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A Hybrid Approach to Improve Energy Dissipation in Stilling Basin

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Abstract: ***This study contains a hydraulic prototype model and experiments that will be conducted to generalize and prove the hydraulic design of a new type of stilling basin that controls discharge with a hollow-jet valve. The stilling basin is usually considered to be the most efficient hydraulic structure for dissipating flow energy. The size and shape of the stilling basin affect the formation of flow patterns, which can affect the overall hydraulic performance of the system. An ogee spillway's is important for dissipating excess water's specific energy. The kinetic energy generated by the release of water from the top to the toe of the spillway is considerable. This will cause scour and erosion on the downstream face of the spillway. The above problems are going to be solve by developing a workable physical model for an ogee spillway that considers the combined impacts of steps, roller buckets and USBR Stilling basin.***

Keywords: Ogee Spillway, Steps, Roller Bucket, Stilling Basin, Energy Dissipation.

I. INTRODUCTION

The toe part of an ogee spillway is necessary for dissipating specific energy and safely releasing floodwater on the downstream side. The water that has been discharged has a high kinetic energy near the spillway's toe causes scouring and eroding the channel bed. A provision of steps on chute is appropriate option to reduce the kinetic energy intensity. Spillway chute profile securely releases flood water and delivers considerable results of dissipation. As a result, the length of the stilling basin is reduced. Many Experiments on stepped spillways were conducted by the researchers. It was determined that energy loss is mainly due to the non-dimensional parameter: ratio of critical depth to step height. When the real head is less than 1.4 times the design head, energy dissipation is effective.

For energy dissipation, a stilling basin is often recommended for safely directing flow from the spillway to the downstream river. The Froude number and the hydraulic jump characteristics are used to choose a stilling basin. The flow in the downstream channel, on the other side, requires a longer span to control.

The roller bucket is the best alternative for energy dissipation if the tail water in the stilling basin is sufficient for the development of the hydraulic jump.

The use of a roller bucket reduces the length of a stilling basin, scouring, and erosion on a river's downstream bed. Due to insufficient energy dissipation, there are concerns in the stilling basin and on the ogee spillway chute of the Khadakwasla dam spillway near Pune, India. A plain and slotted roller bucket is an excellent alternative for overcoming the dam spillway's scouring and erosion problems. The current research looks at a hydraulic model of the Khadakwasla dam with a simple roller bucket, a slotted roller bucket, and alterations to the stilling basin for an ogee profile stepped spillway.

II. AIMS & OBJECTIVES

1) To design and develop a physical prototype model of ogee spillway.
2) To reduce the scouring and erosion action, occurred at the spillway's terminal end.
3) To identify suitable energy dissipator model.

III. PARAMETERS

1) Study of existing stilling basin with case study of Khadakwasla dam spillway.
2) To modify alternative design of existing stilling basin type II.
3) To modify the existing stilling basin with the appropriate energy dissipator.
4) To resolve problems of stilling basin caused due to highest Kinetic energy.

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IV. LITERATURE REVIEW

1) Dr. Ahmed Sayed Mohamed Ahmed, "A Hybrid Approach to Improve the Design of Stilling Basin" conducted an experiment work for confirming flow patterns of upstream and downstream of the proposed structure, as well as providing input for future 3-D hydraulic scale model testing of the Barrage architecture, is a well-designed 2-D hydraulic detail model of the sluiceway bay (in a flume).The water drop on the sill is higher (53.45) than the water drops on the sill level (52.80). It means that the Upstream water levels are unaffected by changes in sill levels. When the gate is entirely open, the baffle blocks in the 3D model have no effect on water levels or head losses, but when the gate is partially open, there is a slight increase in head losses.

2) Dr. Alka Sunil Kote, Dr. Prakash Nangare, "Hydraulic Model Investigation on, "Stepped Spillway's Plain and Slotted Roller Bucket," enhanced energy dissipation performance and reducing the length of the stilling basin, scouring and erosion can be reduced. In Pune district, the Khadakawasla dam is located on the Mutha river basin, which has a cultivable area of 677.43 km and an annual irrigation capacity of 621.46 km. It provides Pune with 280.3 million cubic meter of water. The ogee spillway has a 2700m design discharge, a 23.75m crest height, a 4.29m design head, and 14 10m wide spans. Because of its mix of steps and roller bucket, stepped spillway models have been found to be particularly effective for energy dissipation. It was also discovered that the OPRB model of an ogee spillway dissipated 80% of specific energy at a low head of 4m but required a longer stilling basin span. At a high head of 6m, the slotted roller bucket model (SSRB) of stepped spillway dissipated 83.86 percent of specific energy.

3) Dr. P.B. Nangare, et.al. "Development of Working Model for Ogee Profile Spillway Using Steps and Roller Bucket for enhancement of Energy Dissipation "By forming a hydraulic jump at the spillway's downstream end. Various types of roller buckets are used (Plain and Slotted) a) Jet diffusion basin b) Free jet stilling basin c) Impact stilling basin d) Hump stilling basin. At a tap distance of 65 cm, the T.E.L for a spillway with an ogee profile is 0.195, which is higher than the 0.177 for a stepped profile spillway. The percent ED for a spillway with steps is 78.01, which is higher than the 75.5 percent ED for an ogee profile spillway at a tap distance of 65 cm. Up to a tap distance of 65 cm, a spillway with steps outperforms an ogee profile spillway.

