Anbar Journal of Engineering Science (AJES) **Vol. 11 , No. 1 (2020) , pp. 33 ~ 37**
P-ISSN: 1997-9428; E-ISSN: 2705-7440 DOI:10.37649/aengs.2020.171284

Anbar Journal Of Engineering Science©

journal homepage: http:// http://www.uoanbar.edu.iq/Evaluate/

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Analysis of seepage through Al-Wand Dam by using SEEP/W Model

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PAPER INFO

Paper history:
Received … … …
Received in revised form …
… …
Accepted … … …

Keywords:
Seepage, SEEP/W, Al-Wand Dam, Clay Core, Filter.

ABSTRACT

In geotechnical engineering, considered the seepage of water that occur through the soil medium is one of the important problems that must be accurately studied; therefor, knowledge of influencing factors on the value of seepage for the soil is a necessary when designing an earth dam. In this study seepage through Al-Wand dam was analyze by using SEEP/W model. It is a sub- program of Geo- Studio where it used to determine amount of seepage through the body of the dam and study the effect of the change of thickness of core and effect of construction without filter in amount of leakage. The results were that the quantity of leakage was small effected when reducing the thickness of core and when construct the Al-Wand dam without filter at different level of water in upstream.

1. Introduction.

Earth dams can be defined as economical hydro-engineering structures that are used for many purposes; firstly, they are used for protecting people from natural disasters such as floods. Secondly, they are used for storing water for irrigation. Thirdly they are used for water supply and energy generation. Earth dam are the oldest type of used dams. They are generally constructed with available soil having high compaction. The investigation of the effect of water on earth dams is inevitable and essential (Sazzad et al, 2015).

Earth dams can be classified into two types: homogeneous and nonhomogeneous earth dams. Non-homogeneous dams are constructed from different parts that each part has much influence separately on the dam body's performance, stability, and other design components. For designing of an earth or rock fill dam, the foundation, abutments and embankment should be considered as a unit. The entire assemblage must retain the reservoir safely without excessive seepage (Mohammadi et al, 2013). An earth dam is a design on previous and investigative studies, special knowledge, experience and the individual designer's preferences. In a particular location, we can typically construct a range of dams that are both secure and economical, and we have a lot of examples in that skillful engineers suggest various designs on a large scale for the same basin. Moreover, the characteristics of the designated location have a bigger effect on an earth dam design (Majeed, 2014). The basic earth dam design should take into account four matters, as the following:

A: Selection appropriate materials: by choosing appropriate materials for the earth dams' core, there are two factors to be taken in to account the quantitative and qualitative factors, in addition to the elimination of materials.

B: Determining of the core thickness: in general, the core material includes a great amount of fine particles of silt and clay will, consequently, get lesser shear strength than the shell substance.

C: The core geometry may be built as the vertical and slope in the earth dam section.

D: the comparative core permeability: whatever core

Permeability is lesser than downstream permeability of the shell, in the shell leakage line is in the lower

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place and vice versa. Therefore, the location of the leakage line in the downstream shell is efficiently pulled off, it is necessary that at least permeability has some hundred equivalent permeability. (Karampoor and Riazi, 2015).

The soil on the downstream sides of some hydraulic structures get lifted up under effect of piping phenomena, that's due to excess pressure of water exert from the soil as a result of water seepage.The interaction between soils and percolating water has many valuable affecting in the following actions:

1- Design of foundations and earth slope.
2- Volume of water loss from a dam by percolation, or fail of sub soil foundation due to piping which are quite common. In case of slope stability, the seepage force is a very important, shear strengths of soils reduced with respect to increase of neutral stress (pore pressures).

Therefore, well understanding of hydraulic conditions is essential for structure design. The computation of seepage loss via a dam includes uplift pressures caused by the water on the base of a dam, and effect of seepage on the stability of earth slopes, which can be studied by constructing flow nets (Murthy, 2003).

