FLOW OVER A SHARP-CRESTED RECTANGULAR WEIR

1. Theory

A weir is a barrier across the width of a river or stream that alters the characteristics of the flow and usually results in a change in the height of the water level. Several types of weirs are designed for application in natural channels and laboratory flumes.

There are many types of weirs depending upon their shape, nature of discharge, width of crest and nature of crest

i. According to the shape:

- Rectangular weir
- Triangular weir
- Trapezoidal weir

ii. According to the nature of discharge :

- Ordinary weir
- Submerged or drowned weir

iii. According to the nature of crest:

- Narrow crested weir
- Sharp crested weir
- Broad crested weir
- Ogee weir

Ventilation of Weirs

It has been observed that whenever water is flowing over a rectangular weir, having no end contractions, the nappe (i.e., the sheet of water flowing over the weir) touches the side walls of the channel. After flowing over the weir, the nappe falls away from the weir, thus creating a space beneath the water as shown in fig-1. In such a case, some air is trapped beneath the weir.

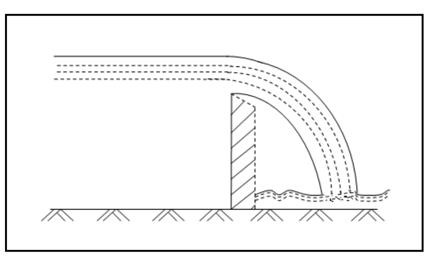


Fig 1.Ventilation of Rectangular Weirs

This air is carried away by the flowing water, which results in creating a negative pressure beneath the nappe. The negative pressure drags the lower side of the nappe towards the surface of the weir wall. This results in more discharge than the normal discharge. In order the keep the atmospheric pressure in the space below the nappe holes are made through the channel walls which are connected through the pipes to the atmosphere as shown in figure. Such holes are called 'Ventilation' of a weir.

Let us consider a small horizontal strip of thickness *dh* under a head h of the sharp-crested weir shown in the figure below. Let H be the working head and B is the width of the weir.

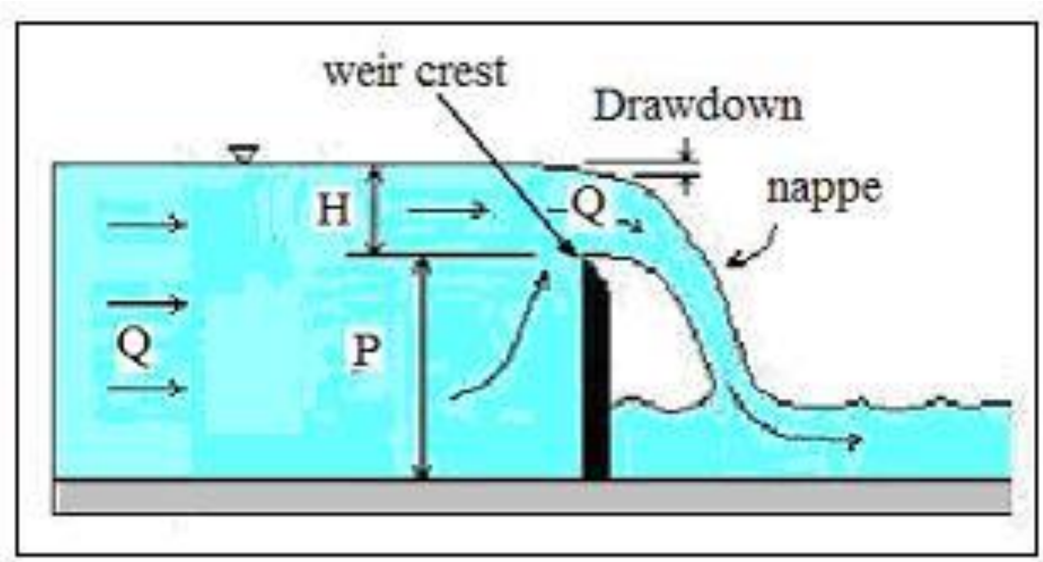


Fig.1. Flow Over a Sharp-Crested weir

Therefore, the theoretical discharge through the strip

$$dQ_t = Bdh * \sqrt{(2gh)}$$

The total theoretical discharge over the weir is given by

$$Q_t = \frac{2}{3}\sqrt{2g}\, BH^{3/2}$$
$$= KH^{3/2}$$

Where,

$$K = \frac{2}{3}\sqrt{2g}\,B$$

Let Q_a be the actual discharge, then the coefficient of discharge, C_d is given by

$$Q_a = K C_d H^{3/2}$$

2. Application

Weirs are commonly used to measure or regulate flow in rivers, streams, irrigation canals, etc. Installing a weir in an open channel system causes critical depth to form over the weir, a weir can be designed as a flow-measuring device. Weirs are also built to raise the water level in a channel to divert the flow to irrigation systems that are located at higher elevations.

