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Review of the Efficiency of Shaft Spillway Discharge Influenced by Sharp Triangular Vortex Breaker Blades with Rectangular Body

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ABSTRACT

Shaft spillways are used where there is not adequate space to build other types of spillways because these spillways are placed on upslope dams and inside dam reservoirs. In this paper, the physical model was constructed and the effect of sharp triangular vortex breaker blades with rectangular (square) body on the efficiency of shaft spillway discharge was examined by conducting 67 experiments. Once the data were analysed, the conclusion was that the sharp-edged vortex breaker blade with rectangular body has the greatest impact on increasing the efficiency of the spillway discharge.

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INTRODUCTION

One of the major water conveyance structures that can act as an emergency spillway is shaft spillway. This type of spillway is so effective when there is not adequate space to build other types of spillways. In earth dams, using it in reservoir and apart from the dam body reduces the risk of scour and saturation of the downstream shell of the dam. Shaft spillway in such dams is a good option in flood discharge. One of the characteristics of these types of spillways is forming eddy current in its inlet. Studying this type of flows in these spillways is important [1]. Vortex prolongs the flow lines and thus reduces the discharge and the discharge coefficient. Although this type of flows has a negative impact on performance of shaft spillway. The most effective method of controlling vortex is using anti-vortex blades which are used to increase the discharge coefficient of the shaft spillways [2]. In these spillways, when the water height over the spillway crest is low, the flow is completely free and control will be in the spillway crest. By increasing the water level when the flow is half full, 75% of the outlet tunnel of spillway is full and in this case, the flow acts like aperture and the control will be in aperture or in the canyon. When the channel of spillway discharge is completely full, flow control will be in the pressure pipe [3]. The relationship of the discharge of shaft spillway is as follows:

$$Q = CLH^{3/2} \quad (1)$$

$$Q = C\,(2\Pi R)\,H^{3/2} \quad (2)$$

In the above equations, Q is the discharge passing through the spillway, C spillway discharge coefficient, L the length of spillway crest, H the water level on the spillway and R the radius of spillway crest [4]. Rankin [5] divided whirlpool into two parts: the central part, relatively small, has a high viscosity, which is like a rigid whirling object and the other part which has a lower viscosity. In the central part, the fluid in the whirlpool turns around in such a way that the tangential speed changes linearly with the radius. Fattor and Bacchiega [6] concluded that if in the shaft spillways, the spillway is submerged, the discharge rate is 1.34 times more than the flow discharge in free mode and we will have turbulence in the case of non-aeration to the pressure tunnel in the spillway. Zomorodian et al., [7] by making a physical model of vertical pond and in vitro studies have concluded that the discharge coefficient of pond is reduced by increasing the circulation number and the aeration to the inlet of vertical pond has a negative impact on the discharge coefficient. In this study, the effect of the sharp triangular vortex breaker blade with rectangular body on the efficiency of discharge in shaft spillway is studied.

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MATERIALS AND METHODS

To study and achieve the objectives of the study, the physical model was made according to Figure (1) in the hydraulic laboratory of Water and Power Authority of Khuzestan and was tested. To supply the water required for the tests, a pond with a volume of 2000 liters with steel sheet with a thickness of 3 mm is used. Connecting the basin reservoir to the spillway reservoir is done by a field-tee on which two valves were used to adjust the inlet discharge. Conveyance of water from the basin to the spillway reservoir is done by a pump with a discharge coefficient 250-1000 liters per minute. After pumping from the basin reservoir, water is entered into the triangular spillway size 0.2 × 0.2 × 0.2 meters and the internal angle of 60 ° for the accurate measurement of the input discharge. The exact value of the bulk discharge is calculated using the scale in the reservoir of the triangular spillway and a graduated glass in the downstream end of the tunnel. To control the volatility and turbulence inside the reservoir, two buffer systems were used, a buffer is considered when the water enters the reservoir of the triangular spillway and the second one is considered as chamber. In this chamber, which is like a metal mesh screens, a series of straw was used to slow the flow that the water passes through the second buffer and entered the reservoir of the shaft spillway. The reservoir of the shaft spillway is sizes 1.2 × 1.1 × 1.2 meter which is completely enclosed from three sides and on the other hand, to observe the phenomenon inside the reservoir, a glass sheet with a thickness of 10 mm and a scale connected to reservoir glass was used to measure the height of the water on the shaft spillway. Shaft spillway in the reservoir according to Figure (1) is made of Teflon with a crest diameter of 35 cm, crest length of 1.1 m, guttural diameter 7 cm, bend diameter 10.16 cm, height 28.2 cm and diameter of downstream tunnel 7.62 cm do the reservoir discharge. At the end of the downstream tunnel, two gate valves were sued: one to enter the graduated glass for the calculation of discharge and the other to return the water to the basing reservoir.

