ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 5, Issue 12, December 2018

Flow Characteristics of Sharp Crested Weirs

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ABSTRACT - Weirs are commonly used devices in flow measurements. Sharp crested weirs are widely used as discharge measuring device in laboratories, industries and irrigation channels. The main objective of these study is to investigate the flow behaviour of different sharp crested weirs and to obtain the discharge coefficient for different bed slope conditions (Horizontal, and 1in 400,1in 200). Measurement of head over the weir crest is the important aspect in discharge analysis through sharp crested weirs. Width of the weir opening affect the coefficient of discharge and thereby the discharge also. Results of this study shows that the average values of coefficient of discharge for different thin plate weirs (i.e Rectangular weir, V-notch weir, Trapezoidal weir, Sutro weir) 0.697, 0.798, 0.578, 0.598 respectively.

KEYWORDS - Sharp crested weirs, Coefficient of discharge, Head over weir, Weir height.

I. INTRODUCTION

In India open channels in irrigation utilities are used for transportation of water for irrigation purpose. Water supplied to the fields by using open channel, implies that discharge measurement becomes necessary, as the Measurement of discharge in open channels plays a vital role in the equal distribution of water among the users in field and accordingly charging correct amount from them by metering the flow. The measurement of flow in open channels is generally made by means of weirs or sluice gates.

Weir is a standard device for the measurement of flow in open channel. It is an obstruction in the path of flow that causes the liquid to rise behind the weir and then flows over it. By measuring the head of water over the weir the quantity of discharge can be estimated by using well established head-discharge relationship. If the jet of liquid passing over the weir springs free as it leaves the upstream face, the weir is known as sharp crested weir, while broad crested weirs are those which support the falling nappe over its crest, in the longitudinal direction and critical depth occurs over the weir. On the basis of shapes the weirs can be classified as the rectangular, triangular, trapezoidal, parabolic, etc. Sharp crested rectangular weir, V-notch and broad crested weir are most common.

Brief summary of significant experimental investigations: **S.A.Tekade et al.**†(2014) The complete work was carried out in the Water Resources Engineering Laboratory of the Civil Engineering Department at Visvesvaraya National Institute of Technology, Nagpur, India. A rectangular flume 4.2 m long and 1.2 m in width, non tilting type was used in the experiment. Based on the observations carried on discharge measurement by rectangular SCW he concluded that Head-Discharge relationship for SCW is found to be a exponential series. And It can be concluded that as the b/B ratio increases, the head over the notch decreases for the same discharge value.also found thatThe crest height has negligible effect on the discharge characteristics of SCW. **HadiArvanaghi et al.** (2013) According their studies on Rectangular sharp-crested weir is one of the flow measuring tools which are usually used in irrigation and drainage channels. The most essential parameter of discharge equation of this type of weirs is the discharge coefficient. In this study discharge coefficient of the rectangular sharp-crested weir is investigated experimentally and numerically. The results show that the Cd has the fixed value of 0.7 when the following condition is maintained: $H/W > 0.6$,$Fr > 0.2$, $Re > 20000$ Beyond these boundaries, Cd is not constant and it is not recommended to usea unique Cd for different flow conditions. Furthermore in this study the water surface profile. **Rahul Pandey.et.al** (2016)studies of Flow Characteristics of Sharp Crested Rectangular Weir and he investigated the flow behaviour of the weirs and obtained the discharge coefficient. So, Now in our study we are going to establish following results to determine coefficient of discharge, and develop

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
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head-discharge relationship for sharp crested weirs (Rectangular, triangular, Trapezoidal, and sutro weir) with varied slopes of channel.

II. EXPERIMENTAL SETUP AND LABORATORY ACCESSORIES

The complete work was carried out in the Water Resources Engineering Laboratory of the Civil Engineering Department at Rajiv Gandhi University Knowledge &Technology, Basar, India. A rectangular flume 5 m long and 30c m in width, 45cm height tilting flume was used in the experiment. It consist of sloping set up ranging from negative 1 in 200 to positive 1 in 200. This entire set up is connected with sensors and the values are recorded through arm field software. The experimental setup is a self contained one having circulating arrangement for the water. A 3 HP pump makes the circulating mechanism work efficiently in the flume. The flume is installed with perplex glass sheets as side walls which make the viewing of the experimental run easy. At the entrance into the channel, flow is regulated by converging vertical plates to prevent vortex motion and thus to control the damp fluctuations at the entry of flume. The water after the weir was then collected into a measuring tank with dimension 4m×3m. A vernier type gauge with accuracy1mm was used for measuring the bed elevation and water surface elevation. Calibration was done before every run of the experiment to prevent instrumental errors. The depth rod was adjusted accurately to the surface of water to get the value of 'H'. While measuring H it was ensured that the flow in the channel was stable and constant. Discharge is maintained for individual run. Fig 2.1 shows the glass sided tilting flume.

