Experiment 8

COEFFICIENT OF DISCHARGE FOR A RECTANGULAR NOTCH

INTRODUCTION:

- Discuss why there is a discrepancy between the theoretical and computed discharge values
- What are the limitations of the experiment?
- How does the C_d value computed from the slope?

The reliability of weir measurements is affected by construction and installation, but when properly constructed and installed, weirs are one of the simplest and most accurate methods of measuring water flow. In fact, hydrologists and engineers treat this as a simple method of measuring the rate of fluid flow in small to medium-sized streams, or in industrial discharge locations.

There are different types of weir. It may be a simple metal plate with a V-notch cut into it, or it may be a concrete and steel structure across the bed of a river. Common weir constructions are the rectangular weir and the triangular or v-notch weir.

OBJECTIVE:

- To determine the 'Coefficient of Discharge' for a rectangular weir.

APPARATUS:

- The F1-10 Hydraulics Bench
- The F1-13 Stilling baffle
- The F1-13 Rectangular
- Vernier Height Gauge
- Stop Watch
- Spirit Level

THEORY:

The objective of this experiment is to study the relation between the discharge coefficient and the parameters influencing the flow. Rectangular shape opening weir is used in this experiment. Stilling baffle is used to ensure minimum turbulence. It will act as a reservoir to collect water volume and slowly disperse in the water from the opening at the bottom of the stilling baffle.

Rectangular Weir is used in practiced to measure a small free flow. A rectangular notch is a thin square edged weir plate installed in a weir channel as shown in figure below. The rectangular weir is able to measure higher flows than the v-notch weir and over a wider operating range.
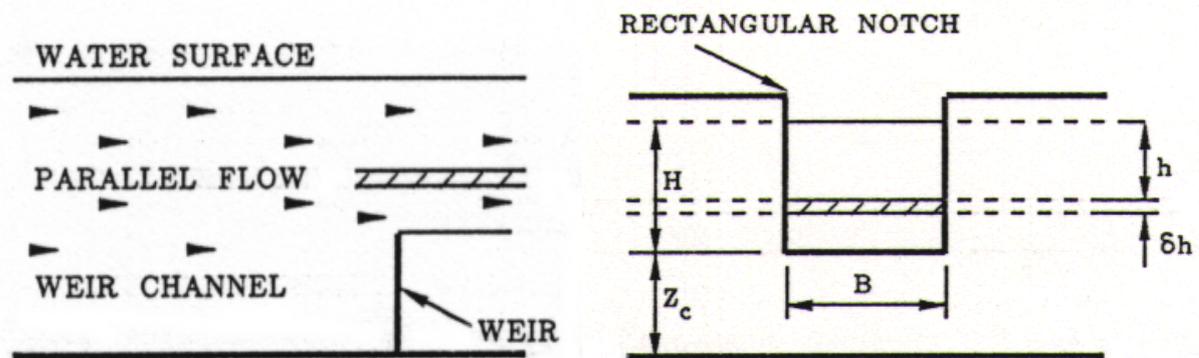
Figure 1: Rectangular Notch

Consider the flow in an element of height δh at a depth h below the surface. Assuming that the flow is everywhere normal to the plane of the weir and that the free surface remains horizontal up to the plane of the weir, then velocity through element $\sqrt{2gh}$

$\therefore$ Theoretical discharge through element

$$dQ = v.\,dA = \sqrt{2gh}.\,b.\,dh$$

Integrating between h = 0 and h = H,

Total theoretical discharge

$$Q_{th} = \int_0^H \sqrt{2gh}. \, B. \, dh = B\sqrt{2g} \int_0^H h^{\frac{1}{2}}. \, dh$$

So,

$$Q_{th} = \frac{2}{3}B\sqrt{2g}H^{\frac{3}{2}}$$

Where, C_d = Coefficient discharge

B   = Width of notch

H   = Head above bottom of notch

Q   = Flow rate

In practice the flow through the notch will not be parallel and therefore will not be normal to the plane of the weir. The free surface is not horizontal and viscosity and surface tension will have an effect. There will be a considerable change in the shape of the nappe as it passes through the notch with curvature of the stream lines in both vertical and horizontal planes in particular the width of the nappe is reduced by the contractions at each end.

$$Q_{act} = \ C_d Q_{th} = \ C_d \ \frac{2}{3} \ B \ \sqrt{2g} \ H^{3/2}$$

PROCEDURE:

1. Weir apparatus was leveled on the hydraulic bench and the rectangular notch weir was installed.

2. Hydraulic bench flow control valve was opened slowly to admit water to the channel until the water discharges over the weir plate. The water level was ensured even with the crest of the weir.

3. The flow control valve was closed and the water level was allowed to stabilize.

4. Vernier Gauge was set to a datum reading using the top of the hook. The gauge was positioned about half way between the notch plate and stilling baffle.

5. Then, water was admitted to the channel. The water flow was adjusted by using the hydraulic bench flow control valve to obtain heads (H).

6. Water flow condition was left to stabilize, head readings were taken in every increasing of 1 cm.

7. Step 4 and 5 were repeated for different flow rate.

8. The readings of volume and time using the volumetric tank were taken to determine the flow rate. The volume taken was constant which 3L.

9. The results were recorded in the tables.

TABLE OF OBSERVATIONS AND CALCULATIONS:

V(L)	H (m)	Time (s)			Average Time (s)	Q (m³/s)
		T_1	T_2	T_3		

GRAPHICAL RELATIONSHIP:

- Plot Q_{act} against $H^{3/2}$ and determine the slope of the graph. Then the coefficient of discharge C_d can then be calculated.

CONCLUSION AND RECOMMENDATIONS:

- Discuss why there is a discrepancy between the theoretical and computed discharge values

- What are the limitations of the experiment?

- How does the C_d value computed from the slope?