Investigation of the leakage and maximum stress in plastic concrete cut- off wall with 100 centimeter width instead of clay core in static state on embankment dam's raz & jargalan

Ahmad Sedighian[1], Abbas Ali Ghezel Sooflo[2]
1- Civil Engineering Department, Faculty of Engineering, Khavaran Institude of Higher Education, Mashhad, Iran
2- Assistant Professor's, Civil Engineering Department, Faculty of Engineering, Azad Islamic University, Mashhad, Iran

Email: Ahmad.sedighian@yahoo.com

Abstract

The clay core rock fill dams have such a special place in the world. In this kind of dams, the implementation of their core and adjacent filters are placed in the critical path of dam construction. While the coarse grain shells are performable easy and quickly. Considering this fact, the possibility of replacing the clay core with other appropriate sealing material, has been studied. following the sealing plastic concrete dams has been widely used in the world if the use it as sealing element is less considered. Leakage has been the main reason failure in body and foundation and solution is cut-off wall. In this research plastic concrete seal's wall with 100 centimeter widths will be compered by clay core earth dam. Modeling Raz & Jargalan dam was conducted by ABAQUS software in north Khorasan. The result show the maximum stress value reduce in sealing cut-off wall and the stress values of authorized dam are lower and The use of proposed sealing cut-off wall reduce the amount of leakage by 66.6 percent which is significant.

Keywords: Clay core, ABAQUS, Plastic concrete, The maximum stress, Seepage.

1. INTRODUCTION

Storage dam was made for save and regulation of river run off in Raz & jargalan. Dam axis is located at the distance of about two kilo meter north of it. This river is permanent and the run off is 11.2 million cubic meters yearly. The fertile coast of shootout incurred huge losses from floods in Raz & jargalan yearly. [1]

So proper control of considered the agriculture and animal husbandry development, drinking water supply in it and addition to the control the destruction of river too. Technical specifications Raz & jargalan dam has been show in table 1.

Table 1- Technical specifications design dam Raz & jargalan [1].

Soil with clay core	Type of dam
920 m	Length of crest dam
8 m	Width of crest dam
1.1 million square meter	The total volume of body dam
23.5 m	Height of dam from river bed
30 m	Maximum thickness of alluvial river
1214 m	Balance of floor river
1233 m	Normal balance water surface of the lake
1237.5 m	Dam crest balance
263.5 m	Catchment domain space
74.8 kilo meter	Catchment domain environment

And the section of the dam is showing in figure.1

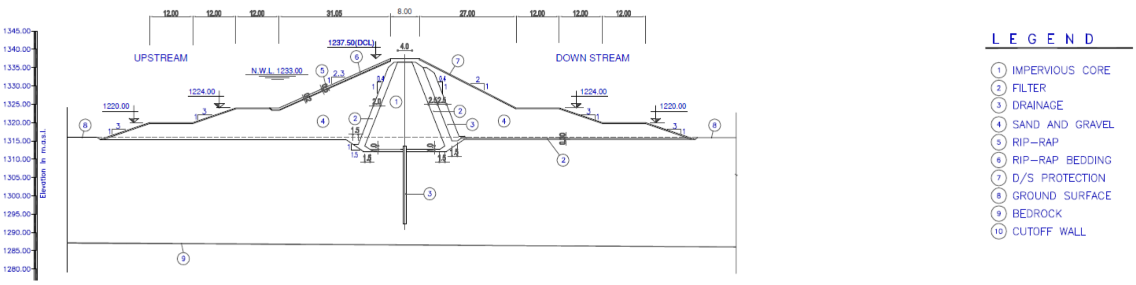

Figure 1. section of body type of the dam Raz & jargalan.[1]

2. SOFTWARE ABAQUS

This software by DASSULT-SYSTEMS American company was built as one the pioneers of finite elements software and researchers put it for took advantage fit and one of the first software that puts the non-linear analysis, fracture mechanics, reservoir and other analysis in its pakage. Powerful solvers and intelligent software, application has promoted research into industrial applications. Modeling and networking in this application is very simple, yet powerful simplicity the rational software. In Abaqus software, the graphical relationship between software and user is access and work with them is very simple. [2]

3. HOW MODELING ABAQUS SOFTWARE

Software on a regular foundation and dam with mesh and improved element is used modeling of this element is very simple. In this section to become familiar with the capabilities of the software and how can model to explain. It should be noted that all parts of the back wall of the dam because of the soil, with the logo that is hardly saturated soil behind the wall we modeling.
Building the dam wall is the same characteristics apply in both sealing and without it.
Material of dam: specification for various materials, including unclear dam, layouts, filters, gutters and wall of sealing are as shown in table 2.

