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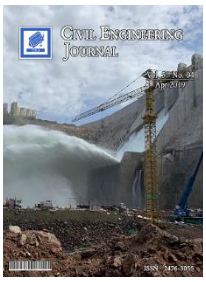

Experimental Study of the Rooster Tail Jump and End Sill in Horseshoe Spillways

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Abstract

In a horseshoe spillways, due to the collision of the falling nappes from their surround walls, in the center of spillway's trough, a spatial hydraulic jump is formed that named "rooster tail". This study by using the physical model of horseshoe spillway, investigates the form, height and length of rooster tail jump. Based on the analytical methods, the effective parameters on rooster tail jump's height and height were determined and their interaction was investigated and linear relationships were proposed to predict jump's length and height. By increasing the amount of water on the spillway's crest and thereby increasing the velocity of flow nappe at the point of contact with the spillway's bed, length and high of rooster tail jump, linearly increased. The result also shows that by increasing number of Froude, the length and height of jump increases and by increasing the spillway's length, the height and length of the rooster tail jump decreases. To control of rooster tail jump in spillway's model, two different size of end sills Inserted at downstream of spillway and result shows that by employing a sill with height of 3.8 cm and 7.6 cm, the flow depth, in average, respectively 122% and 272% increase compared to no sill conditions, also flow state change from super-critical to sub-critical. At the sill of 3.8 cm it was observed that the rooster tail jump did not submerged, but at the height of 7.6 cm the jump submerged and static pressure increased more. The results revealed that by placing the sill of 3.8 and 7.6 cm, respectively 45% and 35% of the maximum pressure entering the bed of the spillway at the collision site is reduced.

Keywords: Rooster Tail Jump; End Sill; Horseshoe Spillway; Velocity; Pressure.

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1. Introduction

The study of the hydraulic jump is a challenging issue because of its intricate nature, where the supercritical flow changes to subcritical flow with a rapid rise of flow depth. The flow in the hydraulic jump was regarded as a turbulent shear layer having an air–water interaction on the upper surface forming the roller in the mixing layer, the extent of which depends on the magnitude of upstream Froude number [1]. Dissipation of the water flow's kinetic energy which is caused by a hydraulic jump inside and downstream of the spillways is requirement. This is essential, not only to protect the banks from erosion, but also to secure that the dam itself and adjoining structures like powerhouse, canal, etc. are not sabotaged by the high velocity turbulent flow [2]. One of the hydraulic structures that hydraulic jump occur inside it, is horseshoe spillway (Figure 1). In a horseshoe spillway, due to the collision of the falling nappes from their surround walls in the center of spillway's trough, a hydraulic jump is formed that named "rooster tail". The rooster tail jump collapses to bed in the downstream of the spillway [3]. Given that the hydraulic jump causes pressure fluctuations,

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