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Investigation of Interaction between Rock Materials and Concrete Slabs in Concrete-Face Rock-Fill Dam (CFRD)

Sediq Vaismoradi, Amir reza Goodarzi*

Department of Civil Engineering, Faculty of Engineering, Hamedan Branch, Islamic Azad University, Hamedan, Iran

*Correspondence should be addressed to Amir reza Goodarzi, Department of Civil Engineering, Faculty of Engineering, Hamedan Branch, Islamic Azad University, Hamedan, Iran; Tell: +989163620733; Fax: +988134481587; Email: amir_r_goodarzi@yahoo.co.uk.

ABSTRACT

In the CFRD dams, a concrete-face with a finite thickness is placed on the upstream side of the dam, which prevents water leakage from the reservoir. The construction of these dams with different heights and various specifications of materials have been welcomed a lot. Therefore, construction of CFRD is appropriate in pumped-storage reservoirs. However, due to the important role of concrete-face, the necessity of optimal studies in order to evaluate the behavior of this type of dams is obvious. In this research, the lower reservoir of Siah Bishe was studied by finite element method in order to investigate the interaction between rock-fill materials and simulated concrete-face and by an appropriate behavioral model in a three-dimensional mode that can simulate the behavior of materials in the body of the dam well. In this research, Plaxis software was used for modeling and static analysis was performed to determine deformations and stresses made in the dam and concrete slab. The elastoplastic behavioral model of Mohr-Coulomb was used to model the behavior of the materials and the technical specifications of the materials used in the body of the dam and concrete-face slab have been applied. The maximum value of settlement calculated by the software from the beginning of the constriction to filling the reservoir under the effect of gravity is 670 millimeter and the maximum settlement after phase 3 in the mode of the full reservoir in long term is 32 millimeter and the maximum horizontal displacement is 52 millimeter. Finally, the results of the settlements were compared to results of the instrumentation. The results indicate the approximation of results of the numerical modeling with results obtained from instrumentation.

Key words: CFRD, Finite Element, Instrumentation, Plaxis Software, Interaction between Materials and Concrete-Face.

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1. INTRODUCTION

The role of sealing in rock-fill dams is on concrete-face in upper part of the dam and any cracking and damage to this coating can lead to water leakage of the reservoir and disruption of the function of the dam. Hence, one of the most important problems of concrete-face rock-fill dams is cracking of the concrete-face (1). Till now, many analyses have been conducted on deformation of the body of dam and its behavior (2-4). Various tests on rock materials indicate a non-linear and non-elastic behavior dependent on stress in rock-fill mass and fracture of the components of the rock leads to significant Volumetric strain (5-8). Non-linear analysis on concrete-face of CFRDs under the static effects using ANYSYS, FERUM software indicates that the probability of failure in connection contact is higher than friction contact between the slab and rock-fill (8). The parameters affecting deformation of the face should be studied. In fact, by deformation of the face, stresses in that are increased and if their amount exceeds the limit, it will damage the concrete slab of the face. The effective parameters are studied using an appropriate behavioral model which well has the capability of simulating the behavior of rock-fill materials in Plaxis software. Given that a little experience about the function of this type of dams (CFRD) is available, prediction of the behavior of the dams and interaction between concrete-face and rock materials affected by effective parameters is very important. Some problems during construction of CFRDs are separation of the concrete slab from body of the dam and tensile stresses in it that causes crack in the slab and, in turn, lead to reduction in safety factor against failures caused by water penetration. Many researches such as [Cattani M et al] (9) and [Hughes MW et al] (10) [Porter et al] (11) [Rezvani et