2. SEEP/W PROGRAM

SEEP/W (a sub-program of Geo-Studio) is a product of finite element software for the purpose analyzing seepage groundwater and the problems of overload pore-water pressure dissipation inside permeable materials like soil and stone. Its inclusive formulation permits you take in to account analyses extended from easy, saturated steady-state problems to complicated, saturated and unsaturated time-reliant problems. SEEP/W may be applied and used to analyze and design the projects of civil, geotechnical, hydrogeological, and mining engineering. A lot of earlier researches and studied various problems of seepage using the SEEP/W program (Irzooki, R. H., 2016).

3. MATERIALS AND METHODS

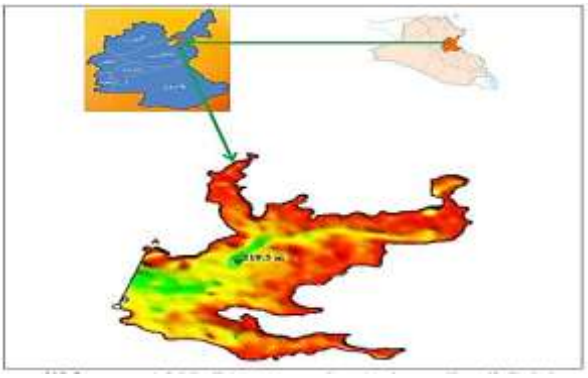
3.1 ALWand Dam Description

The project was very effective to keep the city Khanaqin from flood of water. The dam is located on the Al Wand River within the province of Diyala on distance 7 km south-east of the city Khanaqin. The coordinates of the study area for dam are shown in the **table 1. Figure (1**) illustrates the general location and layout of the project site.

Table (1) coordinates of the study area for dam

Name	East	Northing
A	540940	3797320
B	540613	3796029

Figure (1) location of reservoir of Al wand dam



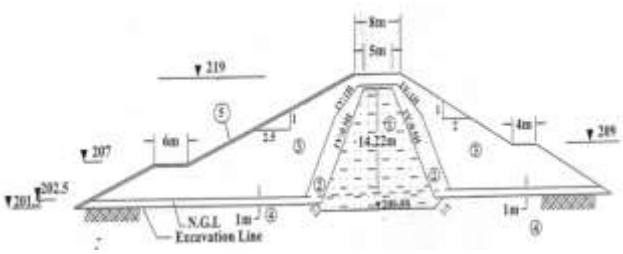
The overall features for ALWand dam according to **table (2)**

Table (2): overall features to Al Wand dam.

Whole dam length	1350m
Dam high	24m
Spillway length	210m
width of the top of the dam (crest width)	8m
Total storage capacity	51830000m^3
Live storage	37820000m^3
works Burial	793000m^3
Maximum flood discharge	1500m^3/sec

3.2 Components of Al-Wand Dam

The dam consists of many layers. These layers had Thickness be variable where it has the bigger value at the base and gradually decreases towards the top of the dam's. **Figure (2)** illustrates a cross sectional area of the dam's and **table (3)** content properties for material used in construction the ALWand dam.



1- Clay core 4- Foundation

2-Filter 5- U/S Riprap (0.3m Thickness)

3-Gravel and sand fill for U/S and D/S

Figure (2): Cross section of Al-Wand dam (the scale 1/500) (after Ministry of water resources)

Table (3): Material Properties of Al-Wand dam.

