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Effect of the Height of Crack in the Slab of CFRD's in Water Pressure Distribution in the Dam Body

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Abstract

Seepage and stability analyses of two cross-sections of concrete face rock-fill dams , homogeneous and zoned embankments, are investigated in the present study due to cracking of concrete slab. Seepage and stability analyses are investigated by using software, Geostudio. Results of analyses show that the phreatic line under concrete slab starts from a point higher than the elevation of the crack. In this condition, stability analyses in homogeneous dam shows that with increase in the crack height, safety factor of the slope stability decreases; while in non-homogeneous dams, phreatic line and safety factor do not change very much in accordance to the great capacity of drainage zone, which cause phreatic line to be at its lowest level.

Keywords: Concrete Face rock-fill Dam, Crack, Numerical Modeling, Seepage, Soil stability.

1. INTRODUCTION

Concrete faced rock-fill dams have been quickly developed in recent decades due to good adaptability to topography, geology, climate, cost-effectiveness and easily available construction material [1].

The main concern for the safety of CFRDs is deformation of the concrete face. During the reservoir filling, the load of water and deformations of the dam body force concrete slab to deform. The concrete slab acts as an impervious membrane and any development of cracks in the slab would allow water to penetrate within the body of the dam and cause the structure to weaken or even loose stability. Around 20% of dam failure caused by piping and seepage due to cracks in dam[2].

Camposnovos is the world's third tallest dam build with a concrete face filled in with rock. The 202 m high Campos Novos Dam sustained huge vertical and horizontal cracks which occurred before 90 % of the reservoir level was reached in 2007[3]. The maximum observed seepage flow was 1,400 l/s which made the responsible engineers perform a complete drawdown. The critical stability situation never occurred. Similar results could be observed for the Barra Grande CFRD (H = 185 m) which also showed strong seepage flows of 1,300 l/s[4]. Crack may develop in different level of the face slab, which some of them are described in this section.

At Guohou in China failure is attributed to a crack that opened at the joint between the face slab and the crest wall following deformation of the zoned gravel embankment (Chen, 1993)[5].

Sherard (1985), showed the influence of transition zone permeability on leaks through concrete slab. He calculated leakage for crack width of 1, 10, 100(mm) and the results show that the width of the open crack in the concrete slab has a relatively small influence on the total leakage, while it is governed by the permeability of the transition zone layer[6].

Launghikaxinadal et al (1997), investigated the face slab cracks of the winick's dam and proposed a surface permeability seepage quantity. In this method, it is assumed that the concrete face slab is homogeneous and it's seepage conforms to Darcy law[7].

Shou-yi li et al(2010), established an equivalent quasi-continuum seepage model of dense cracks slab, based on the law of equi- width joint steady flow. They conclude that adopting these models to obtain dam seepage change rule under the situation of face slab with massive cracks confirms to general seepage rule earth rock-fill dam[8].