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Comparative Study of Discharge by the Insertion of Sharp Blade at the Crest of Ogee Spillway

[1]*H.V. Hajare,* [2]*N.S. Raman and* [3]*Er Jayant Dharkar*

[1]Department of Civil Engineering, G.H. Raisoni College of Engineering,
Digdoh, Hingna Road, Nagpur 440016 Nagpur, India
[2]N.E.E.R.I., Nagpur, India
[3]Department of Water Resources, Nagpur, India

Abstract: This paper deals with the comparative study of discharge by the insertion of sharp blade of different sizes such as 5mm, 6mm, 8mm & 9mm at the crest of ogee spillway and without the blade and variation in discharge is measured. The present study shows that the discharge is increased due to insertion of sharp blade at the crest of spillway As the discharge is found to be increased then it will be very much useful to farmers as well as to irrigation department and for the hydroelectric power station.

Key words: Discharge . ogee spillway . sharp blade . crest

INTRODUCTION

Spillway is a passage in a dam through which the design flood could be disposed off safely to the downstream. The ogee-crested spillway, because of its superb hydraulic characteristics, has been one of the most studied hydraulic structures. Its ability to pass flows efficiently and safely, when properly designed, with relatively good flow measuring capabilities, has enabled engineers to use it in a wide variety of situations. Although much is understood about the general ogee shape and its flow characteristics, it is also understood that a deviation from the standard design parameters such as a change in upstream flow conditions, slightly modified crest shape, or construction variances can change the flow properties. These small changes often require engineers to evaluate the crest and determine whether or not the change or deviation will be detrimental to the spillway's performance. Such is the case when an updated probable maximum flood calculation requires a spillway to pass a larger flow than it was designed to handle

Savage and Johnson [9] compared the dis charge characteristics and pressure distribution for flows passing over an unnumbered ogee spillway using a physical model, a numerical model and information published in various design guides (Maynord 1985; USACE 1990; USBR 1977/1987). This study is an extension to the previous study with the focus being on the comparison of the pressure distribution on the spillway when tail water is present. Because a physical model is considered the best available analysis tool, it was used as the baseline from which the other methods were measured against. However, because the flow changes from sub critical to supercritical and then back to sub critical as the discharge passes through a hydraulic jump or a drowned hydraulic jump, the hydraulics are more complex. This paper provides information on how accurately a commercially available Computational Fluid Dynamic (CFD) model can predict the spillway pressures when submergence occurs. It should be noted that there is a distinct difference between submergence of the spillway jet and dam submergence. Dam submergence occurs when the depth of the tail water increases sufficiently to affect the discharge over the dam (USBR 1977/1987). This note deals primarily with jet submergence. The intent is to give engineers and potential users of numerical tools, more information about the performance and application of CFD model studies that may be used to assess the hydraulic performance and assist in.

Many researchers carried out studies on the various aspects of ogee spillway, still it is required to carry out the research on the discharge of ogee spillway by the insertion of sharp blade at the crest

This paper deals with the comparative study of discharge without blade and by the insertion of sharp blade of different sizes such as 5mm, 6mm, 8mm & 9mm at the crest of ogee spillway The main aim of this project is to check weather there is any change in the discharge is occur or not. If the discharge will found to be increased then this concept will be very much helpful to irrigation department as well as for the hydroelectric power station.

Corresponding Author: Dr. Er Jayant Dharkar, Department of Water Resources, Nagpur, India

