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STUDY ON EFFECT OF SEEPAGE RESPONSES IN SEEPAGE FLOW OF WATER UNDER CONCRETE DAM

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Abstract

The gravity dam is one of the most used dams in the world and has enormous integral benefits in flood control, irrigation, power generation, water supply, sea transportation, tourism, and more. The Seepage problem has now become the main factor that affects the safety of dams. It is very important to carry out Seepage analysis of dams. This paper introduces the study of Seepage and relevant work to study the effect of Seepage, its calculations in various configurations, including basic equations and contour positions of the Seepage field, and also presents Seepage calculation software. It is used in water conservation design.

Keywords: *Gravity Dam; Concrete; Finite Element Analysis; Seepage.*

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1. Overview

A gravity dam is a dam constructed from concrete or stone masonry and designed to hold back water by primarily utilizing the weight of the material alone to resist the horizontal pressure of water pushing against it. A gravity dam is a massive sized dam fabricated from concrete and designed to hold back large volume of water. By using concrete, the weight of the dam is actually able to resist the horizontal thrust of water pushing against it. This is why it is called a gravity dam. Since gravity dams rely on their own weight to hold back water, it is key that they are built on strong foundation of bedrock. If a gravity dam is straight in plane it is known as Straight gravity dam, while if it is curved in plane it is known as Curved gravity dam. A curved gravity dam (or Arch-gravity dam) however, resist forces exerted upon it both by gravity action and arch action. Further a gravity dam is also classified as Solid gravity dam and Hollow gravity dam. A solid gravity dam has its entire body consisting of a solid mass of masonry or concrete. On the other hand, a Hollow gravity dam has a hollow space left within the body of dam. The reason for which the gravity dams need rehabilitation are mainly the time damage and the destructive effects of flash floods and earthquake effects. In our case the dam is heavily distressed and is facing seepage problem. Never the less the lifetime can be extended if they are regularly maintained.

The most important event when planning and designing a dam is the Seepage of water through and below the dam. If maintenance-free Seepage occurs, then over time, the dam may break and cause loss of life and property. Important quantities that must be estimated when studying this phenomenon include Seepage volume (flow rate), elevation pressure, and output gradient. The flow of water below the dam creates a lifting pressure on its floor, and if the thickness of the floor is insufficient, its weight will not withstand this pressure, and the floor will break, which will cause the failure of a structure.

2. Literature Review

Jelenkovi and Travas (2013) studied for a steady flow condition beneath a physical model of a typical gravity dam, a comparative analysis between the measured flow data and the one predicted by numerical analysis. The velocity vector field is compared qualitatively and the pressure field is compared quantitatively (on a relevant sections of the flow domain). The numerical analysis is performed by solving the Laplace differential equation by finite difference method. Finally, a particular interest is dedicated to a velocity field and the process of local erosion.

Fujisawa et al (2013) studies on seepage failure, known as sand boiling or the piping phenomenon, has been to determine the critical hydraulic gradient or the critical seepage flow velocity. However, the transport of soil after seepage failure also needs to be well investigated in order to estimate the damage to soil structures or the ground. The purpose of this study is to experimentally investigate the relationship between the seepage force and the velocity of the sand particles during sand boiling induced by upward and horizontal seepage flows. In the experiments, silica sand is used as the test material and the migration velocities of the seepage water and the sand particles are calculated from the measured amounts of their discharge. The test results reveal that the equilibrium of the forces exerted on the sand particles, i.e., gravity, buoyancy and fluid-particle interaction, can be successfully used to estimate the velocity of the sand particles subjected to upward seepage flow and that the seepage force needed for the horizontal transport of the sand tends to decrease as the velocity of the sand particles increases.

Li et al (2015) used the finite element method (FEM) to analyze the stress field and the Seepage area of a roller compact concrete dam (RCC), forming an upstream waterproof layer with a variety of concrete materials. Done, three-degree RCC, two qualified RCCs, conventional vibrated concrete (CVC) and vibrated RCC enriched with grout (GEVR) Land, who's in line with the plans of the 1 S 4. It evaluated the anti-seepage performance of the anomalous layer in the four design schemes under normal water level and flood verification level. Analysis of the stress field of a retention section and a discharge section shows that the maximum tensile stress is near the heel of the dam, the maximum compressive stress is near the foot of the dam and the stress distribution occurs in four schemes of stress control. Can meet the criteria.

Shahrbanozadeh et al (2015) In their study, height pressure, Seepage discharge and output gradient were calculated using the IGA approach. The IGA model was validated using available experimental data. For a convenient comparison, experimental data were used to preserve information on the relative magnitudes of various empirical and theoretical predictions, such as Khosla et al., Lane and Bleigh's methods.