Table 2- Elastic properties of dam's material. [3]

Vertical permeability (cms^{-1})	Horizontal permeability (cms^{-1})	Passion's ratio	Modulus of elasticity (kpa)	Density tm^{-3}	
10^{-6}	5^{-7}	0.48	22900	2	Clay core
4.62^{-2}	4.62^{-2}	0.2	40000	2.2	Crust
4.62^{-2}	4.62^{-2}	0.2	40000	2	Filter
4.62^{-2}	4.62^{-2}	0.2	40000	2	Drain
10^{-6}	10^{-6}	0.2	600000	2.1	Plastic concrete

4. BOUNDARY CONDITIONS

In Abaqus finite element mesh nodes boundary condition instead of applying to apply to the geometry of the assembly. The relationship between the assembly geometry, boundary conditions and the possibility of changing the mesh without the need to the re- define and extend the boundary conditions provides. After all nodes of the mesh model boundary conditions that apply geometric area. In the analysis of Raz & jargalan dam without cut-off wall proposed conditions for foundation bed is rigid. Boundary condition of bed foundation is encaster. The means that all degrees of freedom to apply for a place, pick a lock that is meant to be completely rigid. [2]

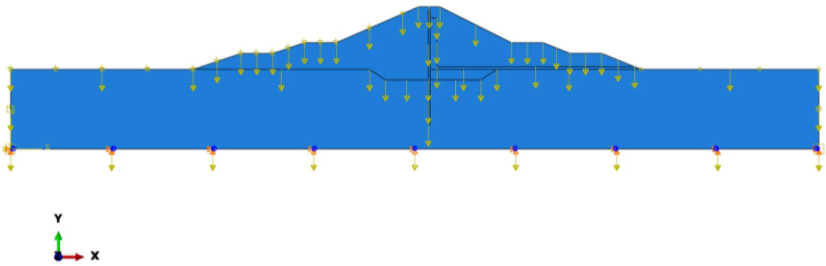

Figure 2. boundary condition on embankment dam without cut-off wall proposed 100 centimeter

In modeling, housing and dam foundation is modeled as two-dimensional as well as water level upstream dam wall is included in the model also. The four node element of CPE4P (fluid/stress) is used for modeling upstream and downstream shell, clay core, upstream and downstream filter and drain CPE4R (plain stress) the four-node element is used for modeling plastic concrete seal's wall. Embankment dam's mesh come by applying the seal's wall proposed and exterior f mesh on the seal's wall proposed respectively in figure 3 and 4. [4]

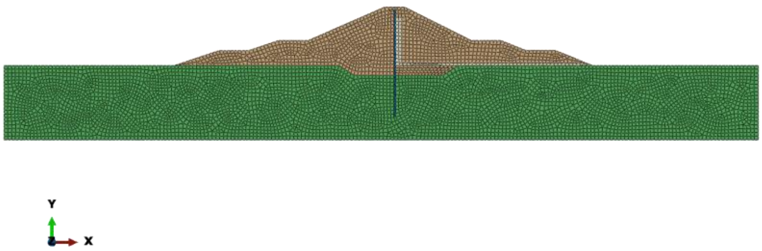

Figure 3. mesh finite element Raz & jargalan dam by method applied seal's wall 100 centimeter proposed

5. Leakage Analysis

The general equation of flow in a non-homogeneous soil masses in the absence of any power supply and discharge is as follow. This equation is known as the Richards equation.[5]

$$\frac{\partial \theta}{\partial t} = \frac{\partial}{\partial x}\left(k_x \frac{\partial h}{\partial x}\right) + \frac{\partial}{\partial y}\left(k_y \frac{\partial h}{\partial y}\right) + \frac{\partial}{\partial z}\left(k_z \frac{\partial h}{\partial z}\right) \quad (1)$$

Where H is water head and K_z, k_y, k_x are electrical conductivity of soil in direction z, y, x respectively, θ is moisture content of soil mass.

