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National Water Program
A Partnership of USDA CSREES & Land Grant Colleges and Universities

USDA-CSREES 2007 National Water Quality Conference

Numerical Modeling of Bank Instability by Seepage Erosion

Predicting bank collapse due to undercutting brought about by seepage flow has not been fully studied or modeled albeit its role in streambank erosion may be important. The limitation originates from the limited field measurements or laboratory experiments that successfully measure or simulate streambank seepage erosion as well as the unavailability of discrete element models that can effectively simulate sapping and the corresponding mass wasting. The objective of this research was to investigate seepage erosion, bank undercutting and mass wasting using results from two-dimensional soil lysimeter experiments. A numerical finite element model, SEEP/W, was used to model pore-water pressure variations during the seepage flow process. Model parameters were calibrated using the measured soil pore-water pressure and cumulative discharge data from the lysimeter experiments. A general limit equilibrium bank stability model called SLOPE/W was then used to simulate bank stability with and without seepage erosion by comparing the computed factor of safety at different stages of the erosion process. Results show that the factor of safety of the critical slip surface when erosion was not considered was higher compared to that when undercutting was taken into account. This research verifies that the propensity of streambanks to fail during the recession limb of hydrographs may be the combined result of seepage erosion undercutting the streambanks and the reduced apparent cohesion of the bank. This work highlights the need to incorporate the dynamic process of seepage erosion into integrated subsurface flow and streambank stability models.

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