To compare sharp triangular vortex breaker blades with rectangular body according to Figures (2) and (3) on the efficiency of the discharge of shaft spillway, 6 vortex breakers in three different lengths of 10, 15 and 20% of the overflow diameter with a thickness of 2 cm and a height of 4 cm m are used. It should be noted that the length of the vortex breakers re increased to the outside of the overflow span. 67 tests were performed in 7 steps. Characteristics of experiments are presented in Table 1.

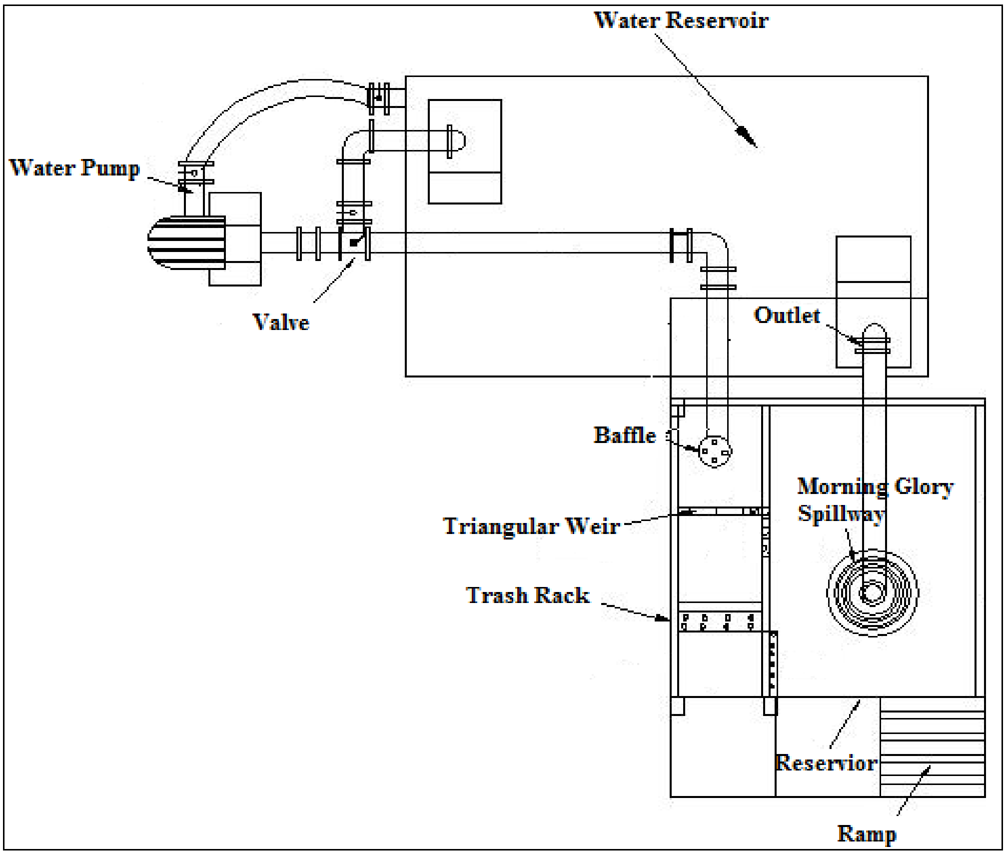

Fig. 1: Plan of the physical model

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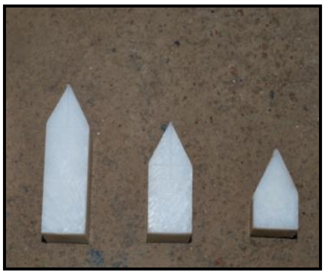

Fig. 2: View of the vortex breaker type A in various lengths

Fig. 3: View of the vortex breaker type B in various lengths

Table 1: Profile of the tests

Number of tests	Amount of elongation of vortex breaker toward the outside of spillway span (L/d) in %	Ratio of length of the vortex breaker to the diameter of the spillway (L/d) in %	Experiments
10	-	-	S
9	0	10	SA1
9	5	15	SA2
9	10	20	SA3
10	0	10	SB1
10	5	15	SB2
10	10	20	SB3

Discussion and Conclusion:

Using the experimental data obtained from experiments, spillway discharge coefficient was calculated for each test. To determine the discharge coefficient of shaft spillway, the formula (2) was used. The results were shown as the discharge coefficient curve to submergence in Fig. (4) to (6). In the presented Figures, the Cd is spillway discharge coefficient and H/R submergence ratio.

