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Three dimensional seepage analyses in Mollasadra dam after its impoundments

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Abstract

Mollasadra dam is an earth fill dam with a clayey core and a height of 72 m from river bed, constructed on Kor River. pore water pressure in the dam was investigated following its construction and first and second impoundments. The dam was modeled by a finite element mesh, and 3-D transient and steady state analyses of pore pressures were performed and the results were compared to monitored data. According to the monitored heads, pressures across the core dropped considerably, reflecting good performance of the core. After the first and second dam impoundments, the overall trend in monitored pore water pressure was well modeled by the transient analysis. Therefore, it was concluded that pore pressures in the core of earth fill dams may not achieve steady state conditions even months after the dam construction and impoundment. It was also concluded that conductivity behavior as a function of negative pore water pressure in unsaturated zone does not play an important role in modeling results.
Keyword: pore water pressure, transient analysis

INTRODUCTION

Construction of a dam plays a vital role in development of a region. On the other hand, dam failure makes a disaster downstream. Therefore, confidence on safety of earth dams during their construction, impoundment, and operation is one of the most important reasons for monitoring pore water pressure within the dam. Other reasons, which are important to researchers, are better understanding of seepage flow patterns through the dam, dam's deformation, and strength [7, 100].

Seepage analysis plays an important role in the design of embankment dams. Some problems like seepage failure and slope stability are significantly affected by pore water pressure in embankment dams**.** Usually the designers utilize a two dimensional seepage analysis in a typical cross section of embankment dam [2]. However, this simplification may be deceptive in V shaped valleys [14]. Also this analysis has problem in a case where high variation of material property exists across the valley [1]. Comparison of pore water pressure in various sections of an embankment dam is another capability of 3D seepage analysis, something which cannot be considered in a 2D analysis.

Piezometers are one of the most common devices utilized for monitoring pore water pressure in earth dams [8]. Their readings reflect how different elements of a dam such as core, and embankment operate. Various types of piezometers are installed in an embankment dam; standpipe and vibrating wire being the most famous ones. Usually, piezometers diversity makes it possible to compensate their drawbacks [6,8].

Seepage in embankment dams can be modeled under steady state or transient conditions based on the need for a simple or rigorous analysis. For example when the reservoir level is constant for a long time, one may expect that steady state for pore water pressure throughout the dam to prevail. On the other hand, during the dam impoundment seepage flow and pore water pressures may be considered at transient state. Furthermore, in order to attain reliable results, seepage analysis needs application of appropriate initial and boundary conditions. Oftentimes simplifications are made on boundary conditions to avoid numerical difficulties, like elimination of upstream and downstream shell in finite element method. [9].

In this article, monitored pore water pressure heads during 15 month of first and second impoundments were investigated on Molasadra dam, an earth fill dam with a clayey core in Fars province, southern Iran. Three dimensional seepage flows were modeled by finite element method at both transient and steady sate according to appropriate initial and boundary conditions. Seep3D software, provided by GEO-SLOPE International Ltd, was used to perform the analysis. Modeled pore water pressure heads were compared to monitored heads, and the response of heads in core due to construction and impoundments were discussed. In addition, the effects of change in certain input parameters, such as conductivity as a function of pore water pressure, on the results were investigated.