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Study of Circulation Number Fluctuations in Papaya Spillway

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Abstract

Papaya spillway, mixing the piano key weir principles on a shaft spillway was tested in this research. Overall 80 experiments were conducted using physical models. Three models of papaya spillway with different angles were tested and experiments data were analyzed. This paper is devoted to explain about effects of using piano key inlet on shaft spillway on circulation number. Comparison between three papaya models showed that papaya model with an angle of 90 degrees has minor circulation number so that it has minor circulation strength compare with other models. As a result, it can pass higher amount of discharge through the shaft. In other words, papaya model with an angle of 90 degrees has better performance beyond comparison.

Keywords: Papaya Spillway, Shaft Spillway, Piano-Key Weir, Circulation number

1. INTRODUCTION

A new shape of free-flow spillway (the "Piano Key weir") can increase the specific flow fourfold or more. It could substantially reduce the cost of most new dams and increase, at low cost, the safety and the storage and/or the flood control efficiency of many existing dams. Preliminary model tests were done in 1999 at the LNH Laboratory in France (owned by Electricité de France) and in 2002 at Roorke University in India and Biskra University in Algeria [1].

Various configurations of Piano Key weirs set on a morning glory spillway have been studied on hydraulic models at LNH hydraulic laboratory. They allow for morning glory spillways, as for straight crested spillways, to reduce the required head of water and thus to maximize the increase in storage capacity, in case the hydraulic performances of the spillway are to be upgraded (re-evaluation of the design flood for instance). An innovative solution based upon PK weir principle better shares the flow between the central part of the shaft and the external part. Findings are rewarding, as even for high flows, the discharge is very stable without any vortex. The optimization can be done on hydraulic for any specific project [2]. This innovative solution is called PAPAYA spillway.

In this study, some laboratory experiments were conducted on papaya spillway models with 3 different angles and effects of using piano key inlet on shaft spillway were analyzed. This paper is devoted to explain the fluctuations of circulation number in different papaya models.

2. MATERIALS AND METHODS

This research was conducted in hydraulic laboratory of water engineering department, college of agriculture, Bu-Ali Sina University, Hamadan, Iran. The experiments have carried out in hydraulic flume with dimensions of 10m, 0.83m and 0.5m, length, width and height respectively. Hydraulic flume is made of glass with 1 cm thick to make flow observation much easier. To decelerate water which flows through a centrifuge pump, we used wave suppressor in the inlet of flume.

All experiments have been carried out in the laboratory flume using physical models. Acrylic sheets were used for making physical models of papaya spillway to make the observation of flow and air entrainment inside the models possible. Dimension of models were selected by considering the dimension of flume due to avoiding vortex formation near the flume's walls. Besides thickness of acrylic sheets was selected according to make sure that model's weight would be appropriate to put it on vertical shaft. Three models of papaya spillway with different angles were made.

3. RESULTS AND DISCUSSION

In this research, overall 80 experiments were conducted on 3 physical models in hydraulic laboratory. Data of laboratory experiments were analyzed and the result would be shown in some graphs as below. In these graphs, non-dimensional

number of circulation is shown versus non-dimensional ratio of H/D.

By increasing N_Γ, H/D ratio will be decreased. Circulation number is related with discharge inversely which means by discharge increase, circulation number decrease. Although by discharge increase, angular velocity and therefore circulation would be increased, the effect of discharge increase is predominate. Γ which used in these graphs is average circulation in distance of 20 cm from central shaft due to the fact that in this area free vortex occurs and circulation is approximately constant.

Comparison between amounts of circulation number versus H/D for all papaya models showed that for a constant circulation number, amount of H/D ratio is less in papaya spillway models by angles of 90, 45 and 60 degrees, respectively.

4. CONCLUSION

Overall 80 experiments were conducted on papaya spillway, an innovative solution based upon piano key weir principles, using physical models in hydraulic laboratory. Hydraulic parameters were measured on 3 papaya models with different angles. Data were analyzed and circulation number for each model were measured.

Circulation number is related with discharge inversely which means by discharge increase, circulation number decrease. Although by discharge increase, angular velocity and therefore circulation would be increased, the effect of discharge increase is predominate. H/D ratio has been decreased by increasing circulation number (N_Γ), experiments results showed. Comparison between 3 papaya models showed that for a constant amount of circulation number, amount of non-dimensional ratio of H/D is less in papaya spillway models by angles of 90, 45 and 60 degrees, respectively. Papaya model with angle of 90 degrees has minor circulation number so that it has minor circulation strength (Γ) compare with other models. As a result, it can pass higher amount of discharge through the shaft. In other words, papaya model with an angle of 90 degrees has better performance beyond comparison.

5. REFERENCES

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