10th International Congress on Civil Engineering, 5-7 May 2015
University of Tabriz, Tabriz, Iran

Modeling of First Filling Settlement in Gotvand Dam

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Abstract

In this paper, a new collapse prediction framework is proposed, involving introduction of a stress dependent collapse coefficient which is directly obtained from results of triaxial tests. Within the proposed framework, the collapse settlement of rockfill dams can be simulated for first impoundment analysis. To make an appropriate choice of the model parameters, some large-scale triaxial collapse tests are numerically modeled employing the proposed framework and the parameters are used for simulation of collapse settlement of Gotvand, 178 m high rockfill dam, and verified by field measurements and monitoring data. Verification of the model has shown that the proposed model could properly simulate the collapse phenomenon and provide results which are in good agreement with field data.
Keywords: Gotvand Dam, Collapse Settlement, Rockfill, Collapse coefficient

1. INTRODUCTION

The use of rockfill as a construction material started during the second half of the nineteenth century with the building of timber-faced mining dams in California [1]. The early embankments were typically short and constructed by dumped rockfill with very steep slopes. With the improvements in compaction techniques the height of recent rockfill dams has reached in excess of 200m.

Observational investigations in laboratory tests and field monitoring have indicated the possibility of collapse behavior in a wide range of geotechnical materials and it has been vastly reported by many researchers (e.g., [2-4] among others). Particularly as cited by Oldecop and Alonso [5] the typical behaviour of central clay core dams with rockfill shells involves the occurrence of sudden settlement during the first filling of the reservoir. They called this phenomenon as collapse deformation. In the context of this paper, the term '*Collapse Settlement*' is used for this phenomenon being related to the flooding of the rockfill in the upstream shell.

Indeed the phenomenon is much more significant in the case of rockfill dams owing to safety hazards, which might be encountered during first filling. The collapse settlement in the upstream shells of the rockfill dams may increase settlement of the rockfill, relative to the core. The deformation at the Cherry Valley dam is an instance of such deformation; where, the settlement of upstream rockfill was more than four times that of central core, therefore longitudinal cracks on the crest were observed at the upstream core-rockfill interface [6]. Hence it is of crucial importance in engineering practice to calculate collapse settlement of first impoundment.

The presence of a coarse grained soil is known to affect intensity of collapse settlement, particularly when the layer compacted with low water content. Moreover, the amount of collapse settlement in rockfills depends on the quality of the material and the extent of its compaction. With increasing usage of poor grade rockfills, a significant settlement is becoming more common, which could lead to instability in body of the dam and damage to rigid structures on the dam crest. Therefore, a satisfactory technique for prediction of collapse settlement is clearly important. Nobari and Duncan [7] pioneered the modeling of collapse settlement; they developed a technique closely tied to the hyperbolic model of Duncan and Chang [8], which related to direct use of triaxial test results. This method, incorporated with an elasto-plastic critical state model, was used by Naylor *et al.* [9] to simulate the effect of collapse settlement. One of well known cases in literature is collapse settlement of Beliche Dam in south-east of Portugal which has been investigated in [9-11]; it was concluded, that collapse settlement was responsible for most of the settlement in the dam.