Iranian Journal of Engineering Geology
Spring 2021, Vol.14, No.1

Seepage analyses in the foundation and body of earth dam using numerical modeling -A case study

H. Fattahi[1*], M. Shahmansouri [2], H. Ghaedi[2]

Abstract

Dams are mainly constructed of earth and rock-fill materials and hence they are generally referred to as embankment dams orfill-type dams. The role of drainage system is also vital as it shifts the phreatic surface ensuring the safety of downstreamtoe. This paper presents the results of seepage analyses of the considered earth dam using finite element method. Slide software is one of geotechnical program that is based on the finite element and canconsider analysis like stress-strain, seepage, slope stability, dynamic analysis and also fast water drop inreservoir. In this research seepage analysis in Roudbar Lorestan dam has been done by Slide software. In orderto evaluate the type and size of mesh size on the total flow rate and total head through the dam cross section,four mesh size such as coarse, medium, fine and unstructured mesh is considered. Result showed that averageflow rate of leakage under the different mesh size for Roudbar Lorestan dam equal 629584 m^3 per year for the entire lengthof the dam.

Keywords: *Seepage analysis, earth dam, Slide software, Roudbar Lorestan dam, Numerical modeling*

[1] Department of Earth Sciences Engineering, Arak University of Technology, Arak, Iran Email: H.fattahi@arakut.ac.ir
[2] Student, Department of Earth Sciences Engineering, Arak University of Technology, Arak, Iran

Extended Abstract:

1. Introduction

Among various engineering projects, dams construction and their industry involves major challenges (Fattahi 2017a; Fattahi 2017b). Since 1980 construction of earth and rock fill dams are more common than other type of dams. The reasons for this common usage are: the method of construction is based on ordinary technology with utilization of cheap raw soil materials, subsurface materials and does not depend on particular valley shape. Also, geometric design of embankment dams depends on barrowed soil materials, subsurface conditions and type of construction. Consequently feasible design can cause significant reduction on construction time, materials and costs. One of the main important factors for the failure of earth dams is the seepage in their body and foundation. In order to prevent the dam failure, it is essential to control the leakage in the dam. leakage in dams, caused the water waste and, the decline of dam stability. therefore, the water leakage analysis in dam is the first effective step and one of the main important issues that has been considered for the related experts. Panthulu et al. (2001) studied the utilization of electrical methods for delineation of seepage zones at two of the four Saddle dams of the Som-Kamla-Amba project, Rajasthan State, India. Zomorodian and Abodollahzadeh (2012) investigated the effect of horizontal drains on upstream slope of earth fill dams during rapid drawdown using finite elements and limit equilibrium methods. Changing of pore water pressure, outpouring seepage flow and factor of safety are inspected. In this research, it would be investigated the amount of water leakage and seepage in the Roudbar Lorestan dam by using the Slide software.

2. Materials and methods

In order to achieve the objectives of this study, Slide software is used. Slide is software products based on finite element code that can be used to evaluate the performance of dams and levees with varying levels of complexity. Slide software calculates the leak using partial differential equations makes the water flow. Differential equations governing the flow in two-dimensional mode to be the following:

$$\frac{\partial}{\partial x}\left(k_x \frac{\partial H}{\partial x}\right)+\frac{\partial}{\partial y}\left(k_y \frac{\partial H}{\partial y}\right)+\frac{\partial}{\partial Z}\left(k_Z \frac{\partial H}{\partial Z}\right)=0 \quad (1)$$

Where: K_x, K_y=coefficient of permeability in (x,y) directions. H= total head of water. Slide can effectively analyze both simple and complex problems for a variety of slip surface shapes, pore-water pressure conditions, soil properties, analysis methods and loading conditions.

3. Results and discussion

Regarding the permeability soils, in the semi saturation status, because of the prevention of water movement by the air bubbles existed in soil is lower than the saturation status. Seepage analysis result for these two types of permeability is differing from each other. In order to prevent this error, a function can be defined in which the permeability can be changed linearity in that range and in outlet of the range, it would be fixed. This function can be defined so that in p=0 kpa, the permeability coefficient equals to the k_{sat} and in p=-100kpa, the permeability coefficient is

considered to be k_{sat}/100. After allocation functions for permeability, boundary conditions for the model are defined. The water height for the permanent seepage is considered as normal water surface in dam. The figure 1 show the seepage and total head analysis by the Slide software under the mentioned the mesh size. According to figure 1 can be seen that the leakage rate difference is negligible under the different mesh size and average flow rate of leakage for Roudbar Lorestan dam equal to 629584 m3 per year.

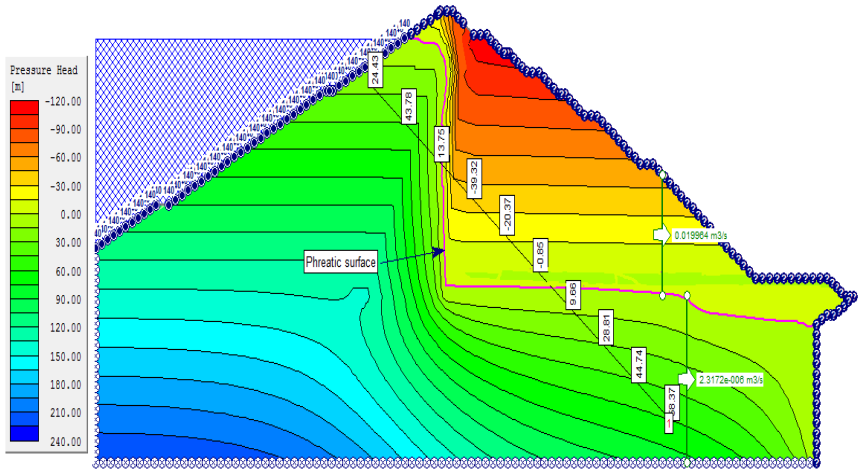

Fig.1 The seepage and total head analysis by the Slide software

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