Fig 2.1-Tilting flume channel

In our Study we are going to perform on sharp crested weirs i.e rectangular, triangular, trapezoidal, sutro weir. Following eq. 2.1, 2.2 and 2.3 are required to measure the discharge for

***Rectangular sharp crested weir*:-**

$$Q = \frac{2}{3} C_d b \sqrt{2g}\, y_c^{3/2} \quad \text{...eq. 2.1}$$

Triangular sharp crested weir:-

$$Q = C_d \frac{8}{15}\sqrt{2g}\tan\left(\frac{\theta}{2}\right) y_c^{5/2} \quad \text{......................................eq.2.2}$$

Trapezoidal sharp crested weir:-

$$Q = \frac{2}{3} C_d b\sqrt{2g}\, y_c^{3/2} + C_d \frac{8}{15}\sqrt{2g}\tan\left(\frac{\theta}{2}\right) y_c^{5/2} \quad \text{..............eq.2.3}$$

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Sutro weir:-

$$Q = C_0 (Y_{datum} + \frac{2}{3} a) ....eq.2.4$$

$$C_0 = 2 b C_d (2 g)^{0.5} a^{0.5}…………………………….eq.2.5$$

Where C_0=The proportionality constant, a=0.030(m), b=0.050(m), Y_{datum}= Depth above datum, y_{base}=Depth above base of rectangular weir(m) , y_{origin}=Depth above origin of upper part of weir(m) C_d= Coefficient of discharge, Q= rate of discharge in Litre/sec ,B= width of channel in cm g= gravitational acceleration in cm/s^2, H= head over the weir/spillway

III. RESULTS AND DISCUSSION

Experiment has been done in a laboratory flume with glass made walls. The flume length, width and height are 5, 0.35 and 0.45 m, respectively. Water enters the flume through a stilling system. Then flow passes over the weir and finally flow discharges to the settling basin of the flume. There is a weirs downstream the settling basin which is calibrated to measure the flow rate. Water surface elevation in the flume is measured by a needle type level meter which accuracy is about 0.1 mm For different flow rates and different bed slope conditions (i.e horizontal,1 in 400). The obtained values were tabulated in following tables.(3.1),(3.2) and discharge-head, Discharge-coefficient of discharge curve for rectangular Sharp crested weir are shown in fig. (3.1),(3.2),(3.3) and (3.4).

Table3.1: **Discharge, head, coefficient of discharge of Rectangular Sharp Crested Weir with slope of Horizontal**.

Up stream depth (mm)	**Head with crest height (mm)**	**Head over weir (mm)**	**Flow rate (l/s)**	**Coefficient of discharge (cd)**
130	120.5	45.5	1.9	0.663
140	131.5	56.5	2.7	0.681
150	140	65	3.7	0.695
160	149.5	74.5	4.3	0.716
170	159.5	84.5	5.21	0.716
180	170.5	95.5	6.2	0.714
190	179	104	6.9	0.697

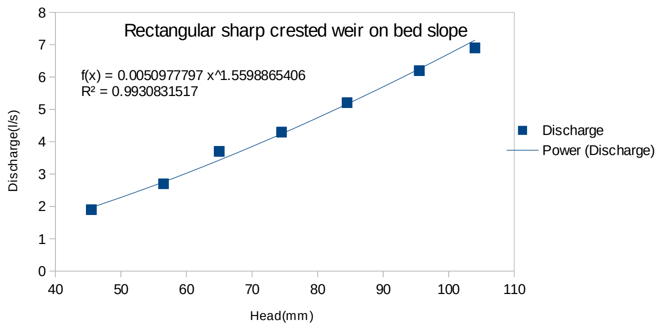

Fig 3.1-Discharge-Head curve Rectangular Sharp crested weir

ISSN: 2350-0328

International Journal of AdvancedResearch in Science, Engineering and Technology

Vol. 5, Issue 12, December 2018

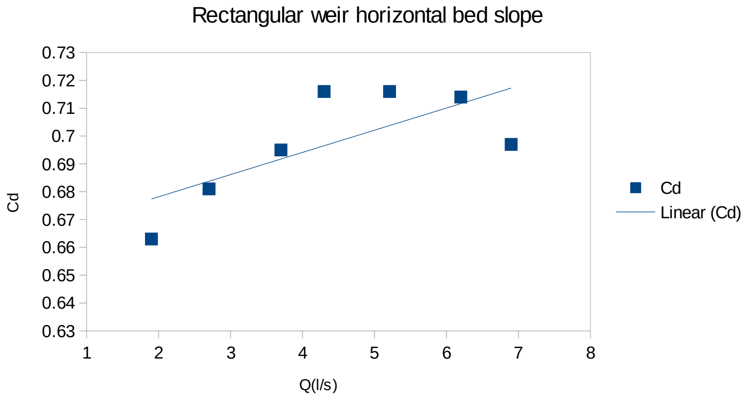

Fig3.2-Discharge-coefficient of discharge curve for Rectangular weir

Table 3.2:Discharge, head, coefficient of discharge of Rectangular Sharp Crested Weir with slope of 1 in 400