In steady-state condition, and for a state in which saturated soil masses change volumetric moisture content over time zero. Therefore, the above equation for a two- dimensional stream is summarized as follows:[6]

$$\frac{\partial}{\partial x}\left(k_x \frac{\partial h}{\partial x}\right) + \frac{\partial}{\partial y}\left(k_y \frac{\partial h}{\partial y}\right) = 0 \quad (2)$$

Where h is peysometric height. Kx permeability coefficient in direct x and k_y permeability coefficient in direct y.

The equation of intersection for a homogeneous environment is used by the equation above as the Laplace equation. Now we use Green's theorem: [7]

$$\int_{\Omega}^{0} \nabla . A . d\Omega = \oint_{\Gamma}^{0} A . n . d\Gamma \quad (3)$$

A: Unit victor Ω: Field of interest Γ: Boundary field n: Vertical unit perpendicular to the boundary.

By dividing the desired field. The problem is achieved by a set of polygonal elements using the Gales Keynes method.[7]

$$\int_{\Omega}^{0}\left(\frac{\partial h}{\partial x}.\frac{\partial N_i}{\partial x}+\frac{\partial h}{\partial y}.\frac{\partial N_i}{\partial y}\right).d\Omega=\oint_{\Gamma}^{0}\frac{\partial h}{\partial n}.N_i.d\Gamma \quad (4)$$

Whereas h in each element, the function is as follows:[8]

$$h=N_j.h_j \quad (5)$$

The above relationship is as follows: [8]

$$\left\{\int_{\Omega}^{0}\left(\frac{\partial N_i}{\partial x}.\frac{\partial N_J}{\partial x}+\frac{\partial N_i}{\partial y}.\frac{\partial N_J}{\partial y}\right).d\Omega\right\}h_j=\oint_{\Gamma}^{0}\frac{\partial h}{\partial n}.N_i.d\Gamma \quad (6)$$

In which according to Darcy low $\frac{\partial h}{\partial x}\ \ \frac{-v_n}{k_n}$ is the speed of perpendicular to boundary.

The above equation forms the basic of the finite element method in the leakage. This equation applies to each element, and then the relation of the final matrix of the assembly with the solution of the Laplace equation can be obtained by obtaining theoretical flow of water from the earth's dam under two-dimensional conditions.[9]

$$k_x\frac{\partial^2 h}{\partial x^2}+k_z\frac{\partial^2 h}{\partial z^2}=0 \quad (7)$$

6. Investigation of the Leakage in Proposed Sealing Cut-off Wall Instead of Clay Core

In finite element method the geometry of the model is dividing into several elements connected to the nodes. The total fields within the flow region are approximated using the interpolation functions within each element. Thesec functions intercept the amount of head in the nodes of the element. By solving an equation, we can calculate the flow through the body of the earth and dam. The accuracy of the answers depends on the number of elements used to approximate the continuous flow field.

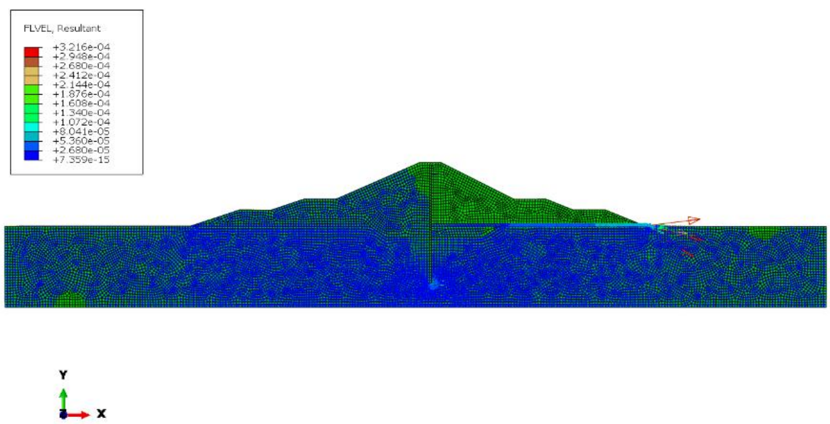

Figure 4. Distribution of water flow rate in the dam by applying sealing cut-off wall