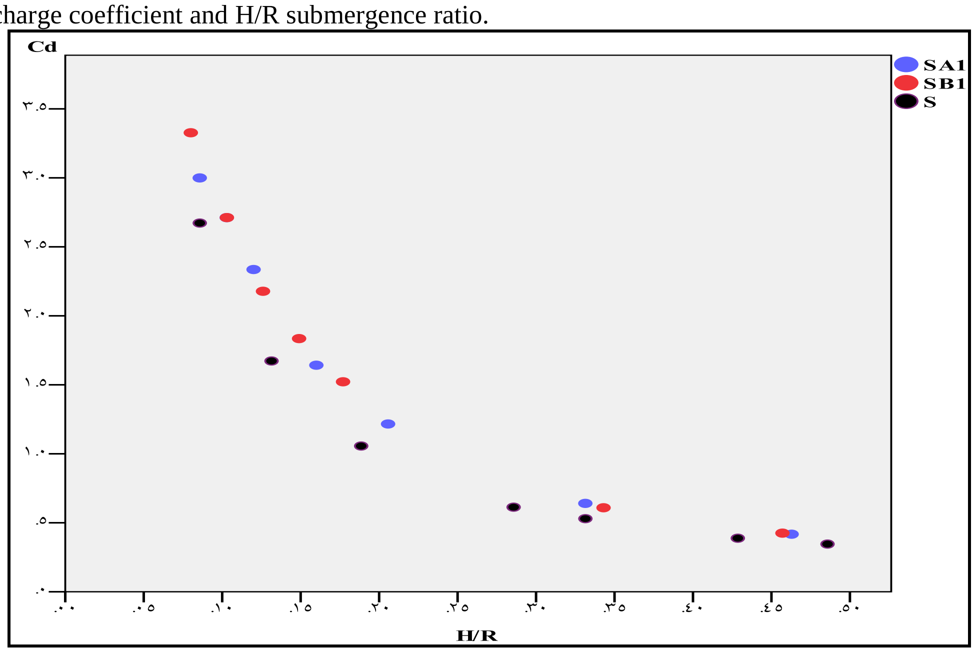

Fig. 4: Discharge coefficient curve to submergence for length with a ratio (L/D = 0.1)

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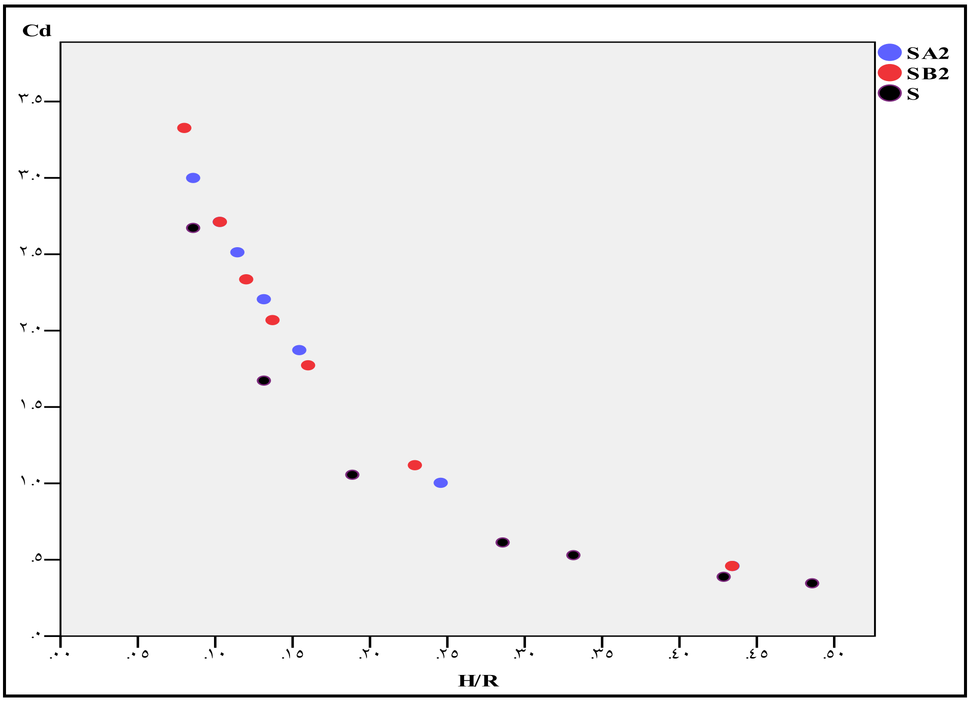

Fig. 5: Discharge coefficient curve to submergence for length with a ratio (L/D = 0.15)

