US Army Corps of Engineers
Engineer Research and Development Center

EVALUATING THE MECHANISMS OF OVERTOPPING EROSION FOR COARSE-GRAINED MATERIALS

Need

Levee breach by overtopping

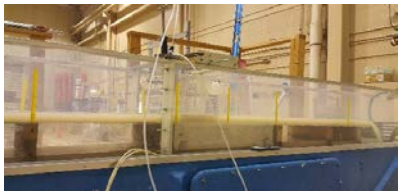
The U.S. Army Corps of Engineers (USACE) uses several models for evaluating breach in earthen embankments (i.e., dams and levees) and spillways. There is some uncertainty in the erosion model input parameters (i.e., erodibility coefficient (k_d) and critical shear stress (τ_c) of coarse-grained materials (sands and gravels) that comprise earthen dams or levee embankments. There is also uncertainty in the type of erosion mechanism (i.e., headcutting or surface erosion) that is active during breach initiation and formation. A better understanding of k_d and τ_c and the dominant surface erosion mechanism for coarse-grained material would reduce the uncertainty when evaluating the likelihood of breach (is overtopping/erosion duration sufficient to cause breach?) as well as allowing for a better understanding of consequences as a result of a better estimate of breach initiation time, breach formation time, and peak breach outflow.

Approach

This approach focuses on specific requirements of the Institute of Water Resources (IWR) – Risk Management Center (RMC) which includes research on determining breach modeling parameters and breach failure mechanism related to coarse-grained materials that comprise the shell layer of dams. The approach includes the selection of test gradation, laboratory tests for material characterization, physical models tests, and test results analysis. The knowledge and data gained from these laboratory tests and physical models will provide better guidance on the selection of breach modeling parameters and modeling approach, supporting improved engineering analysis of flood risk arising from dam and levee overtopping erosion and breach processes.

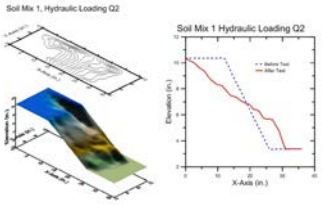
Outcomes

Erosion rates at varying shear stresses (flow velocity and depth) will be reported for coarse-grained soil mixes that have different median grain size and various fines content. Erosion rates will be recorded in real time under flowing conditions using Shallow Water LiDAR system. Mechanism of erosion will be documented and conditions that cause surface erosion or head-cut will be identified.



Small-scale flume used to study erosion for different soil mixes under incremental loading conditions.

Shallow water Lidar demo for a levee physical model erosion test



3D surface erosion of small scale sandy material embankment section

Point of Contact

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For more information on FRM R&D, see the ERDC FRM wiki:
https://wiki.erdc.dren.mil/Surface_Erosion