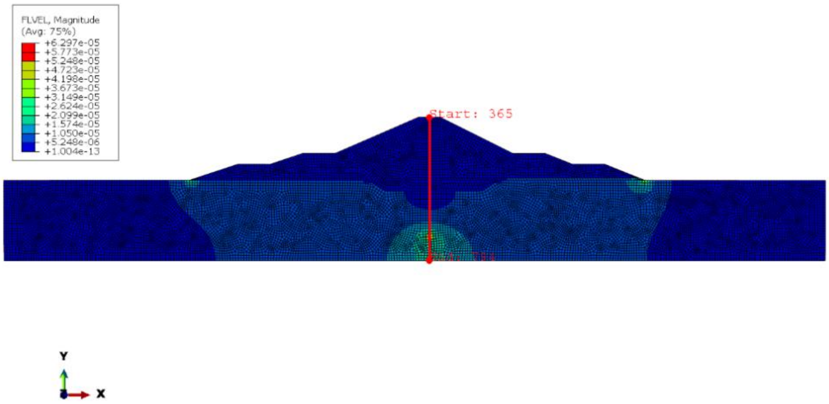

Figure 5. Selection section for calculating leakage value

As you can see in the figure above the amount of discharge with no action recommended cut off wall was 45000 cubic meter per year and by applying the proposed sealing cut-off wall this amount is reduced to 15000 cubic meter per year. The use of proposed sealing cut-off wall reduces the amount of leakage by 66.6 percent which is significant.

7. INVESTIGATE THE MAXIMUM PRINCIPLE CAUSED BY THE PROPOSED DAM ON THE WALL 100 CM

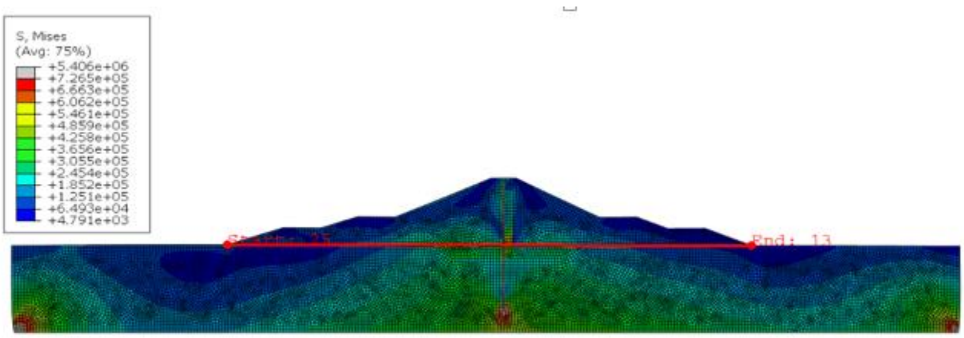

Figure 6. select section for check the maximum stress in the cut-off wall proposed 100 cm

The result show that the tension in the core of dam is more than of upstream and downstream shells. Because upstream of the dewatering tank that the shell is immersed.

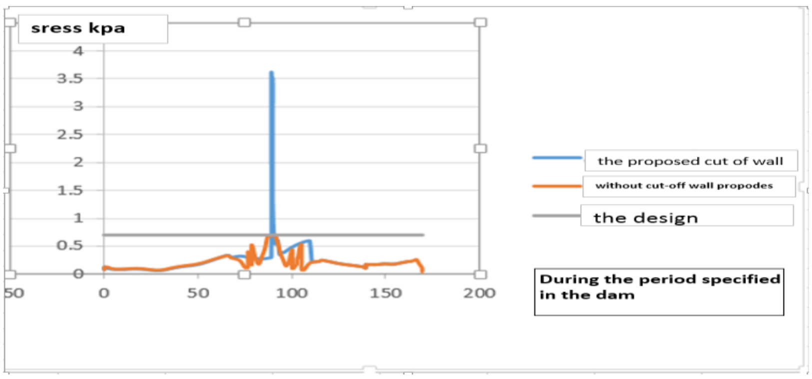

Figure 7. selectsection for check the maximum stress in the cut-offwall proposed 100 cm

As can be seen in figure 7, amount of the tension on the dam wall proposed is (3.7 M pa). that the amount is much higher than its actual value (0.7 M pa). so the dam wall proposed is not tolerated forces and defeat is inevitable.