Core	Gravel	Nil
	Sand	20%
	Silt	60%
	Clay	20%
	Liquid limit (L.L)	28.5%
	Plasticity limit (P.L)	16.2%
	Plasticity index (P.L)	12%
	Dry density	1.52 gm/cm^3
	Hydraulic conductivity	1.44x10^{-7} m/days
	Carbonates	28%
	Organic Materials	0.55%
	Percentage of salts	2.53%
	Gypsum	0.91%
	Cobbles	10%
	Gravel	60%
	Sand	25%
	Silt	3%
	Clay	2%
Shell	Dry density	2.11 gm/cm^3
	Hydraulic conductivity	0.072 m/days
Fine filter	Unite weight	19.227 KN/m^3
	Hydraulic conductivity	483.84 m/day
Coarse filter	Hydraulic conductivity	43200 m/day

4. Seepage analysis through Al-Wand Dam

Seepage through Al-Wand dam was study according to the defined specifications for nonhomogeneous earth dam with help of SEEP/W software (2012).

The following steps were adopted to model the seepage through the dam:

- Define the type of analysis to be steady state,
- Set the work sheet, scales, axes and grids,
- Drawing Al-Wand dam according to cross section,
- Definition hydraulic conductivity for different parts of the dam and location of the dam materials,
- Assign material properties defined for different areas of the dam
- define boundary condition,
- Select the mesh barrier with combination elements of square, rectangular and triangular.

The quantity of seepage that passing through cross-section area (which cross section figure 2) is calculated using SEEP/W as shown in figures (3to5) for different height of water in upstream.

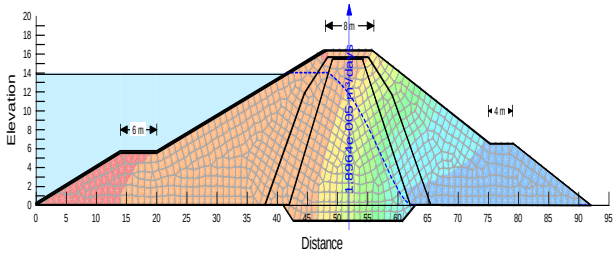


Figure (3) phreatic line and seepage quantity to Al Wand dam for 14 m water head

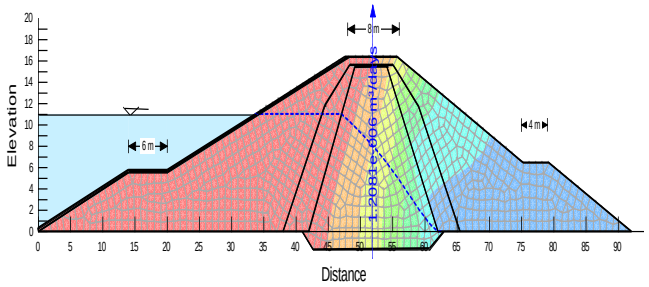


Figure (4) phreatic line and seepage quantity to Al Wand dam for 14 m water head

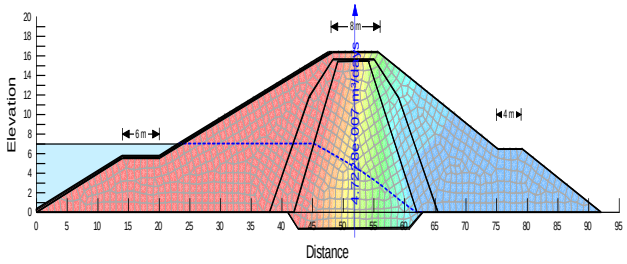


Figure (5) phreatic line and seepage quantity to Al Wand dam for 14 m water head

5. Seepage Control in the Al-Wand dam

Two points studied in this sections, each point will study variable one part of the dam body and then check the effect of this change on the amount of leakage and seepage line.

5.1. Reduces a thickness of core

In this case studied reducing the thickness of the core to decrease the unit cost of placing impervious materials may be more than the unit cost of placing pervious materials.

The thickness mentioned lies on the ground line in the basic and foundation. The studied cases were focused on change the thickness of the core by (2.5 m) from each side (u/s and d/s) for keep the core in all cases symmetric with the original. The phreatic line and velocity vectors for the various changes in core thickness at different reservoir levels have been presented in **Figures (6) to (8).** The relationship between the quantity of seepage with change in the thickness of the core at different water levels in reservoir are shown in **figure (9).** It can be said, that amount of leakage was effect very small when change in the thickness of the core.

