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EXTENDED ABSTRACT

Numerical Study of Earthdams after Construction and First Impounding (Case Study of Doyraj EarthDam)

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1. Introduction

Engineering and economic investigations in dam construction projects throughout the world indicate that, in many cases, rockfill dams with impervious clay cores are the best selection for the final design (Rezaei and Salehi, 2011). This approach makes the investigation of different issues affecting the stability of rockfill dams worthwhile. In general, dam safety is the first and foremost reason for controlling deformation and physical parameters in dams. Another reason is the importance of basic design concepts for engineers to apply in future designs as well as understanding the resistive and behavioral characteristics of soil and pebbles. One of the most effective approaches for interpreting the mechanical and hydraulic behavior of structures such as dams is to use data and compare the results with numerical modeling predictions.

In the field of earth and rockfill dams, monitoring of typical physico-mechanical behaviors is a fundamental issue. Measurements of displacements, total stresses, pore water pressures, and arching ratio can be used to carry out a number of tasks (ICOLD, 1982), such as characterizing the dam's overall behavior (Pagano et al., 1998), checking the behavior of specific zones, obtaining information about the in situ mechanical properties of embankment soils (Marsal and Resendiz, 1975), and finally, supporting the difficult task of evaluating dam safety and efficiency (Gould and Lacy, 1993). Justo (1991) and Naylor (1997) proposed methods for the incorporation of collapse settlement of rockfill into constitutive models. Naylor (1991) performed the finite element analysis for Beliche dam, a central core earth and rockfill dam, by considering the collapse settlement of the upstream rockfill in the modeling. The effect of pore water pressure dissipation in earthfill during construction was also considered by a number of authors including Eisenstein and Law (1977) and Cavounidis and Hoeg (1977), amongst others. For these cases, the incremental embankment construction was modeled as a two-stage process, the first stage modeling the new layer construction using undrained properties for the core and the second stage modeling pore water pressure dissipation. Zomorodian and Kuchi studied internal deformation, pore water pressure, and total vertical stresses in Masjed Soleiman Dam and compared it to numerical results, they also showed that the development of excess pore water pressure in the clay core of zoned earth dams during construction may lead to the onset or progression of hydraulic failure.

Numerical analysis is widely used to solve complex sustainability problems. For example, Zhou et al. (2011) assessed the settlement behavior of Shuibuya dam during construction, initial impounding, and two years after the operation. They carried out two-dimensional (2D) numerical analyses using the finite element method (FEM), and compared the results with the data measured by the instruments in terms of settlements.

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2. Methodology

2.1. Case study

In this paper, the behavior of the Doyraj earth dam at the end of construction and first impounding is investigated and analyzed. The technique process adopted in this study for numerical modeling, based on the finite difference and finite element approach, is based on FLAC 2D and Geo studio software, which is used in two-dimensional plane stress conditions. In this modeling, for use in numerical analysis, Mohr-Columb's behavioral model is applied in two software.

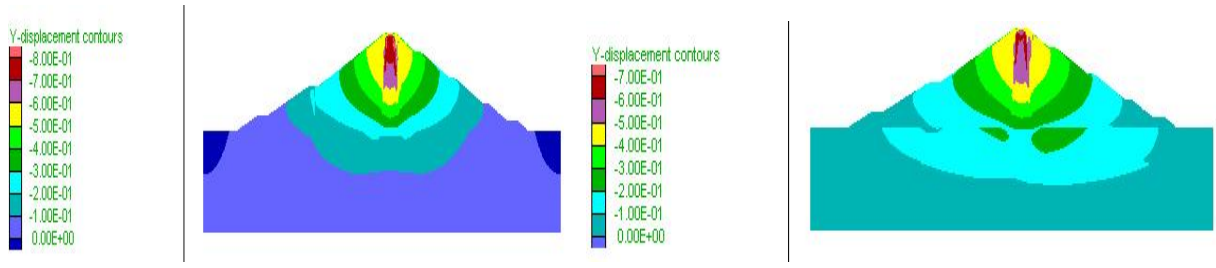
2.2. Software Modeling

In all sections of the dam, according to the recommendations of the sources cited above, square and triangular elements of 3 and 4 nodes should be used of approximately the same size. Nuclear elementalization is also done with finer elements because of its importance. After constructing the model geometry, due to the nonlinear nature of the geotechnical materials, especially the soil, it is necessary to use a nonlinear behavioral model in the analysis. Therefore, for the materials used in this dam, the complete Mohr-Columb elastoplastic behavior model, which is the most well-known model in soil materials, has been used in two applications. The purpose of using this model is in addition to being widely used, especially in geotechnical engineering, because the input information of this behavior model is simple and very consistent with conventional geotechnical experiments and interpretations.

3. Results and discussion

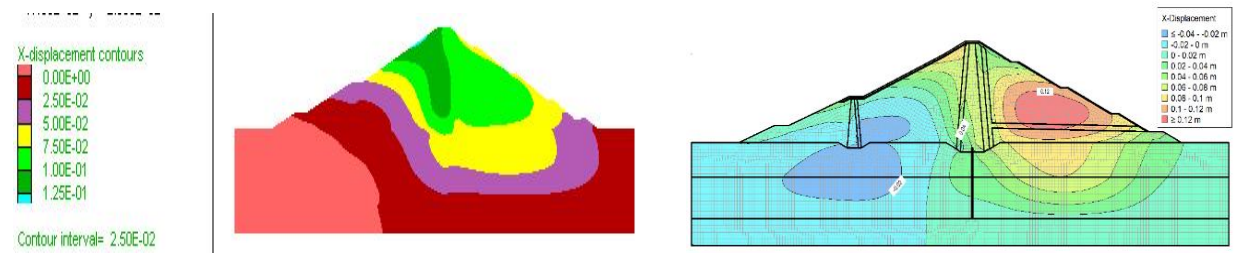
3.1. Investigation of settlements in the dam body

The settlements created after the end of construction confirm the fact that the main loads on the dam body are the loading caused by the body itself during construction. As predicted, the maximum settlement value increased from the lateral sections to the intermediate sections, and most of it happened in the middle. The values of vertical settlements before and after impounding by the two software are shown in the following figures.



(a) (b)

Fig. 1. a) Vertical displacement before impounding in FLAC software, b) Vertical displacement ofter impounding in FLAC software



(a) (b)

Fig. 2. a) Horizontal displacement before impounding in FLAC software, b) Horizontal displacement ofter impounding in Geo studio software

4. Conclusions

- Most of the horizontal movement after impounding occurred in the analysis of the two software downstream of the dam this is due to the movement of the dam downstream due to the horizontal water pressure of the reservoir.
- The analysis results show that water pressure upstream of the core increases the total lateral tensile stresses and moves the dam downstream.
- The most important factor for vertical settlements that reduces frictional resistance and hardness of barrier materials under the impound layer is the heavy weight of the embankment layers.
- In general, the two software are in pretty good agreement on all physical parameters.

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