9. DISPLACEMENTS

The vertical and horizontal displacements in this analysis are illustrated in figures 8 and 9. As you can see, upstream and downstream displacements of the dam are almost symmetrical. Maximum horizontal displacements in upstream are calculated as 12 centimeters and in downstream are calculated as 14 centimeters. The reason of this little difference in the horizontal displacements in downstream and upstream of the dam is the slope angle difference between the upstream and downstream shells. The vertical displacement in the center of dam reaches to maximum 75 centimeters. Stress-Deformation Modeling with Abaqus (2007)

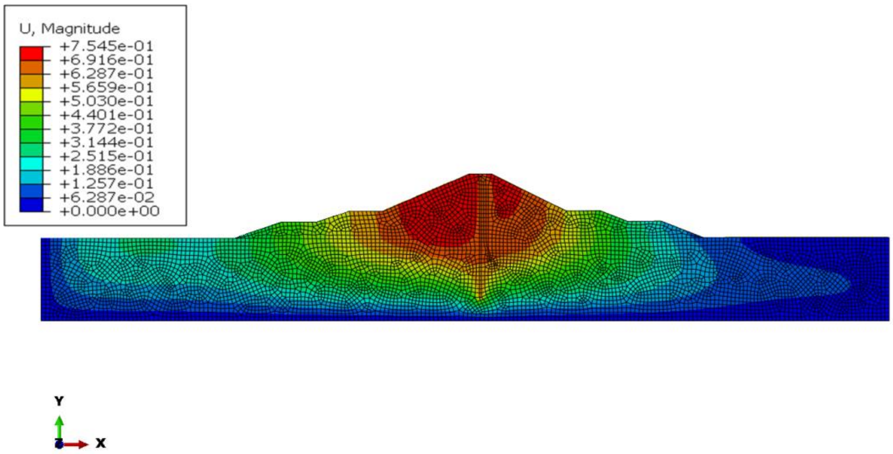

Figure 8. Total Vertical Displacements at the End of Construction Stage Considering the Sealing Wall Implementation up to the Crest Level

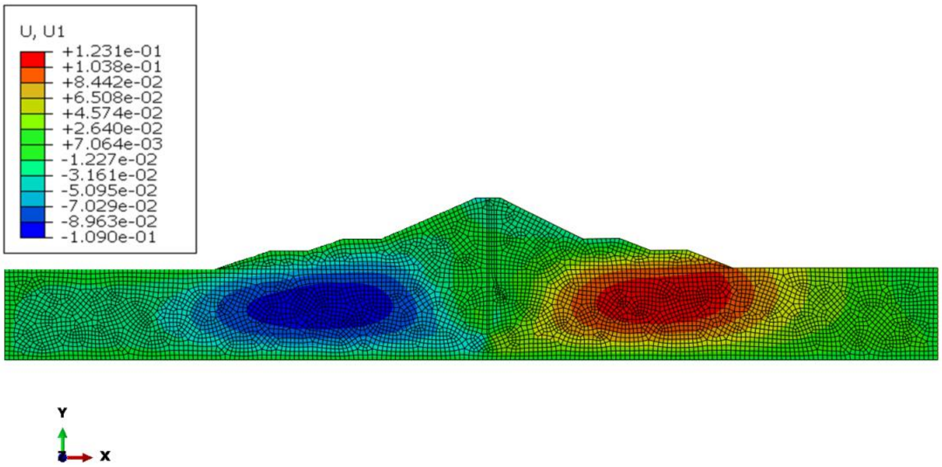

Figure 9. Total Horizontal Displacements at the End of Construction Stage Considering the Sealing Wall Implementation up to the Crest Level

10. CONCLUSIONS

The clay core rock fill dams have such a special place in the world. In this kind of dams. following the sealing plastic concrete dams has been widely used in the world if the use it as sealing element is less considered. Leakage has been the main reason failure in body and foundation and solution is cut-off wall. Performance of the plastic concrete seal's wall instead of clay core dam with 100 centimeter widths checked out by the finite element analysis of static load. The result show that the maximum stress value reduce in sealing cut-off wall and the stress values of authorized dam are lower.
The use of proposed sealing cut-off wall reduces the amount of leakage by 66.6 percent which is significant.

The replacement of the clay core with the plastic concrete sealing wall for the constructed dams on the subsiding alluvial foundation is not advised. The replacement of the clay core with the plastic concrete sealing wall for the constructed dams on the subsiding alluvial foundation is not advised.

11. REFERENCES

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