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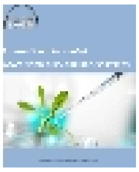

On the effect of homogeneous soil dams upstream slope

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ABSTRACT

Leakage is infiltration or slow moving water through the soil mass. Leakage losses from dams have a large proportion of water losses in the agricultural sector. Create leaks in the soil dam, causing water loss, reducing the stability of the dam and the creation of health risks. In this respect, analyzing and seepage of soil dam is one of the first step and the most important issues in the design of dams that are considered by professionals. Sufficient knowledge of the basic rules of geotechnical leakage allows to the professionals to managing the appearing of serious problems in analysis and selects the best type of control system to avoid Leakage. Up to now, many efforts of researchers and scholars in communication about the effect of leaking and its controlling in soil dam have been studied. In this study, changes in the slope of the dam was evaluated in a laboratory model, and the results showed that by reducing the slope of the output rate on other side the dam will rises. Then obtained data from dimensional analysis by using SPSS statistical software analyzed and the obtained relations of software was compared with relations of dimensional analysis and finally good results have been obtained.

1. Introduction

Soil dam is the most common type of small dams. For construction of the dams normally local materials can be used. Water leakage and the method of control it in soil dams is one of the most important issues in the design and operation of dams which is particular interesting for specialists. Awareness of the impact of many parameters which are involved in the leak can quickly help to resolve the design problems. In general, in the issues which are related to leakage, the soil mass is a contentious environment that contains numerous interconnected pores. Therefore leakage is inevitable, and to optimize the flow rate its calculation and complete understanding must obtain (Kharaghani, 2004). Analyzing and seepage of soil dam is one of the first step and the most important issues in the design of dams that are considered by professionals. Sufficient knowledge of the basic rules of geotechnical leakage allows to the professionals to managing the appearing of serious problems in analysis and selects the best type of control system to avoid Leakage. . Up to now, many efforts of researchers and scholars in communication about the effect of leaking and its controlling in soil dam have been studied but because each block has its own geometry so its material properties are different. The design problem which has created, particularly in relation to the leakage has its own treats (Kharaghani, 2004).

Upstream slope of soil dam and pebbles, are protecting against the impacts of lake's waves. The most common causes of destroyed dams are internal corrosion and leakage phenomenon of the body. Research has shown that approximately 30% of the dams have been destroyed because of the leakage.

The important factors in the failure of soil dam are leakage of the body and beneath of the dam.

In 1968 Bob AND Mernel have prepared a list of 600 dams that have been damaged or have produced catastrophic event. These persons have mentioned that main Destruction of soil dams is dealing of free surface leakage on the downstream with the slope of dam or create internal scour by the leakage of the dams. To reduce leakage saturated flow energy in the body of soil dam several measures shall be taken which are include: Use the clay core, horizontal drains, sealing shields on the foundation of construction, condition and uniformity of grain size and density range between layers of soil etc., to reducing leakage, the body can be used. Vafaian and Nomerof (1998) have obtained the homogeneous and isotropic soil dam leakage characteristics by using advanced mathematical relations:

After a series of assumptions he concluded that:

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$$q = \frac{k \times h^2}{[L + \sqrt{L^2 + (\frac{h^2}{3})}]} \qquad (1)$$

q: flow rate per width unit (m sec)

K: coefficient of permeability of soil (meters per second)

E. The water level behind the dam (m)

L: Length of dam (m)

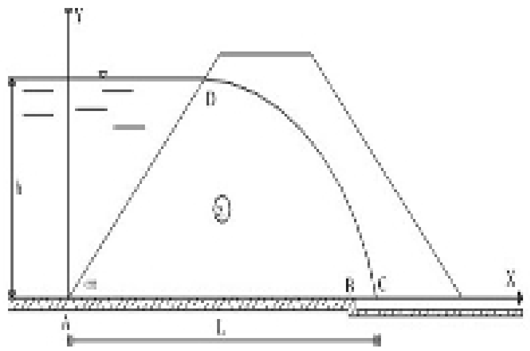

Fig. 1: Hypothetical dam section of Nomerof

After a series of assumptions he conclude that the equation (1) does not have a lot of usage in engineering field .Nomerof to simplify the equations assumed $\frac{L}{h} \langle 10$ and the angle of inclination of the upper slope is p/2 and thus entered large error into his equation. According to the aforementioned error, to reduce errors and remedy defects it seems that to calculate the leakage of the dams, more research is essential.