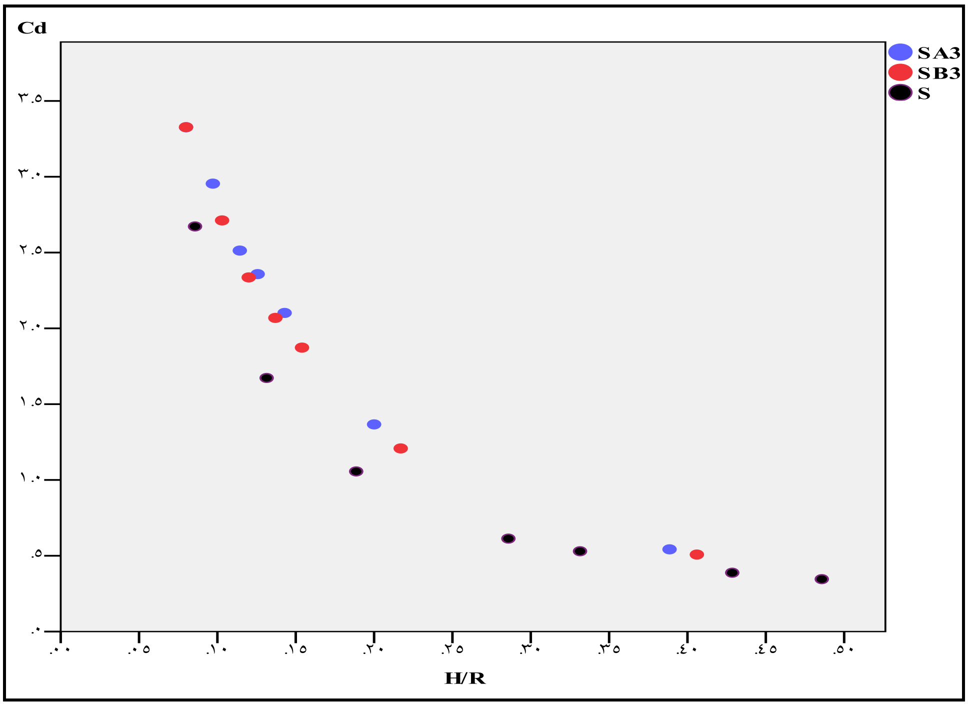

Fig. 6: Discharge coefficient curve to submergence for length with a ratio (L/D = 0.2)

With regard to the figures (4) to (6), it is obvious that using vortex breaker blades increase the efficiency of discharge in spillway than the control spillway. It can also be seen that the triangular vortex breaker first has a discharge coefficient more than the sharp vortex breaker with rectangular body. By increasing the ratio of submergence ratio, the efficiency of the sharp vortex breaker edge with a rectangular body has raised and since the experiments were continued to the complete submergence, it is seen that by getting close to the complete submergence, vortex breakers have similar performance, that for the lengths with ratios L/D = 0.1, L/D = 0.15 and L/D = 0.2 triangular vortex breaker are respectively 22, 26 and 32 percent, and the sharp vortex breaker with a rectangular body with 24, 29 and 39 percent increase the discharge coefficient to the control spillway. A view of the position of the vortex breakers in figures (7) and (8) is provided.

Fig. 7: A view of the position of triangular vortex breaker for length with a ratio of (L/D = 0.2)

Fig. 8: A view of the position of sharp vortex breaker with the rectangular body for length ratio (L/D = 0.2)

Conclusions:

In this study, the effect of sharp triangular vortex breaker blades with rectangular body on the efficiency of shaft spillway discharge was investigated. The results showed that the sharp vortex breaker with rectangular body has greater impact on the efficiency of spillway discharge than the triangular vortex breaker. Also, when the length of the vortex breakers is more, the impact of shape on increasing the spillway discharge will increase, so that it can be seen that a 10 percent increase in vortex breaker length for sharp vortex breaker with a rectangular body increases the efficiency of discharge in spillway by 15 percent.

REFERENCES

[1] Ellesty, K., 2006. Effect of Whirlpool-break Blades on the Discharge Coefficient of the Glory spillway. Irrigation and Drainage Networks National Conference, Shahid Chamran University, Iran, Ahvaz. In Persian. pp: 8.
[2] Nohani, E and H. mousavi, 2010. The Effect of number and thickness Vortex Breakers on Discharge Coefficient for the Shaft Spillways. Proceedings of 1th National Conference of water, soil, plant and agricultural mechanization, Islamic Azad University.
[3] Khatsuria, R.M., 2005. Hydraulics of Spillways and Energy Dissipators, Marcel Dekker, Department of civil and environmental engineering Georgia. Institute of technology Atlanta. New york. Usa.
[4] USBR, 1976, Design of Small Dams.
[5] Rankin, A., 1985. Efficiency Of Air-Entaining Vortex At Water Intakes, Journal of Hydraulic Endineering, ASCE. Div. By:7.
[6] Fattor, C.A. and J.D. Bacchiega, 2003. Analysis of instabilities in the change of regime in morning glory spillways, Journal of Hydraulic Research, 40: 4.
[7] Zomorredian, M.A., 2004. Effect of the Geometry of Headrace Channel on Vortex and Discharge coefficient. Iranian, J. Agricultural Sci., In Persian., 35(3): 10.