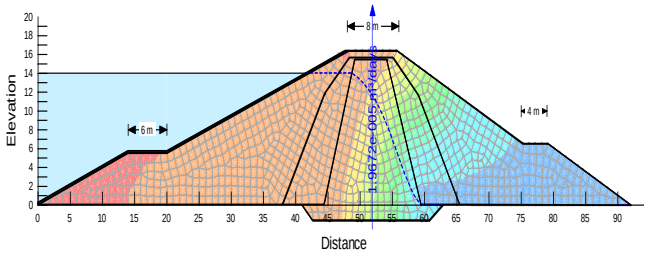


Figure (6) Velocity vectors and seepage line when reduced a core thickness (5 m) and water head 14 m

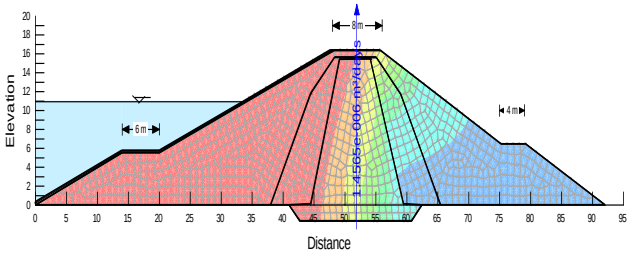


Figure (7) Velocity vectors and seepage line when reduced a core thickness (5 m) and water head 11 m

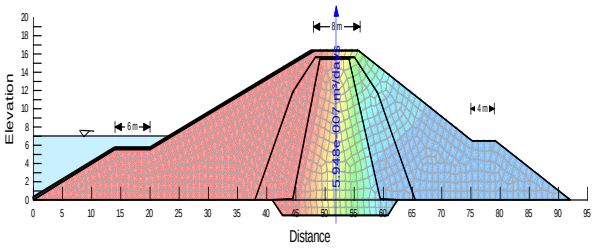


Figure (8) Velocity vectors and seepage line when reduced a core thickness (5 m) and water head 7 m

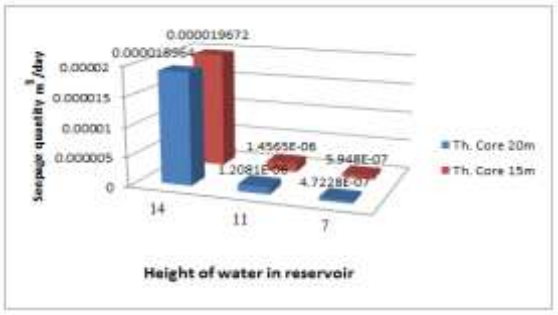


Figure (9) Relationship between amount of leakage & water levels for different core thickness

5.2. The effect of u/s and d/s filters.

In earth fill dam's filters are constructed from coarser-grained soils located within or adjacent to the dam body for prevent the soil particles movement from or between the layers and the foundation. Such movement If not controlled the movement could cause the development of concentrated leakage, which allowed to serious situation also in extreme cases may cause failure. To explore effects construct earth dam without filters from the core on the seepage quantity, the leakage line and velocity vectors. as show in figure (10) to (12).

figures (13) illustrate the relationship between the quantity of leakage for removed filters from the dam and change the water levels in the reservoir. It can conclude from the results that are a small change in the seepage discharge due to replacing the filter by the shell.