Fig. 1: Experimental set up of spillway showing flume and water collecting tank

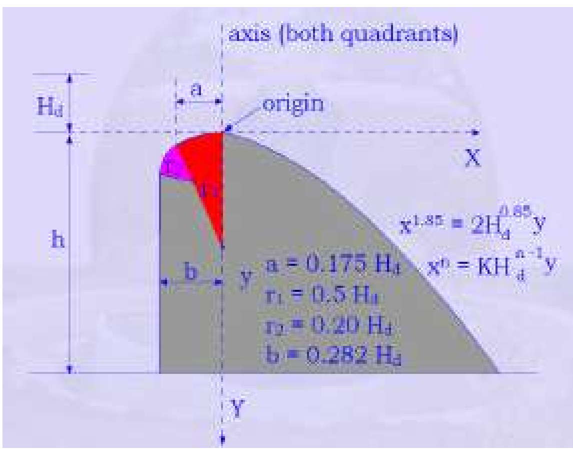

Fig. 2: Geometrical shape of spillway

EXPERIMENTAL SETUP

For this study, a physical model as shown in Fig. 1 was fabricated using steel and was tested at Fluid Mechanics laboratory, G.H.R.C.E., Nagpur. The model had the distinct shape characteristic of ogee spillways crest as per design and used different sizes of blades at its crest. The model was approximately 1ft. wide and the height was 1ft. The model was tested in a flume approximately 20ft. in length and 1ft. wide as in Fig. 1. The tests were performed by using the blades of sizes 5mm, 6mm, 8mm, & 9mm.

DESIGN OF SPILLWAY

The spillway was designed taking various parameters into assumptions and the flume into consideration mentioned as above. The parameters were assumed according to the *IS* 6934:1988 (Hydraulic design of high ogee overflow spillways-

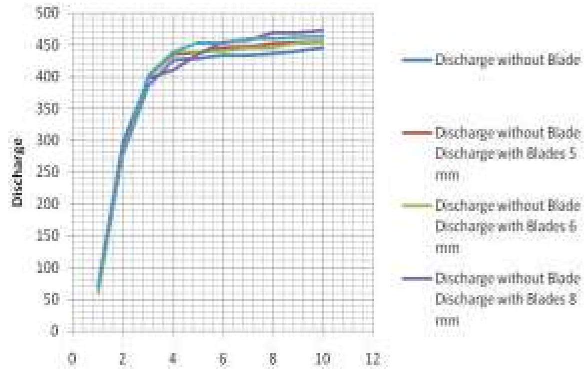

Fig. 3: Variation of dis charge with and witout blade

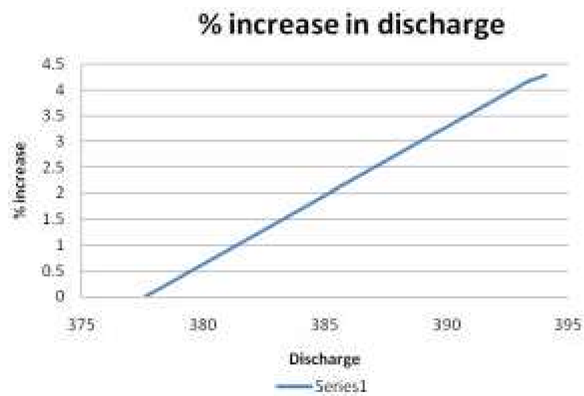

Fig. 4: Percentage increase in discharge for different blades

Recommendation). According to the manual provided for the pump the maximum head was taken and the design was carried out.

Data of the setup

1. Depth of the plume = 60cm.
2. Inner width of the plume = 30cm.
3. Length of the pipe carrying discharge = 5.7+2.7 = 8.4cm.
4. Head according to the manual of pump h_d= 1.93m.
5. Discharge, Q = 14.3×10^{-3} m^3/sec.
6. Diameter of delivery pipe, d = 65mm = 0.065m.
7. V = 4.31 m/s.
8. Reynolds no. Re = 280150.
9. For G.I. pipe, K_s= 0.115m.

Relative roughness = $K_s/d = 0.115\times10^{-3}/0.065 = 0.002$.

10. From Moody's chart, friction factor (f) = 0.024

Total head is 6.5m.

