Wave runup on a constructed berm: Implications for dune design

Motivation and Community Need

Although many prior studies have examined wave runup on coastal structures and beaches, few studies have focused on the effect of runup on a nourished beach with a designed berm. Design guidance is not widely available for construction of relatively small, termed "starter" dunes in areas like the Town of Kitty Hawk, North Carolina, where the distance between the active shoreline and infrastructure (roads, houses) constrains the potential dune size considering the width of the design berm and the beach slope. The purpose of this research is to develop a method to assess runup on a constructed beach berm in order to evaluate the potential overtopping of small "starter" dunes.

Erosion mitigation on NC 12 in Kitty Hawk, NC, Oct. 2015. Photo: County of Dare.

This project came directly out of the needs of coastal managers in the Town of Kitty Hawk and practitioners working to design a beach and dune nourishment project for the Town. It was hypothesized that an extended berm would provide some resistance to runup and decrease the runup elevation that would reach the toe of the dune. Work by de Waal and van der Meer (1992) conducted with structures containing a berm established an "equivalent slope" based on the structure berm geometry and wave conditions. This work was used in the design of the Kitty Hawk project to enable consideration of the berm, however, it had not been field tested for sandy beaches until the present study.

Approach

The locally-funded beach and dune nourishment project in Kitty Hawk that took place during the summer and fall of 2017 served as a full-scale laboratory for investigation of constructed beach berm effects on runup. High water marks were surveyed along the study area using Real Time Kinematic (RTK) GPS techniques four times, including dates prior to the project, during a high-wave event, and post-project. In addition to the field surveys, XBeach, a numerical model, was employed to assess runup using pre- and post-construction beach profile surveys provided by the consulting firm who designed the nourishment project. The XBeach model results and field survey data were compared with empirical equations used to predict runup [e.g. Stockdon (2006), de Waal and van der Meer (1992)].

Post-nourishment field survey.

Findings/Benefits

Findings from this project indicate that estimating runup elevation on a beach nourishment project using an equivalent slope approach (de Waal and van der Meer (1992) is sufficient for design of starter dunes. Estimates of runup using this approach were slightly conservative compared with XBeach results and field observations, which is considered reasonable for design purposes. This approach allows consulting firms to quickly evaluate project designs considering berm with effects on potential dune overtopping. Researchers presented these findings along with a description of the project to the Town of Kitty Hawk and interested public in February 2018.

Status/Steps Moving Forward

In addition to the primary aim of the project, an ancillary collaboration was initiated with the USACE Field Research Facility (FRF) and the N.C. State Institute for Transportation Research and Education (ITRE). As a part of this collaboration, teams from the FRF and ITRE traveled to the site and conducted Unmanned Aerial Vehicle (UAV) and terrestrial lidar surveys, which were compared with Real-Time Kinematic Global Positioning System (RTK-GPS) data. Video time series captured by the UAV were processed using techniques developed by the Coastal Imaging Research Network to extract runup time series (Sciaudone et al. 2017). Further data were collected and will be analyzed in the future to compare with the results from the field surveys.

More Information

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