energy at the start of wave runup.

Figlus et al. (2010) found dune profile evolution and overwash transport rate are mainly controlled by the initial dune geometry. However, in their work, the factor with respect to incident wave conditions cannot be evaluated because they used the same wave condition. Matias et al. (2019) provided a more complete analysis of influencing factors based on field measurements and numerical modelling. They found that the incident wave height, nearshore bathymetry, sediment grain size and lagoon water level are all non-negligible for overwash prediction. Other studies have paid attention to the individual overwash event (e.g., Wang and Horwitz 2006) and the overwash frequency at a particular beach (Lashley et al. 2019). Previous studies about overwash were mostly carried out on natural beaches, in fact, coastal structures can also play an important role in overwash deposits control. Kobayashi et al. (2010) examined overwash and overtopping on an impermeable levee. Furthermore, Kobayashi and Kim (2017) found the rock seawall is efficient in reduction of wave overtopping and overwash. So far, comprehensive understandings of the coupling between overwash deposits and shoreface nourishments are scarce. In field site, the time-scale of an overwash is usually within several hours (Elko 2006). Furthermore, temporal and spatial measurement resolution of fieldworks are limited due to the hard condition. Nevertheless, by selecting appropriate scale relationships, conducting laboratory experiments is a well-controlled method.

Morphological coupling mechanisms have been a traditional research question for coastal scientists. It represents the interactions between different parts of topography on the beaches, and it is a kind of self-organized phenomenon. It usually occurs in the inner-outer sandbar interactions (Ruessink et al. 2006) and upper-lower shoreface connections (Anthony and Aagaard 2020). The objective of this study is to improve the understanding of morphological coupling between overwash deposits and shoreface nourishments based on a flume experiment. Based on that, the volume of overwash deposits is calibrated with shoreface nourishment geometry parameters and berm shapes to provide a useful guide for beach nourishment implementation.