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Stability Analysis of Upstream Slope of Earthen Dams Using the Finite Element method Against Sudden Change in the Water Surface of the Reservoir, Case Study: Ilam Earthen Dam in Ilam Province

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ABSTRACT

The goal of this study was stability analysis of the upstream slope of earthen dams using the finite element method against sudden change in the water surface of the reservoir in the case study of Ilam Earthen dam in Ilam Province. This research was of applied type and respecting the data analysis type, the field method is used for data collection. In this research using numerical modeling by the finite element method and applying the GEOSLOPE software, attempt is made to perform stability analysis of the earthen dams to overcome existing shortcomings present in the finite element methods. The results showed that at a discharge equal to 47.7 l/s, the piezometric pressures in the body, bed and within the dam which were considered to investigate the efficiency and upstream slope of Ilam Dam, we demonstrated that the amount of upstream slope of Ilam Dam for the piezometric pressures in the body, bed and within dam were better and showed a lower compressibility. The highest exerted pressures were related to the left section at the top and bottom of dam. At discharge of 69.175 l/s we demonstrated that the amount of upstream slope of Ilam Dam for the piezometric pressures in the body, bed and within the dam was better and showed a better compressibility. The highest pressures belonged to the left section at the top and bottom of dam. At discharge of 100.55 l/s we demonstrated that the amount of upstream slope for the highest exerted pressures corresponded to the left section at the top and right section at the bottom of dam. The results of numerical analysis showed that at the time of 0.2 seconds and for the five ramps of 1, 5, 10, 20, 40 degrees, the velocity (fluctuations) in axial direction, the kinetic energy of velocity turbulence (fluctuations) at the radial and axial axes increase with increase in the ramps slope. In other words the upstream slope at a ramp of 40 degrees and time of 0.2 seconds performs better for control of the sudden changes. At the time of 0.8 seconds by increase in the ramps slope, the above mentioned characteristics are first decreased and then increased. In other words the upstream slope has a better performance for control of the sudden changes for a ramp of 40 degrees and time of 0.8 seconds. For the time of 1 second, by increase in the ramps slope the above mentioned characteristics are first decreased and then increased, in other words for the ramp of 20 degrees and time of 1 second it has better performed for control of the sudden changes.

Key words: Upstream slope, Piezometric pressure, Numerical analysis, Finite element method, Dam reservoir.

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1. INTRODUCTION

Earthen dams are among the world important dams which have significant role in the control of water flow and its optimal use. Earthen dams due to their special design and their execution conditions have different characteristics with respect to the concrete dams or RCC dams. One of these characteristics is the high importance of the upstream slope and its stability against water level at the reservoir, and any disturbance in this respect could affect dam quality and disturb optimal use of its capacity (1-4). In earthen dams, the upstream slope is often taken as 1 to 1.5-3, although slopes up to 1 to 6 or milder ones are also taken for special conditions. In addition, design of the ramps with different slope degrees is very common and the upstream slope is taken steeper than the lower parts. One of the most important features of the long-term behavior of an earthen dam is its stability during the operation period. The dam stability is affected by the fluctuations of water