Archive of SID

AERI

Irrigation and Drainage Structures Engineering Research/Vol.20/No.77/ Winter 2020/P: 57-72

Experimental Study of Piano Key Weir by Changing Width Ratio of the Keys

S. M. H. Saeidi, M. Rahimpour*, M. Zounemat-Kermani and M. R. Madadi

* Corresponding Author: Associate Professor, Department of Water Engineering, Faculty of Agriculture, Shahid Bahonar University of Kerman, Kerman, Iran. Email: Rahimpour@uk.ac.ir

Received: 13 March 2019, Accepted: 22 June 2019

Extended Abstract

Introduction

Piano key weir (PKW) is a hydraulic structure that can be installed at dams and canals for regulating the flow surface and discharge. The main feature of this weir is the ability to pass a large flow of water over a small head.

Regarding its geometrical properties, this weir is classified into four types of A, B, C and D. PKW with symmetrical upstream and downstream overhangs is classified as Type A, one with only upstream overhangs as Type B, one with only downstream overhangs as Type C, and one without overhangs as Type D.

Despite various studies on piano key weirs (some of which were mentioned in the text), the flow behaiviour over these structures is very complex, unpredictable and three-dimensional.

So further laboratory investigations on PKWs are needed. In the present study, the effect of the width of the inlet and outlet keys on the hydraulic characteristics of these weirs is investigated. In addition, the occurrence of undular flow on these types of weirs is reported for the first time. To achieve the aims of this study, more than 300 experiments were conducted at a laboratory flume.

Methodology

The experimental tests of this research were conducted in the hydraulic & water structures laboratory of Shahid Bahonar University of Kerman, on a laboratory flume with 8 m length, 80 cm width and 60 cm height, having glass walls and metal bottom.

The flow discharge was adjusted in a range of 5 to 60 liters per second by a valve. In total, 16 physical models of PKW-A and PKW-D weirs were constructed to investigate the effect of width of inlet and outlet keys on the hydraulic characteristics of flow over such weirs. Seven discharges were tested for each model of weirs, and experiments were repeated three times for each discharge.

www.SID.ir

Archive of SID

Results and Discussion

The results demonstrated that at low water loads (Ht <3cm), both types of weirs have almost the same performance. But as the water load increases, the performance of PKW-A weir deviates from the type PKW-D weir, i.e. it was able to pass larger discharges for an identical flow head. The superiority of PKW-A weir was more evident in small inlet-to-outlet ratios of keys.

For low flow heads, the performance of weirs with different Wi/Wo ratios in terms of discharge capacity is almost similar. Anderson and Tullis (2013) found similar results in their experiments.

At higher flow heads, the PKW-A1.66, compared to other models, had the largest discharge capacity in same flow heads, indicating its better performance. At maximum flow head (5.5cm), this weir was able to discharge 52 liters per second, which is 24% more than PKW-A0.6 weir. Similar trend exists for D-type piano key weirs.

It was observed that undular flow is formed on D-type piano key weirs. Although, this phenomenon was previously observed on rectangular broad-crested weirs (Chanson, 1976; Madadi *et al*, 2013), but for the piano key weirs, this is the first report on formation of undular weir flow above D-type PKW.

Conclusions

According to the results of this study, the ratio of the width of the inlet keys to the width of the outlet keys is a very effective parameter in the discharge capacity of the piano key weirs, and the presence of a forehead can also play a role in enhancing the performance of the weir.

Also, the results indicated that for a given head, not only the A-type PKW has more discharge capacity comparing to D-type weir, but also due to its special geometry, the undular flow phenomenon cannot be formed above such weir. Furthermore, the PKW weir with inlet to outlet key width ratio of 1.66 demonstrated 30% higher performance comparing to the other investigated models.

Keywords: Flow Characteristics, Flow Measurement, Geometrical Dimensions, Physical Model

www.SID.ir