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An Experimental and Numerical Comparison of Flow Hydraulic Parameters in Circular Crested Weir Using Flow3D

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Abstract

Circular crested weirs consist of a circular crested of upstream and downstream walls. These weirs are widely used in hydraulic engineering as water discharge structures and can be used to control water level in channels and tanks. In the present study, using Flow3D software, hydraulic properties were investigated to find weir geometry optimization through CFD method. Also, this study attempted to investigate flow on some sections of circular crested weirs in 3 groups and 11 models. Upstream and downstream slope changes as well as the height of the weir were also studied. To validate the model, laboratory models were used. In the research, flow depth parameters on crest, pressure distribution, velocity distribution, energy loss on circular crested weirs, as well as the height and changes of upstream and downstream slope were evaluated. Flow depth on the body of circular crest in this state is about 0.71 (H_1). Upstream slope changes on flow depth on the weir's crest revealed that increasing upstream slope causes to the increase of flow relative depth (H_1/R) on the crest about 62%. Downstream changes in H_1/R values less than 0.7 have no significant effect on discharge coefficient; however, increasing H_1/R values seems to cause more change in slope.

Keywords: Circular Crested Weirs, Flow3D, CFD, Upstream Slope of Weir, Downstream Slope of Weir.

1. Introduction

At the late 19th century and at the beginning of the 20th century, cylinder weirs (circular crested weir without upstream and downstream slopes) were common before ogee spillways. During the 19th century, the attempt to improve the capacity of weirs' discharge capacity leads to designing circular crested weirs. In water distribution systems, due to their affordability and easy construction compared to other weirs, circular crested weirs can be used to measure the intensity of flow as well as water discharge structures in channels and tanks. The simplest type of circular crested weirs is includes a circular crest with the radius of R and upstream and downstream walls. These walls are tangentially installed on the surface of the crest. This set is vertically placed at the path of flow [1 and 2]. Figure 1 shows a circular crested weir with geometrical parameters and hydraulic parameters. Hydraulic parameters include depth on crest' maximum point (Y_2), total water load at upstream of crest surface (H_1), water depth at upstream (Y_1) and geometrical parameters entail weir crest radius, upstream and downstream walls' slope (α, β) [3].

According to the studies performed by Bazin, during the 19th century, advancement was performed to improve discharge capacity of these weirs which finally led to designing circular crested weirs [4]. Kreeger (1917) developed Bazin's studies to identify ogee weir profile. He also performed some experiments about circular crested weir profile which was later used in designing France's Burgundy Dam [5]. Sarginson (1972) investigated the effect of surface tension on discharge coefficient of circular crested weirs. He used models with ventilation, water and Lissapol N liquid with $0.034 < \sigma < 0.059$ N/m (σ= surface tension) and crest's radius of 0.0068-0.00315 m. in the interval of $2<H_1/R < 4$, he presented a relation to determine discharge coefficient [6].

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