To reduce these errors and compensate for the shortcomings Morandi (2004), by Using seep-w software he has evaluated the analytical model of homogeneous and isotropic of Nomerof in controlling the leakage of the dams showed that The Nomerof model is not a good approximation from the pass rate and to calculate the flow through the dam does not have enough accurate. So they have offered necessary suggestions .Marandi et al Suggestions were as below:

The results of the flow passing is a function of cot A , COT B, H, K. parametersand h/H ,x/L and equation (2) which shows that the leakage through the dam.

$$Ln[\frac{q}{kh}] = -0.503 - 0.317\cot\alpha + 0.024\cot\beta + 0.763 Ln(\frac{h}{H}) - 1.145(\frac{X}{L}) \qquad (2)$$

q: Flow rate per unit width (m sec)

k: Soil permeability (meters per second)

h: Water level behind the dam (m)

cot a : the Downstream slope angle

cot B : the Upstream slope angle

The horizontal distance from the drainage upstream of the dam (m) x:

L: The length of the Dam (m)

And concluded that:

The Ratio of rate increase as the leakage through the dam , the downstream slope angle increases with increasing H/h amplitude.

The Ratio of rate increase as the leakage through the dam , the upstream slope angle increases with increasing x/L amplitude.

2. Materials and Methods

2.1. The ruling equations for the flow

The governing equations of hydraulic phenomena cannot be obtain directly from the rules of governing the movement of fluids and theories such as the conservation laws of mass, energy and momentum.

In such cases it is trying to extract a mathematical relationship that governs such these phenomena , First of all determining the variables that are involved in creating the phenomenon Shafaei Bajestan(2010).

General equation has 10 variables that after calculations were obtained by using Buckingham equation.

$$f(\frac{h_2}{h_1}, \frac{Q}{\sqrt{g \times h_1^5}}, \frac{\mu}{\rho.\sqrt{g}.h^{\frac{3}{2}}}, \frac{b}{h_1}, S, Fr$$

(3)

h_1 : Upstream water level

h_2 : Downstream water level

b : Width of the dam crest

g : Gravity

ρ : Mass per unit volume

V :The average rate of water discharged from the dam downstream

Q : Water output rate from downstream of the dam

Dynamic viscosity: μ

$S: \frac{\delta h}{\delta x}$: The slope of the dam, that δx is the dam length and δh is the dam height changes

2.2. Physical model

To evaluate the effect of body slope on leakage current in a homogeneous soil dam, Physical model of soil dam (Fig. 2) was established in a flume at the Hydraulic Laboratory.

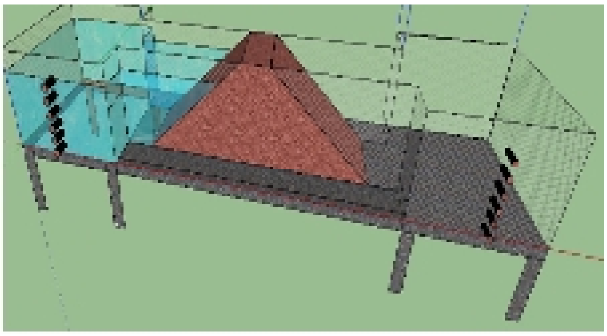

Fig. 2: Overview of the model

Physical model flume body has been made of galvanized iron and dam's structure has been made of the homogeneous clay barrier.