Up stream depth (mm)	Head with crest height (mm)	Head over weir (mm)	Flow rate (l/s)	Coefficient of discharge (cd)
130	124	49	2.5	0.705
140	135	60	3.2	0.71
150	145	70	3.9	0.72
160	150.3	75.3	4.4	0.723
170	163.8	88.8	5.5	0.71
180	175	100	6.4	0.686
190	181.9	106.9	7	0.718

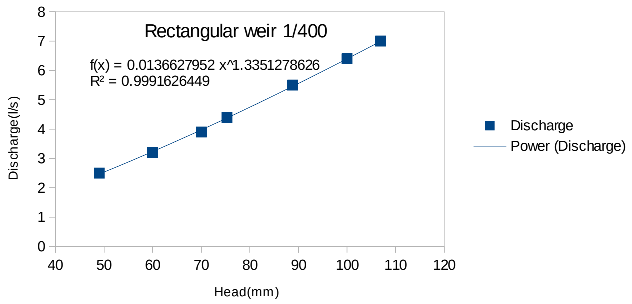

Fig 3.3-Discharge-Head curve for Rectangular weir

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International Journal of AdvancedResearch in Science, Engineering and Technology
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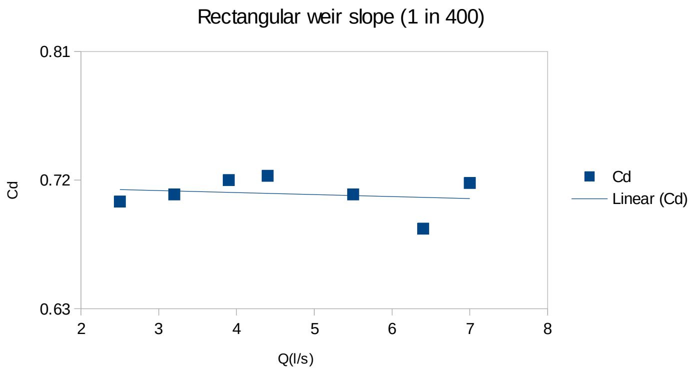

Fig 3.4: **Discharge-coeffcient of discharge of a rectangular sharp crested weirs**

Till now we have conducted for rectangular weir with different bed slope conditions, in the same manner we have performed for the triangular, trapezoidal, sutro weirs. In our experimental study, we have calculated coefficient of discharge for different bed slope conditions i.e horizontal and 1 in 400.and we have observed that the coefficient discharge is got almost same for these bed slope conditions for a particular a sharp crested weirs.

VI: CONCLUSION

Sharp crested weirs is one of the flow measuring tools which are usually used in irrigation and drainage channels. The most essential parameter of discharge equation of this type of weirs is the discharge coefficient. In our study we got average cd values for rectangular, triangular, trapezoidal and sutro weir is 0.697,0.798,0.578,0.598 respectively. Why cd value is more to triangular weir because small contact area so that low frictional stress, low wall surface stress,low drag forces and low surface tension are exist. For other weirs contact area is more so that Cd value is less compare with triangular weir. From the obtained results we concluded that in the practical applications

- For low discharge with high accuracy we can use triangular sharp crested weir to measure the flow.
- For high discharge with considerable accuracy we can use rectangular sharp crested weir to measure the flow.
- For high discharge and less accuracy we can use trapezoidal and sutro sharp crested weirs to measure the flow

REFERENCES

1. Asawa G.L. (2000). " Irrigation Engineering" New Age International (P) limited, publishers. Second Edition.
2. Aydin I., Sakarya A.b., Ger A.M. (2002). "measurement of small discharges in open channels by slit weir", Journal of hydraulics Engineering, ASCE; Vol.128(2): 234-237.
3. Bagheri S., Heidarpour M., (2011). "Characteristics of flow over rectangular sharp crested side weirs"., Journal of irrigation and Drainage Engineering, ASCE; Vol.138(6):541-547.
4. Chow V.T.(2002). "Open Channel Hydraulics" Tata McGraw-Hill publication.
5. HadiArvanaghi, NavidNasehiOskue, (2013)." Sharp-Crested Weir Discharge Coefficient ",Journal of Civil Eng. Urban,3(3):87-91
6. Rahul Pandey, Dr.S.K.Mittal and Prof. M.K.Choudhary(2016). "Flow Characteristics of Sharp Crested Rectangular Weir",International Journal of Innovative Science, Engineering&Technology,Vol.3 Issue 3, March 2016.
7. Tekade.S.AandA.D.Vasudeo (2015)."Head Discharge Relationship of Thin Plated Rectangular Sharp Crested Weirs "JAFM, Vol. 9, No. 3, pp. 1231-1235, 2016.
8. RangaRaju, K. G. (2013)." Flow through open channels", Tata McGraw-Hill publications New Delhi Second Edition.
9. Subramanya, k. (2011). "Flow in Open Channels", Tata McGraw-Hill Publication, Third Edition.
10. Vatankhah, A. R. (2010). "Flow measurement using circular sharp-crested weirs", Flow measurement and Insturmentation. Vol. 21(2), 118-122.