Stony Brook University
The Graduate School

Doctoral Defense Announcement

Abstract

Wave and Current Interactions with Sharp-edged Beachfront Structures on Rigid and Erodible Berms

By

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This research combines experimental and high-fidelity numerical approaches to study the interactions among waves, following/opposing current, and structures clustered on a berm beach—a macro-roughness environment—with different configurations (i.e., layout and elevation). The process of scouring and sedimentation around the structure by solitary wave and current is also quantified. The results highlighted the significance of the relative position of a structure within an array as well as its lowest floor elevation, with respect to base flood elevation, for flood wave propagation pattern and loading distribution among the structures. Further, it was shown that flow channelization, influenced by the presence of a steady current, can drastically alter the wave breaking process and the resulting bed shear stress within the macro-roughness environment. The extent of this influence was determined to depend on the intensity and direction of the current.

The comparative analysis of two different turbulence models, k-ω SST and Large Eddy Simulation (LES) indicated that the LES model was able to capture the turbulent kinetic energy better than the k-ω SST model, and in turn provided more accurate predictions of the wave runup/rundown and depth-integrated pressure force. However, the computation cost of the LES model may overshadow its advantages over the RANS models, depending on the application.

The scouring around a sharp-edged structure by the wave was found to be driven primarily by wake vortices. The blockage by the structure modulated the velocity field and intensified the scouring process. Furthermore, the presence of the steady current, in addition to the wave, significantly altered the scour pattern and depth. Further investigating the laboratory observation by employing two different numerical models revealed that, even though computationally demanding, the SedWaveFoam model, which uses the three-phase formulation can simulate the scouring and sedimentation processes more realistically than the REEF3D model, which is based on the conventional transport models.

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Dissertation Advisor: Ali Farhadzadeh, Ph.D.

(*If an outside member of the community would like to attend the defense, please contact Ms. Erin Giuliano: Erin.Giuliano@stonybrook.edu)