
EXPERIMENTAL STUDY ON COMPARISON OF DISCHARGE COEFFICIENT OF NOTCHES

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ABSTRACT

Notches are common devices to measure the flow rate and to control the discharge of hydraulic. The indispensable idea of each weir is to determine the flow coefficient. This paper is to conduct the experiment on measurements of coefficient of discharge for two different types of notches. The measurement of discharge is one of the main concerns in hydraulic engineering in order to obtain accurate measurement of flow mechanism as well as designing the hydraulic structures for future. The designed structures like rectangular and v-notch are placed in a channel to measure the flow rate and coefficient of discharge. The equations were derived using Bernoulli's equation and used to determine the discharge flow rate. The main aim is to determine the optimum discharge of hydraulic for different types of notches. Overestimated of discharge may cause failure to the structure, as well underestimated it may not fulfill the design requirements. The studies are experimented from maximum flow to minimum flow by measuring head over the weir in different working sections.

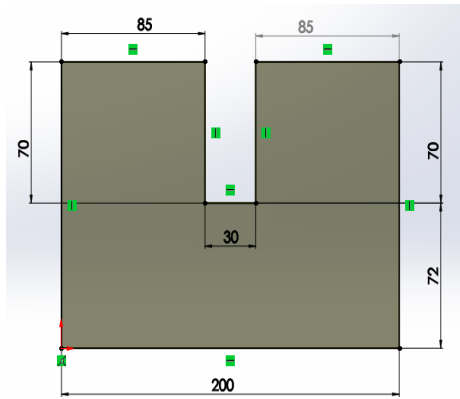
KEYWORDS: Notches, Bernoulli's, Hydraulic structure Discharge, Rectangular and V-notches

INTRODUCTION

Notches are widely used as flow measuring/flow control devices in the fields of Hydraulics, Environment, Irrigation and Chemical engineering. The rectangular and triangular structure notches are among the oldest notches. Through laboratories experimental triangular notches gives accurate to measure low flow discharge [7]. Rectangular notches and Triangular notches are often used in water supply, wastewater and sewage systems. They consist of a sharp edged plate with a rectangular and triangular or v-notch profile for the water flow [4]. Notches are commonly used to control the flow rates of the rivers during periods of high discharge. The sluice gates are used to operate increase or decrease the volume of water flowing downstream [1]. To measure the flow rate through hydraulic structure relationship of head and discharge is considered as an important factor to determine empirically in the laboratory. The coefficient of discharge is defined as the ratio of actual discharge to the theoretical discharge delivered by the structure. If theoretical discharge delivered by the structure is known by a formula, actual discharge delivered by the structure can be multiplied by the coefficient of discharge with theoretical discharge. Therefore, this laboratory study was planned to study Head Discharge relationship of two notches.

DESIGN OF NOTCHES

A. Rectangular Notch



All dimension are in mm

Fig. 1: Deign of rectangular Notch

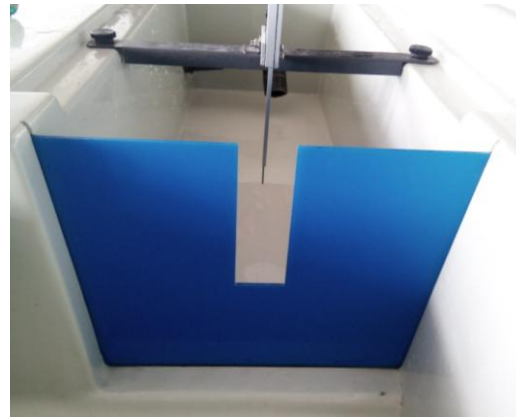


Fig. 2: Experimental setup for Rectangular Notch

Table I: Data tabulation of Rectangular notches

Sl/No	Pressure guage = kg/cm^2	Point guage reading				Discharge measurement					$Cd = \frac{Qac}{Qth}$
		Initial (cm)	Final (cm)	Difference (cm)	Difference (m)	water rise in tube		Time (t) taken for 5 litres (s)	$Qac = \frac{m^3}{t}$	$Qth = \frac{8}{15} \sqrt{2} g \tan(\frac{\theta}{2}) (H)^{\frac{5}{2}}$	
						(ltrs)	(m3)				
1	0.2	7.2	9	1.8	0.018	5	0.005	39	0.000128	0.000214	0.60
2	0.3	7.2	9.4	2.2	0.022	5	0.005	28	0.000179	0.000289	0.62
3	0.5	7.2	9.9	2.7	0.027	5	0.005	23	0.000217	0.000393	0.55
4	0.6	7.2	10.3	3.1	0.031	5	0.005	16	0.000313	0.000484	0.65
5	0.7	7.2	10.7	3.5	0.035	5	0.005	14	0.000357	0.000580	0.62
6	0.9	7.2	11.2	4	0.040	5	0.005	12	0.000417	0.000709	0.59
7	1.0	7.2	11.4	4.2	0.042	5	0.005	9	0.000556	0.000763	0.73
8	1.2	7.2	11.7	4.5	0.045	5	0.005	8	0.000625	0.000846	0.74
9	1.3	7.2	12.1	4.9	0.049	5	0.005	7	0.000714	0.000961	0.74
10	1.6	7.2	12.2	5	0.050	5	0.005	7	0.000714	0.000990	0.72
11	1.8	7.2	12.4	5.2	0.052	5	0.005	6	0.000833	0.001050	0.79

