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Optimization of Clay Core Dimensions in Earth Dams Using Simulated Annealing

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ABSTRACT

Earth dam is a structure as homogeneous or non homogeneous forms for raising water level or water supply. Earth dam consist of different parts that one of the main parts is clay core. Choosing an optimal non permeable core which causes reduction of seepage through dam body and also being stable is necessary. The objective of this research is to optimize the geometry of earth dam clay core such that, beside of reduction of seepage through dam body, the volume of core material is minimized. For access of this objective a consolidated model consist of a simple model which obtained by linear regression and SA algorithm were used. So the necessary model has been written in Matlab7.8 and using SA algorithm, to optimize the Birjand Hesar Sangi dam. Optimal parameters such as seepage through dam body, hydraulic gradient and safety factor of stability access from model compared by the values access from the direct run of the software modeling that show a good agreement. Also the result of access by modeling have been compared by real dimensions of Birjand Hesar Sangi dam, that cause reduction of material volume for construction core dam about 21% and shell dam about 8% with satisfactory stability.
Result show that the consolidated model have successful operations and a general optimal plan design of clay core dimensions in stable condition can be achieved.

KEYWORDS

SA algorithm, Optimization, Earth Dam, Geo – Studio Software, Clay Core.

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1- INTRODUCTION

Goldin and Raskaz (1985) initiated optimization studies for the clay core of the homogeneous dam using complete factor test and factor analysis. Hillo (1993) used finite element method for seepage below hydraulic structures on anisotropic soil foundation. Akyuz and Merdun (2003) carried out experiments for predicting the seepage from an earth dam placed on an impervious base by using the Hele-Shaw viscous fluid. They validated their results with several traditional equations. Benmebarek et al. (2005) used the finite difference method to numerical studies of seepage failure of sand soil within a cofferdam. Based on this study, the conditions for seepage failure are clearly identified by using the boiling. Abdul Hussein et.al (2007) used multi-objective functions by weighting method to optimize the designing of the homogeneous earth dam. Andrew and Anop (2009) applied genetic algorithm to determine the critical failure level in slope stability analysis.

2- METHODOLOGY

One of the key aims of this study is to develop the numerical model for measuring seepage through dam, stability factor and hydraulic gradient based on materials and geometry specification of earth dams. Methodology include parts such as: Simulated annealing algorithm, Modeling and optimization that modeling include parts such as: Seepage Model, Slope stability Model and Hydraulic Gradient Model.

3- SIMULATION RESULT

In this study, a new model is proposed to predict seepage rate, slope stability, hydraulic gradient in non-homogeneous earth dams using Geo-Studio software. Thorough this model, seepage, slope stability, and hydraulic gradient are formulated by different factors which are related to material properties and geometric dimensions of dam. It should be noted that permeability in

shell for the non-homogeneous earth dams is more than core. Hence, the seepage rate for shell can be ignored because existing remarkable difference between shell and core dam. Therefore, the core can be considered as a homogeneous dam (Goldin et al. 1992). In the research, 150 assumed sections with different materials and dimensions are designed.

4- RESULT

In this paper, new regression models including leaking from dam body model ,hydraulic gradient model , and stability safety factor model were developed to calculate the designing variables. The results indicated the high performance of new regression models for determining coefficient of stability, leakage from the body, and hydraulic gradient. For developing the necessary model, hydraulic gradient and stability safety factor were considered as constraints Also, the multi objective function was expressed as reduction of seepage through dam body, and the volume of core material is minimized. This problem was optimized using the SA. The results of modeling were compared with actual geometry of Birjand Hesar Sangi earth fill dam(Table1). The values of the core dimensions, coefficient of stability, leakage from the body, and hydraulic gradient obtained from a models development were compared with actual values of the dam. Development of SA algorithm was proven remarkably prosperous capability in form of 21 percent reduction for material type in dam core and 8 percent in shell dam.

TABLE 1 COMPARISON OF ACTUAL DIMENSION BY OPTIMAL DIMENSION OF CLAY CORE

	actual dimensions of clay core	**optimal dimensions of clay core (SA)**
Core crest width (*m*)	4	3.1
Core width on foundation (*m*)	9.8	7.8
Slope of Shell	1:2.5	1: 2
Slope of Core	1: 0.21	0.15
Dam width on foundation (*m*)	75	66.8
hydraulic gradient	-	0.46
Slope stability	-	1.69
Seepage	-	1.3

5- MAIN REFERENCE

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