V. PROPOSED METHODOLGY

A new approach is provided in this study to reduce scouring and erosion by improvement of energy dissipation performance and reducing the length of the stilling basin. In Pune district, the Khadakawasla dam is situated in the Mutha river basin, with a cultivable area of 677.43 km^2 and an annual irrigation capacity of 621.46 km^2. It provides Pune with 280.3 million cubic metres of water. The ogee spillway has a design discharge of 2700 m^3/s, a 23.75m crest height, a 4.29m design head, and 14 spans of 10 m width.

A. Design of an Ogee Spillway

On the tilting hydraulic flume at the fluid mechanics laboratory, we proposed to build a physical hydraulic model with a model scale ratio of 1:33. The research of the model is based on hydraulic similarities, the model dimensions and Froude's model rule.

B. Design of Stepped Spillway

The stepped spillway model has a size of 1:33 and is designed for a single span of 10 m width. The design is based on Froude's model legislation, which may be found in the following assumed hydraulic conditions.

1) The real head should be less than 1.4 times the design head.
2) Tail water depth should be proportional to subsequent depth.
3) Froude number must be greater than 4.5.

C. Design of Roller Bucket

In comparison to the hydraulic jump type of stilling basin utilized for energy dissipation, the roller bucket is a comparatively short structure. It needs a tail water depth of 1.1 to 1.4 times the subsequent depth, as well as a Froude number greater than 4.5. There will be two types of roller buckets consider: plain and slotted roller buckets. In abroad Grand Coulee and Angostura dam type buckets inspired the creation of the roller bucket.

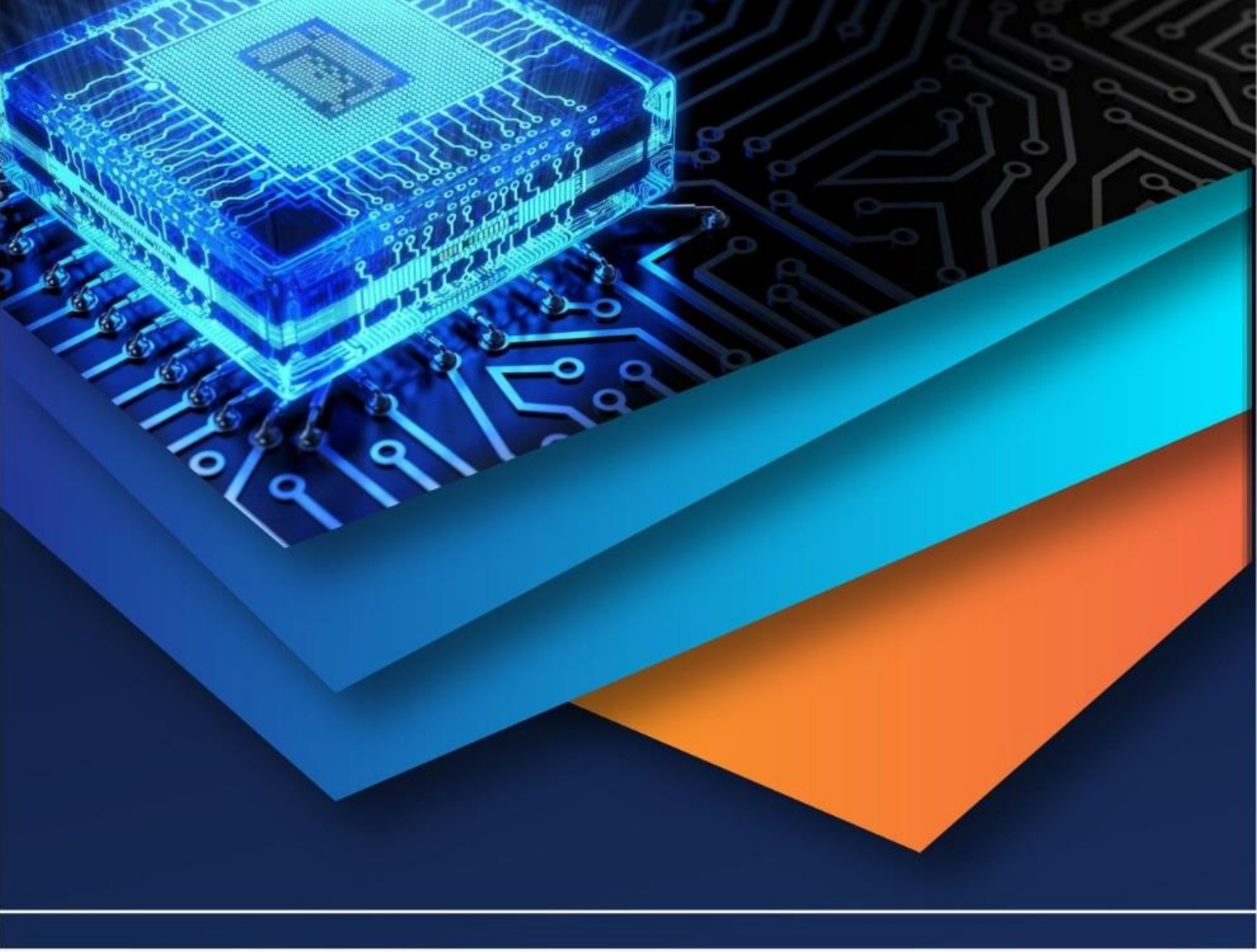
VI. CONCLUSION

Through the above literature review we came to know about the problem of scouring and erosion occurred on dam spillway structure. So, to reduce the problem that had occurred at the spillways terminal end by developing a workable prototype physical model inclusion with new type of stilling basin, It will helps to improve the energy dissipation as a proposed work of this research.

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