The above table I. shows pressure head and time taken for discharge of water in 5 liters for rectangular notches to determine the coefficient of discharge. Through this experimental it has observed that time taken is decrease when increase in pressure and water head. Similarly, actual discharges of water through the notches are also increase.

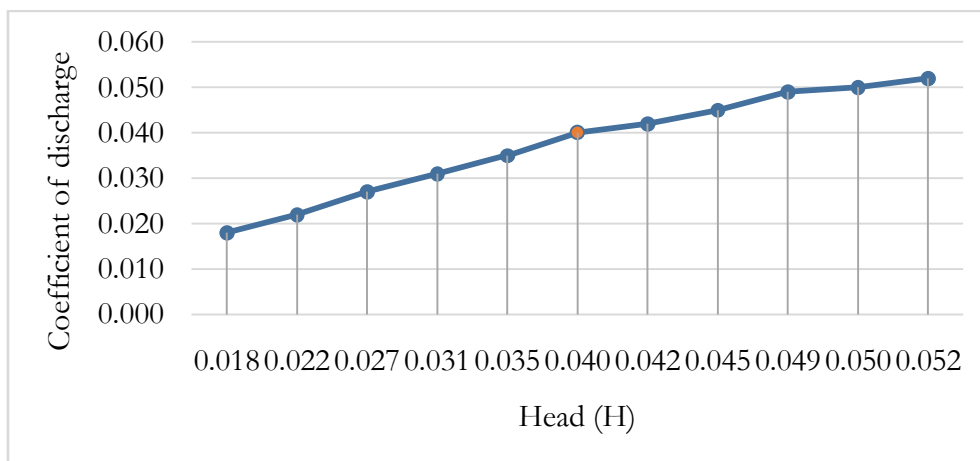
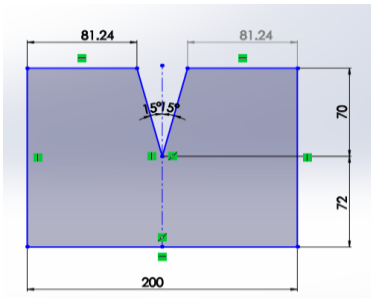


Figure 3: Graph between Cd and H for Rectangular Notch

The above graph is between coefficient of discharge and head of water in rectangular notches, from the graph its observed line is gradually increase, and mainly due to increasing the value of head obviously increase in coefficient of discharge. Based on the theoretical information its state that rectangular notches are best for larger discharge of fluids, where is it bring to conclude, as state in theoretical information are true by an experimental proof.

B. V-Notch



All dimension are in mm
 Fig.4: Design of V-Notch

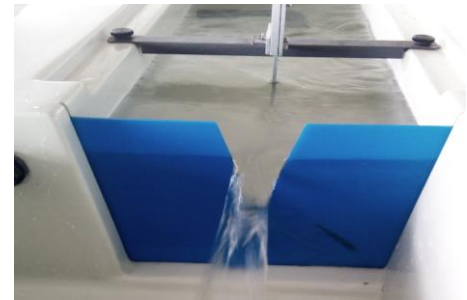


Fig. 5: Experimental setup for v-Notch

Table II: Data tabulation for V-Notch

Sl/No	Pressure guage = kg/cm^2	Point guage reading				Discharge measurement					$Cd = \frac{Qac}{Qth}$
		Initial (cm)	Final (cm)	Difference (cm)	Difference (m)	water rise in tube		Time (t) taken for 5 litres (s)	$Qac = \frac{m^3}{t}$	$Qth = \frac{8}{15} \sqrt{2g} \tan\left(\frac{\theta}{2}\right) (H)^{\frac{5}{2}}$	
						(ltrs)	(m3)				
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3	0.5	7.2	9.9	2.7	0.027	5	0.005	23	0.000217	0.000393	0.55
4	0.6	7.2	10.3	3.1	0.031	5	0.005	16	0.000313	0.000484	0.65
5	0.7	7.2	10.7	3.5	0.035	5	0.005	14	0.000357	0.000580	0.62
6	0.9	7.2	11.2	4	0.040	5	0.005	12	0.000417	0.000709	0.59
7	1.0	7.2	11.4	4.2	0.042	5	0.005	9	0.000556	0.000763	0.73
8	1.2	7.2	11.7	4.5	0.045	5	0.005	8	0.000625	0.000846	0.74
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In the Table II, shows pressure head and time taken for discharge of water in 5 liters for V-Notches to determine the coefficient of discharge. Through this experimental it has observed that time taken is decrease when increase in pressure and water head. Similarly, actual discharges of water through the notches are also changed.