Table 1: Geometric characteristics of dams constructed

Dam crest length (Cm)	Dam width (Cm)	Dam height (Cm)	Dip both sides (-)	The number of dams built
50	*25*	*60*	*1:1.5*	*1*
50	*25*	*60*	*1:75*	*2*
50	*25*	*60*	*1:2*	*3*

Each experiment must be drawn before starting the test, thus, according to the purpose of this study, the following variables and schemes were studied and tested.

1) Changes in the height of upstream dam
2) Changes in upstream and downstream slope of the dam

Now on the base of presented contents we can pay attention to description of experiments. Clear water conditions of the experiment were considered. Water in upstream has stabilized the dam at a height of 60 cm ,and after complete saturation of the soil and the establishment of downstream leakage ,by using a graduated cylinder and also by using a stopwatch to measure the time, the leakage flow was measured. In these measurements to increase the accuracy an error which is equivalent to ml was used. At each measurement time was 20 minutes and measurements will continue until the output rate (constant) achieved to equilibrium. Then some embedded openings used in the water upstream dam which body of the flume was reduced to a height of 50 and 40 cm and measuring in these heights has done Similar to 60 cm height.

For completing the test Whatever that was conducted from the dam with 1:1.5 slope for dams with of 1:1.75 and 1:2 slopes repeated and the results were recorded. Then the results were analyzed by 19spss statistical software and Leak Line was traced for the whole network.

3. Analysis

3.1. Outflow rate of the dam

All Data from dams have incurred in Excel and a comparison was made between data that are described in the following diagram. Kachymv (1998)

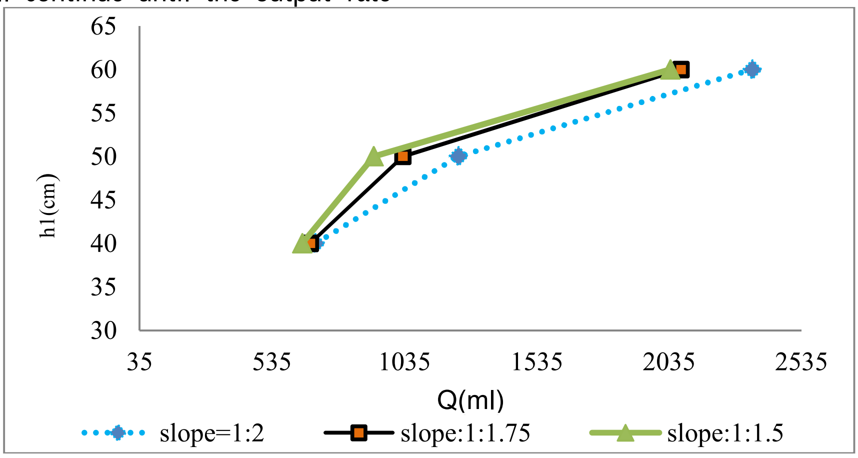

Fig. 3: Comparison of results in all gradients

According to Fig. 3, we can see the following results:

1. According to increases of water contact the creep length of the water according to the theory of Lin flow rate increases too.
2. With the increase in the slope from 1:1.5 to 1:1.75 flow rate has less changes but from 1:1.75 to 1:2 the ratio will change too much.
3. Flow Changes at 40 cm height is a little and can change with increasing the altitude.
4. Due to the changes in the slope of the body it can be seen that outflow of the dam In constant height of 50 cm will significantly increase and if the height of 60 cm was also noted, this result is obtained that by increasing the height and reducing the and slope then the outflow of the dam

will increase too. Between the upstream water level and outflow at the dam is a direct relationship. With the increase of water level upstream, output rate will increase too and vice versa.

3.2. Analysis with the software

According to the number of variables in the multiple regressions method that estimates the value of dependent variable on the values of the independent has been used .Several tests were performed on samples to ensure the best curve of reflected sample.