11. Design head: H_d = 8cm.
12. The downstream crest equation is given by-

Table 1: Comparative study of discharge

Sr. No	Discharge without Blade	Discharge with blades 5 mm	6 mm	8 mm	9 mm
1	69.39	65.64	59.23	74.18	68.49
2	277.30	281.82	281.82	297.05	281.87
3	385.45	398.93	397.34	397.24	402.33
4	426.36	435.05	438.55	410.05	438.53
5	428.09	438.05	438.55	435.06	452.62
6	433.31	445.54	440.30	454.39	452.62
7	433.31	447.32	445.56	456.16	459.71
8	436.80	452.62	445.56	468.62	459.71
9	440.30	454.39	452.62	468.62	461.48
10	445.56	456.16	454.39	472.26	463.27

Table 2: Percentage variation of discharge

	Without blade	5 mm blade	6 mm blade	8 mm blade	9 mm blade
Average discharge	377.587	384.352	385.39	393.34	394.06
Increase (%)	-	1.790%	2.07%	4.17%	4.28%

$$X^{1.85} = 2 \times H_d^{0.85} \times y$$

Hence the profile is designed as per the following table by trial and error method and is shown in Fig. 2.

Sr. No	1	2	3	4	5	6	7
Y (cm)	2	4	6	8	10	12	14
X (cm)	5.5	8.0	9.96	11.64	13.13	14.49	15.75

8	9	10	11	12	13	14	15
16	18	20	22	24	26	28	30
16.93	18.04	19.09	20.1	21.07	22	22.9	23.77

EXPERIMENTATION

The designed spillway was fitted into the flume and was checked for leakage if any. It was fixed in such a way that the water flowing over it should not leak by its sides. The KBS-527++ pump used has 3.7KW/ 5hp of capacity 14-8LPH, head range 17.8-26m, efficiency is 59% and head 23.5m(hose power) and the design was done according to it. The connection to the pump for electricity supply was checked for default if any. The height of the crest was noted carefully in centimetres. The valve of pipe carrying discharge was left open fully for some time and the pump was started and water is allowed to flow over spillway without blade. It was left until the water started overflowing over the crest of the spillway and then the valve was closed. The pipe was let open for the first round of the valve as there were total of 10 rounds of valve to open up the pipe fully and allow the full discharge..The reading was noted, i.e. the head over the crest by using the measuring rod suspended over the flume as attached in the arrangement. Then the valve was rotated for the second round and the readings were taken for the head. Again the valve was opened for third round and readings were taken. The readings were taken till the valve was opened completely i.e. up to 10th rounds and the readings were tabulated. Experiment was also carried out by insertion of a blade of 5mm size on the crest of the spillway and was tightened. The procedure was repeated and the corresponding values were noted and tabulated. The experiment was repeated for the blade of sizes 6mm, 8mm and 9mm and the corresponding readings were tabulated. Every time the blade was changed and the flume and spillway were checked for achieving accuracy with minimum faults.

DISCUSSION &CONCLUSION

Presently in Irrigation Department in India, ogee spillway is used to measure the discharge as it gives high discharge as compared to other types of spillway. As it is a concrete structure placed across a reservoir many researcher has carried out study on ogee spillway.

The ogee stricture is generally made up of concrete. Generally while in construction, there must be a sharp crest. but it is observed that a sharp crest is very difficult to maintain during construction.This failure in maintaining the sharp crest during construction can be overcome by placing the sharp edged steel blade at the crest of spillway to get the maximum discharge. The experiment was carried out in test flume for both the condition without blade and with blades of different sizes of 5mm, 6mm, 8 mm and 9mm at the crest of ogee spillway. The spillway with blade gives higher discharge as compared to without blade at crest. The blade of 8mm gives maximum discharge. Initially at low head the discharge is approximately very near to each other in all cases but at high head 8mm blade given her value of discharge. After carrying out the experiment for comparative study of discharge over ogee spillway by the insertion of blades at the crest of spillway. it is observed that there is increase in discharge due to insertion of sharp blade of various sizes of 5mm, 6 mm, 8 mm, 9 mm at the crest of spillways as compared to without blade at crest. Initially there is little variation in discharges ie at low discharge but at high discharge, remarkable change in discharge was noticed It is also observed that 8mm sharp blade gives maximum discharge. it will be also useful to raise the level of water upstream of spillway during flood which gives sufficient time to the people to migrate

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