P17

Effect of seepage flow on erosion process of bank which is composed of non-cohesive material

○Ahmed ALY EL-DIEN・Hiroshi TAKEBAYASHI・Masaharu FUJITA

1. Introduction

Riverbanks composed of non-cohesive sediment are frequently eroded by both the river flow and the seepage flow. The bank erosion causes many problems such as loss of structures, inundation and expensive restoration cost. In this study, erosion characteristics of riverbanks composed of non-cohesive sediment under the combined conditions of seepage and river flows are studied by flume experiments and numerical models.

2. Experiment and Numerical analysis

Laboratory experiments were conducted to investigate the evolution of sapping erosion in a flume filled with non-cohesive silica sand of mean diameter 0.6 mm.

Three main experimental cases are investigated; Case 1: Riverbank is subjected to seepage flow only. The effect of hydraulic gradient and seepage force are focused on. Case 2: Riverbank is subjected to river flow only. The effect of shear stress by river flow is focused on. Case 3: Riverbank is subjected to the combined action of the seepage and the river flows. The total forces that act on the sand particles, and inception conditions of sediment motion are focused on. In each case, erosion rate, shape of failure, seepage flow rate, and pore water pressure, are measured. Critical hydraulic gradient for the used sand is estimated by a constant head permeameter.

A numerical model based on the finite element method (FEM) is used to simulate the effect of seepage flow. The model estimates the distribution of pore water pressure, hydraulic gradient at exit face, velocity profile, and seepage discharge. The model is verified with the experimental results of case 1, and good agreements are obtained.

3. Results and Discussion

Zones of expected fluvial erosion by seepage flow are determined by comparing the calculated hydraulic gradient with the measured critical value in Figure 1. The case of sudden drawdown of river stage after flooding is simulated and the changes of hydraulic gradient, pore water pressure with time are also calculated in Figure 2.

4. Conclusions

Experimental results showed that bank erosion by seepage flow is always induced when a certain region near the toe of the bank reaches the quick condition. Seepage hydraulic gradient is one of the key factors in the incipient motion of sediments on a riverbank slope.

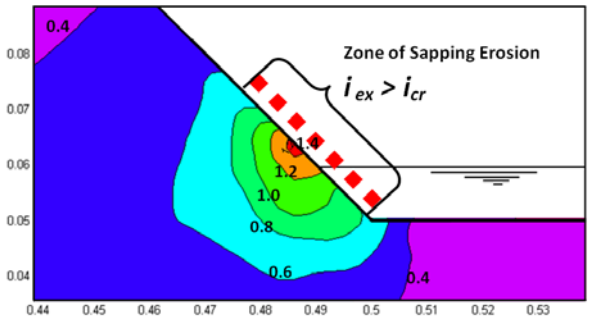

Figure 1. Hydraulic gradient Distribution at the riverbank toe

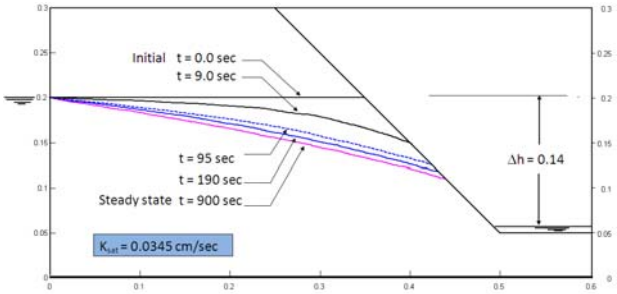

Figure 2. Variation of water-table level during sudden drawdown