Chen et al (2016) presented entropy theory, as a relation between definition and probability, used to prospectively analyze the characteristics of the Seepage system in a complex rock mass dam. Based on the principle of maximum entropy, an equation is derived for the vertical distribution of the Seepage rate in a well in a dam. The obtained distributions are tested and compared with real field data, and the results show a good agreement. According to the entropy of the flow velocity in the wells, the degree of rupture of the rock bed from the dam has been successfully estimated. In addition, a new sampling scheme is presented. The sampling frequency has a negative correlation with the distance to the site of minimum speed, which is preferable to conventional. This article demonstrates the important benefit of applying entropy theory to the analysis of Seepage rate in a complex rock mass dam.

Drahansky et al (2014) present a compendium of the main methods used to perform water flow analysis with a focus on computational approximation methods. Some current algorithms for performing this type of analysis are summarized. In addition, general guidelines are provided for using the methodology for specific types of analysis, such as transient state flow due to water drainage and flow in unsaturated media. The need for a stochastic analysis of water flow has been emphasized. Finally, general conclusions and recommendations are made for performing numerical analysis of groundwater Seepage in soil.

Cao et al (2016) An experimental laboratory study was carried out to obtain information on the mechanism of development of cracks in soil under dry-wet cycle. Soil samples were weighed and photographed at regular intervals during the experiment. MATLAB based photo processing programs have been used to convert ground crack photos into binarization images. From these images, parameters such as porosity and crack width have been calculated.

Lin et al (2018) addressed the difficult closure of a frozen wall in a coal mine pit due to excessive Seepage rate in an aquifer when the aquifer is entered by an artificial freezing method. Based on the principle of hydrothermal coupling and observing the effect of absolute pore reduction in Seepage during the freezing process, a mathematical model of hydrothermal coupling of absolute parameters with a phase change is made. A shaft is used as a prototype, and COMSOL multiphysics finite element software is used to perform numerical simulations of the shaft freezing process at different stratum Seepage speeds. The results of numerical simulations are verified by comparison with field measurement data. Based on the results of numerical simulations, the effects of multiple groundwater Seepage speeds on the process of building artificial frozen walls with the coupling effect of the Seepage temperature field are analyzed. Based on the results of the analysis, the recommended principles of optimization design for a freezing scheme are described below: first, the drift area is closed to allow the effect of water separation, and second, the water area. Closure is expanded upwards to reduce the total closing time of a frozen wall.

Saleh (2018) developed a SEEP / W model to find the Seepage rate and the exit gradient below the concrete dam provided with two sheet piles. The independent variables were head differences; Coefficient of permeability of soil; And inclined angles of space, length and sheet pile. The model was executed for three different values of each independent variable. Results obtained from the STEP / W model were used to construct two models of artificial neural networks (ANNs) (A and B) in which the output variables were Seepage rate (model A) and output gradient (model B). The most suitable structure, which provides minimal relative errors, was the (7 3 1) nodes for both models. Results from ANN models indicated that the variable with the greatest effect on the Seepage rate was the soil permeability coefficient, with a significance ratio of approximately 76%, followed by a difference in height (8%). Distance between battery (5.5%), downstream stack length (5%), upstream stack length (4%) and tilt angle downward and above sheet piles, about 1% and 0.5% with ratio.

Yulu et al. (2018) developed the theory and method of inSeepage analysis of rock-land dams, including basic inSeepage equations and boundary conditions, and also introduced a hydraulic analysis software, Autobank Seepage Module, including step analysis and boundary conditions. . Then, two-dimensional Seepage analysis of the earth and rock dam is performed using Autobank. The Seepage line of the dam is calculated under three working conditions. This result can be used as a reference for design.

Fadaei-Kermani et al (2019) concluded the applicability of the non-mesh method, i.e. soft particle hydrodynamics (SPH) method, to analyze the Seepage problem in porous media. Two different cases of Seepage problems were considered: Seepage through the base of the concrete dam and Seepage through the earth dam. To verify the results of the proposed method in intrusion analysis, a well-established parallel intrusion software has been used. The agreement between the SPH methodology results with those of the STEP / W model shows that the SPH technique is capable of analyzing the Seepage problem.

3. Conclusion

Seepage problems with complex drainage systems are commonly encountered in dam engineering, slope engineering, and underground engineering, and are generally not linear. In combination with the substructure technique, a numerical solution with a finite element analysis / method-based approach is suggested in this study. The effectiveness and robustness of the proposed method are compared across several types of configuration models or examples and show results. The focus of this work is the impact of drainage systems on various engineering practices. A total assessment of the performance and safety of such engineering facilities, such as those that consider coupled hydropower effects on Seepage behavior and safety, is beyond the scope of the present study.

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