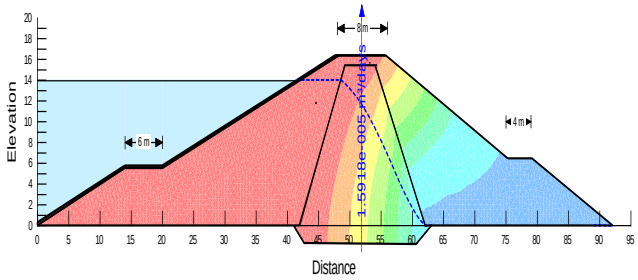


Figure (10) seepage quantity when the dam is without filters and the head of water at (14 m)

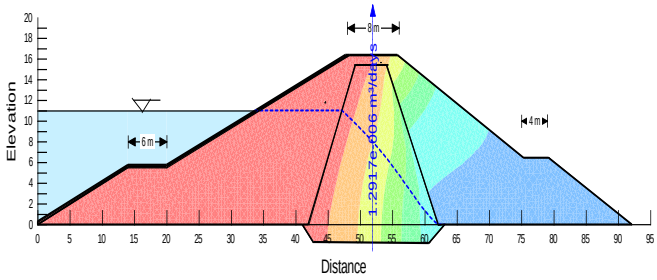


Figure (11) seepage quantity when the dam is without filters and the head of water at (11 m)

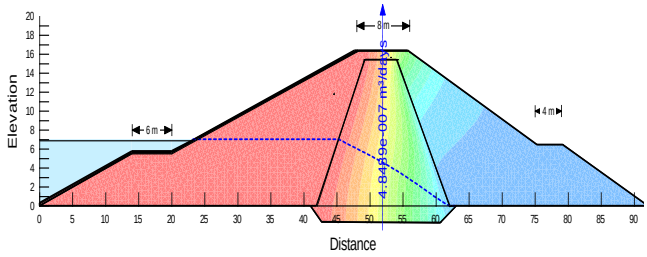


Figure (12) seepage quantity when the dam is without filters and the head of water at (7m)

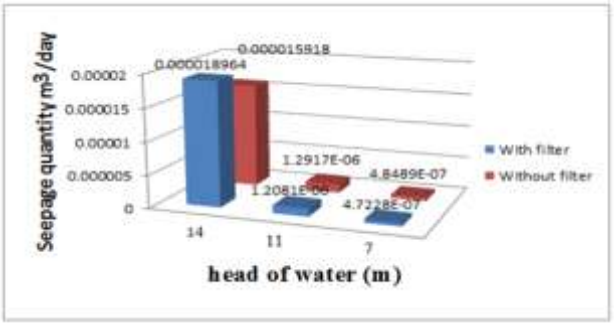


Figure (13) Relationship between seepage quantity & head of water in the reservoir when the dam is with & without core

The program SEEP/W (which is a sub-program of Geo-Studio) version 2012 used to calculate amount of seepage through dam body for steady state case to different water head in upstream. It is concluded that the quantity of seepage was small affected when reducing the thickness of core. In addition, the seepage discharge is a small change when replacing the filter by the shell.

REFERENCES

1- Sazzad, M., Roy, M., and Rahman, M.S., (2015), "FEM Based Seepage Analysis through dam" international Journal of advanced structures and Geotechnical Engineering, Vol. 4, No.03, pp158- 164.

2- Mohammadi, M., Barani, G. A., Ghaderi, k. and Haghighatandish, S. (2013), "Optimization of earth dams clay core dimensions using evolutionary algorithms" European Journal of Experimental Vol. 3, No. 3, PP. 350-361

3- Murth, V. N. S., (2003), "Principles and practices of soil mechanic and foundation engineering" 10th edition publishing in the United States of America.

4- Majeed, Q. G., (2015), "Flow and deformation analysis of zoned earth dam by the finite element method" Diyala Journal of Engineering Sciences, Vol. 08, No. 03, PP. 38-62

5- Karampoor, F. and Riazi, R. (2015) , " investigation the effect of clay core in seepage from non-homogenous earth dams using SEEP/W Model" Journal of scientific research and development 2(5) pp. 280 285.

6- Irzooki, R. H., (2016), ″Computation of Seepage through homogenous earth dam with horizontal Toe drain ″ Eng. and Tech. Journal. Vol. 34, No. 3, PP. 430-440.