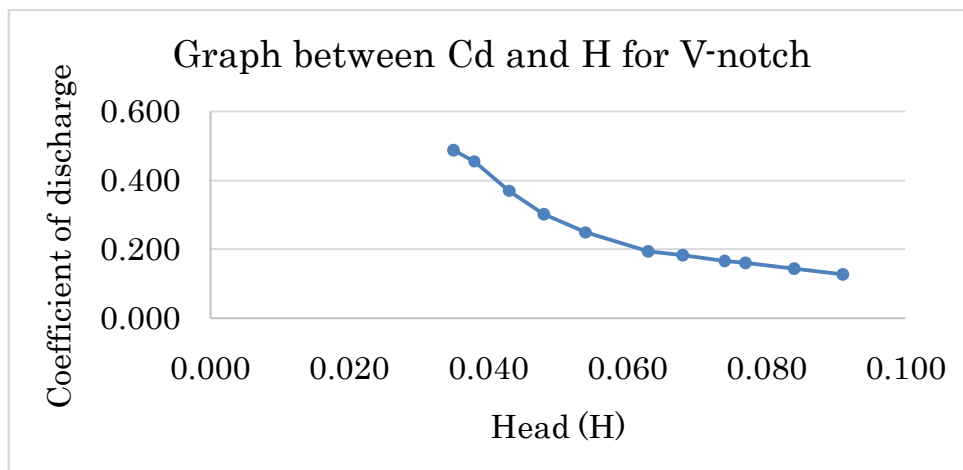


Figure 6: Graph between Cd and H for V-Notch

The above graph is between coefficient of discharge and head of water in V-notches, from the graph its observed line is gradually decrease, and mainly due to increasing the value of head obviously decrease in coefficient of discharge. Based on the theoretical information its state that V-notches are only best for low discharge of fluids, where is it bring to conclude, as state in theoretical information are true from this experimental.

CONCLUSION

In conclusion, it observed that the discharge is entirely effect by types of weir. The main objective of this paper is to determine the coefficient of discharge of the weirs and comparison between them. The laboratory experimental experience that the discharge of the weirs is based on coefficient of discharge. This coefficient of discharge is also dependent to other parameters like head of water over the crest, different sizes and angle of notches. It can provide the real value for detail design in agriculture implication, hydropower plant and Industries development. At the low discharge, a triangular notch gives more accurate results than other notches. In this experimental result shows coefficient of discharge is greater in rectangle notches though the Head in V-notches are high as compare.

REFERENCE

1. Binnie A (1952) the flow of water under a sluice gate. Q. J. Mech. Appl. Math. 5 (4) 395–407. <https://doi.org/10.1093/qjmam/5.4.395>
2. Hydrovolts (2012) Case study: Roza canal. URL: <http://hydrovolts.com/wp-content/uploads/2011/05/Hydrovolts-Roza-Case-Study1.Pdf> (Accessed 3 December 2013).
3. Modi P.N, Seth S.M. a textbook of Hydraulics and Fluid Mechanics including hydraulic machines. (2004) 705-706.
4. Shesha Prakash, M.N. and Shivapur, A.V. (2004), "Generalized Head-Discharge Equation for Flow over Sharp Crested Inclined Inverted V-Notch", JI. of Irrigation and Drainage Engineering Div. American Society for Civil Engineers, Vol. 130 (4), Aug. 2004, pp 325-330.
5. Shesha Prakash, M.N. and Shivapur, A.V. (2002). "Design and Experimentation of an Inclined Inverted V Notch" Proc., Int. Conf., Fluid Mechanics and Fluid Power, Indian Institute of Technology, Roorkee, India, 65-72.
6. Ambica A., Tamizharasan V., Venkatraman K., Treatment of domestic wastewater by electrochemical method, International Journal of Applied Engineering Research, v-9, i-22, pp-5537-5542, 2014.
7. [1]B.Kaviya Shivam Kumar, Vikram Raj, Syed Huzair Ali, Shirish Kumar Shrivastav Assistant Professor¹ Student²⁻⁵ Department of Civil Engineering, BIST, BIHER, Bharath University, Chennai.
8. Borghei, S.M., Jalili, M.R., and Ghodsian, M. (1999) "Discharge coefficient for sharp crested side weir in subcritical flow", Journal of Hydraulic Engineering, Vol.125 (10), pp.1051-1056.
9. LMNO Engineering Research and Software Ltd. (1999) "Focus on open channel flow measurement: V-notch weirs" Newsletter, Vol. 1, Athens, Ohio.