



Study on the Compaction Effect Factors of Lime-treated Loess Highway Embankments

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Received 15 October 2017; Accepted 30 November 2017

Abstract

Morning-glory spillways are usually used in dams constructed in narrow valleys or those on steeply sloped supports. Furthermore, one can adopt this type of spillway in cases where guiding and diversion tunnels of adequate diameter are available. One of positive characteristics of these spillways is that, their maximum capacity can be approached at relatively low head. This characteristic can be seen as an advantage in cases wherein maximum outflow from the spillway shall be limited. On the other hand, should water head on top of the spillway exceeds the project baseline head, changes in output discharge will be negligible. Morning-glory spillways are commonly used in large dam construction projects across Iran (e.g. Sefid-Rood Dam, Alborz Dam, Haraz Dam, etc.). Given that spillway is one of the most important axillary structures for dams, accurate and realistic characterization of the hydraulic conditions affecting them seems to be necessary. On this basis, the present research is aimed at accurate determination of flow behavior and discharge coefficient of morning-glory spillways from the flow inlet down to horizontal tunnel of the morning-glory spillway of Haraz Dam. For this purpose, the most significant hydraulic parameters (including flow depth, flow velocity, flow pressure at different sections of the spillway, and rate of outflow at spillway) will be determined. In this study, an effort was made to use the numerical model of Flow3D to numerically model three-dimensional flow based on physical model and actual data from one of the largest and most important morning-glory spillways for calibration and verification purposes, and determine accuracy of the numerical modeling and associated error with simulating the numerical model. Results of this study show that, the flow at morning-glory spillways is controlled in either of three modes: flow control at crest, orifice control, and pipe control.

Keywords: Morning-Glory Spillway; Numerical Modeling; Flow3D; Flow Hydraulics.

1. Introduction

Morning-glory spillway is a vertical and horizontal tunnel conduit which transmits flood flow from a higher level to a lower level at high rate. This type of spillway resembles siphon spillways, except that its function is different from that of siphon spillways. This type of spillway is designed and constructed in narrow valleys wherein supports on either sides of the valley are steeply sloped, or in diversion tunnels. Another advantage of this type of spillway is that, one can achieve a capacity close to their maximum capacity at relatively low heads. This characteristic ends up with ideal performance of morning-glory spillways in cases where maximum outflow at spillway is limited. Accordingly, these spillways suit the dams with adequately large reservoirs. Moreover, in surface wastewater drainage systems or water transmission systems, the morning-glory spillways serve as a conduit for transmitting the flow from upstream to downstream (from catchment area to tunnel discharge system in mountainous watersheds). In such cases, morning-glory spillways are used with particular types of catchments generally known as vortex flow catchments and provide the flow with an angular velocity which develops a rotation flow at morning-glory. As of current, various studies have been performed on morning-glory spillways in the form of experimental studies, numerical modeling and simulation studies,

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 <http://dx.doi.org/10.28991/cej-030943>

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