Table 2: Correlation coefficients and statistical variation

Significant	Statistics					Standard error of estimate	r Adaptation Given	r^2	r	Model
	Sig. F Change	df2	df1	Changes F	Changes r^2					1
0/003	0.003	4	4	31.727		0.00006181473	0.939	0.969	0.985	

The criterion factor: $\frac{Q}{\sqrt{g.h_1^5}}$

Table 3: Standardized and non-standardized regression coefficients are

	T	Standardized coefficients	Standardized coefficients not			
Significant		Beta	Standard error	B	Fix ed values of predictor variables	Model
0.421	0.896		0.004	0.004	Constant	1
0.357	1.040	6.588	6243.740	6490.791	$\frac{\mu}{\rho.\sqrt{g}.h_1^{\frac{3}{2}}}$	
0.421	-0.896	-5.951	0.019	-0.017	$\frac{b}{h_1}$	
0.207	-1.504	-0.200	0.000	-0.001	S	
0.039	3.032	1.224	0.099	0.300	Fr	

According to Table 3 and the correlation coefficient r is 0.985 that Indicating the high accuracy of the regression which has done. According to Table 2 and column B, equation (4) is as a proposed relationship:

(4)

$$\left(\frac{Q}{\sqrt{g.h_1^5}}\right) = 0.004 + 6490.791\left(\frac{\mu}{\rho.\sqrt{g}.h_1^{\frac{3}{2}}}\right) - 0.017\left(\frac{b}{h_1}\right) - 0.001(S) + 0.300(Fr)$$

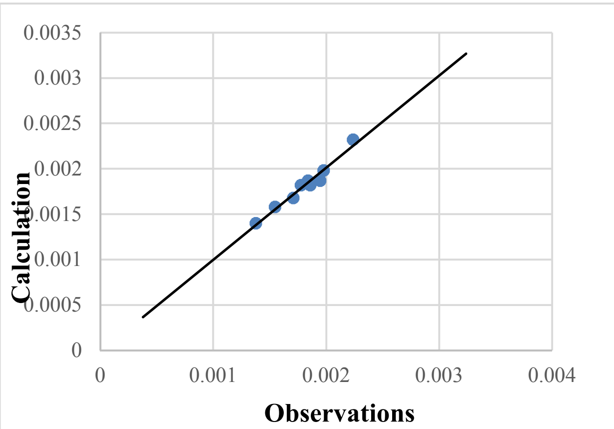

Fig. 4: compares the observed correlation and regression values

According to the Fig. 4 as well as data obtained from a dimensional analysis of the relationship and the result of regression equation it can be realized that the obtained data from software relation has low error rate and high reliability (less than 0.5) and its correlation coefficient is 0.969. This model can be used by having Fr ، $\frac{b}{h_1}$ ، $\frac{\mu}{\rho.\sqrt{g}.h_1^{\frac{3}{2}}}$ ، S variables instead of $\frac{Q}{\sqrt{g.h_1^5}}$ in dimensional analysis relation.

4. Results

1. Decreasing slope leads to increase the water contact and according to the Lin theory leakage will increase too.
2. Between the upstream water level and outflow at the dam is a direct relationship. With the rise in water level upstream output rate increases too and vice versa.
3. .by Increasing the outflow from the dam body , $\frac{Q}{\sqrt{g.h_1^5}}$ Froude number (Fr) will increases too.
4. Flow is a function of Fr ،، $\frac{b}{h_1}$ ، S ، $\frac{\mu}{\rho.\sqrt{g}.h_1^{\frac{3}{2}}}$ $\frac{h_2}{h_1}$ /effective parameters.

Relation

$$\left(\frac{Q}{\sqrt{g.h_1^5}}\right) = 0.004 + 6490.791\left(\frac{\mu}{\rho.\sqrt{g}.h_1^{\frac{3}{2}}}\right) - 0.017\left(\frac{b}{h_1}\right) - 0.001(S) + 0.300(Fr)$$

Shows the ratio of Leakage through the dam body in a homogeneous state.

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