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EXTENDED ABSTRACT

A Laboratory Study on the Effect of One and Two Perforated Sills from the Beginning of the Stilling Basin on Head Loss and Hydraulic Jump Characteristics

R. Khankhani zorab[1] and S.M. Kashefipour[2*]

1- M. Sc. Student, Faculty of Water Sciences Engineering, Shahid Chamran University of Ahvaz, Iran.
2*-Corresponding Author,Professor, Faculty of Water Sciences Engineering, Shahid Chamran University of Ahvaz, Iran. (*kashefipour@excite.com*).

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Introduction

There are different types of stilling basins, including the standard stilling basin USBR, stilling basin SAF, the stilling basin with a continuous sill, and the stilling basin with perforated sill noted. Each basin, depending on the intensity of the hydraulic jump, usually needs components to reduce the length of the hydraulic jump as much as possible while shaping it at a specific location. These components include the chute block, baffle piers, and perforated sills that are the subject of this study. These types of dampers are the most common energy dampers in dams and irrigation and drainage networks, and they generally have a high efficiency of over 60% in energy dissipation. The purpose of this study is the evaluation of one and two perforated sill(s) in the stilling basin and its impact on characteristics of the hydraulic jump, such as the length of the hydraulic jump, the dissipation of energy, and the required tailwater depth, and also, to determine the optimal distance of one and two perforated sill(s) from the beginning of the stilling basin with a fixed height for the perforated sill and ratios of the opening of holes equal to 50%.

Materials and Methods

The experiments were carried out on one and two perforated sills in Shahid Chamran University Lab in Ahwaz, in a Plexiglas flume and an iron tank. The experiments were carried out so that, given the minimum and maximum flow rates in the flume, the height of such discharges was marked on a deck mounted next to the storage tank at the beginning of the flume. After determining the optimal distance of a single perforated sill, the two perforated sills were tested in such a way that the second wall was located at distances of 10, 20, and 30 centimeters from the first perforated sill. After investigating the results and determining the best pair of perforated sills in increasing the energy loss and decreasing the basin length, the best pair of perforated sills with a constant distance between them were moved to the jump toe at three distances of 50, 60, and 70 centimeters from the first wall to give the best distance for a pair of perforated sills. In all experiments, to avoid the splashing conditions, a forced jump was created so that the jump would first be submerged and then a full (non-submerged) jump would be formed by opening the end gate of the flume. Experiments were carried

out in the form of 72 tests for different discharges in range of 47.3 to 145.5 lit/s and Froude number in ranges of 3.6 to11.2.

Results and Discussion

The greatest effect on decreasing the energy loss in the single perforated sill mode is related to the wall with a relative distance of 20 centimeters. The maximum energy loss compared to the free hydraulic jump increases by 4.9%, i.e., the perforated sill energy loss rate reached 80.3% at Froude number 11.2. A couple of perforated sills with relative distances of 20 and 26.7 produce the highest relative energy loss in the jump. The relative energy loss in the pair with the relative distances of 16.7 and 23.3 is 0.2% higher than the pair with the relative distances of 20 and 26.7. The length of the hydraulic jump in the stilling basin with the single perforated sill is reduced to 2.2 times the secondary depth of the hydraulic jump. In other words, the perforated sill reduces the jump length by 63.4% compared to the free jump. The pair of perforated sills with relative distances of 20 and 23.3 had the greatest effect on decreasing the hydraulic jump length. This pair of perforated sills with relative distances of 16.7 and 23.3 reduces the relative length of the jump to 1.89 times the secondary depth of the free jump. It should be noted that several tests were performed to confirm the pair of perforated sills with relative distances of 60 and 70 centimeters from the jump toe at the mentioned positions and showed that the pair of perforated sills with relative distances of 16.7 and 23.3 had the greatest effect on decreasing the relative length of the jump. Based on the results of experiments, an analytical expression was developed for the prediction of the length of the hydraulic jump in the case of two perforated sills. Results of experiments on two perforated sills showed that they can only reduce the length of the hydraulic jump to an acceptable level that the distance between them provides the conditions for creating a stable jump and the length of the jump does not decrease by reducing the distance between the sills.

Conclusions

They decrease the relative length of hydraulic jump up to 1.89 times the secondary depth of the free hydraulic jump and the amount of energy loss is reduced up to 87.1 percent for the Froude number of 11.2. Compared to the USBR III and SAF stilling basins, the stilling basin in the presence of two perforated sills with the characteristics mentioned in the description of this study has a lower relative length.