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EXTENDED ABSTRACT

Hydraulically Failure Mechanism of non-Cohesive Homogenous Protective Embankments by Overtopping

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Introduction

flood control is one of the important requirements in development projects of major water resources. In this regard, the main purpose is to reduce or eliminate the economic, social and environmental damages that are caused by floods. On the other hand, many irrigation and drainage networks are in the vicinity of the rivers and, therefore, the occurrence of floods can cause irreparable damage to the land and network structure. Embankment failure due to water overtopping during floods is a common phenomenon which brings great financial losses, human casualties and environmental damages. Therefore, this research was aimed at investigating the mechanism as well as the effective variables on embankment failures.

Material and Methods

Initially, to achieve the purposes of this research, the dimension analysis was performed. However, the influential parameters on failure of dikes are as follows:

$$f(d_{50},\rho_s,D_r,q_u,\phi,g,h,L,\theta,Q_{in},Q_b,w(t),xh(t),H_0,H(t),t_b,t)=0 \qquad (1)$$

where d_{50} is the average of particle diameter, ρ_s is the particle density, D_r is the relative density, q_u is the unconfined strength of soil, ϕ is the friction angle, g is the gravity acceleration, h is the embankment height, L is the bottom length of embankment, θ is the angle of side body, Q_{in} is inlet discharge to levee, Q_b is the passed discharge of slot, w(t) is the slot width to time, xh(t) is the head cut location to time, H_0 is the initial water depth, H(t) is the upstream water depth, and t_b and t are the failure time and the time parameters, respectively. On the basis of analytical dimensionless methods, the important dimensionless parameters are as follows:

$$f\left(\frac{w(t)}{d_{50}},\frac{w(t)}{h},\frac{xh(t_0)}{L},\frac{xh(t)}{H(t)},\frac{\rho_s g d_{50}}{E},\frac{Q_{in}}{Q_b},\frac{t}{t_b},\frac{Q_b}{\sqrt{g}H(t)^{1.5}w(t)},D_r\right)=0 \qquad (2)$$

In this research, four types of non-cohesive soil with average diameters of 0.44, 0.7, 1.7 and 2.4 mm were investigated to construct a levee with 1.35m bed width, 0.25m height, 0.1m crest width, 0.35m length and a body slope of 1 to 2.5. Inflow discharge was considered to be equal to 1.4 L/s.

Results

In this research, different quantitative and qualitative results were obtained. These results included slotted widths, failure discharges, variations of water depth rather than time, and many other results. For example, slotted width variations to time were investigated and the findings for t=10s showed that the slotted width was equal to 10cm where it was equal to the initial slotted width for samples 1 and 2 while they were smaller for samples 3 and 4. These results are shown in Fig.1.

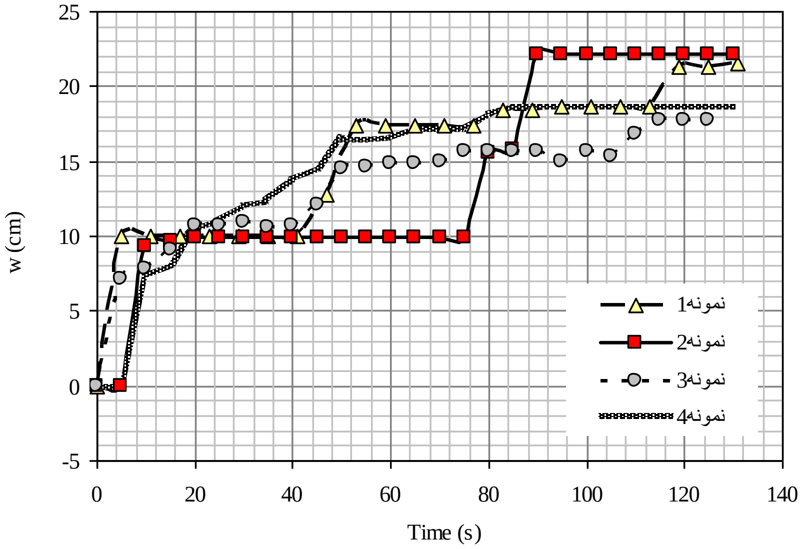

Figure1- Variations of slotted width to time

In addition, Fig.2 shows instantaneous discharge to relative time parameter of the slotted width. However, the dimensionless failure discharge increases up to 1.6 and decreases by w(t)/h.

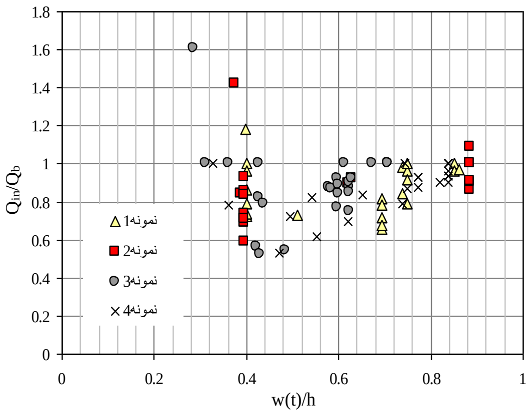

Figure2-Variations of dimensionless failure discharge to slotted width

The results showed that in diameters of 0.44 and 0.7, deep erosion occurs first. In other words, in soils with a smaller equivalent diameter, the erosion groove transverse changes are stair-like and the in models with larger diameters, transverse erosions are more intense. On the other hand, the discharge through the slot have oscillates when the corresponded failure gets to maximize. Also, the results indicated that the groove's maximum discharge increases by 12% as the particles’ diameter changes from 0.44 to 1.7mm. Moreover, the maximum discharge for 1.7 mm and 2.4 mm particles are almost equal. Generally, the failure times of dikes decreased as the average diameter of particles increased. In the next step, the governing non-dimensional equations were extracted and discussed in details.