3. Objective

i. To observe the nappe for ventilated and non-ventilated conditions.
ii. To find C_d for for ventilated and non-ventilated conditions.
iii. To plot Q_a vs. H in a plain graph paper for ventilated and non-ventilated conditions.
iv. To plot Q_a vs. Q_{th} in a plain graph paper for ventilated and non-ventilated conditions.
v. To plot Q_a vs. H in a log-log graph paper and to find
   (1) The exponent of H and
   (2) *Cd*

4. Apparatus

i Rectangular weir
ii Constant steady water supply
iii Approach channel
iv Flow rate measuring facility
v Point gauge

5. Procedure

i. Measure the dimension of the weir and set up the weir plate with sharp edge on the upstream side at end side of the approach channel in a vertical plane,

ii. Allow water to the channel so that water flows over the weir and wait until water surface comes to a steady condition and ventilate the nappe with a pipe.

iii. Check again whether the nappe is ventilated or not after setting elevation as zero with reference to the bottom of the channel. If not, ventilate it.

iv. Take the gauge reading on the water surface 4 to 6ft upstream of the weir and take the discharge reading from the flow meter.

6. Observation Sheet

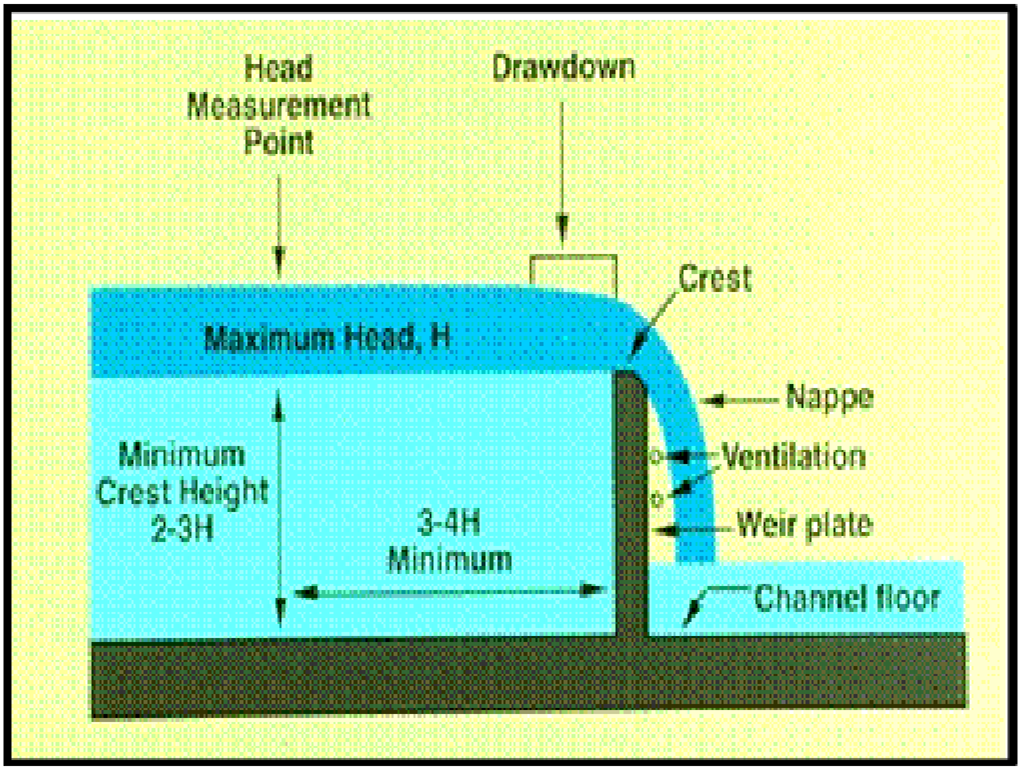
Width of the weir, B = 2.7 cm

7. Calculation sheet

Obs. No.	Actual discharge	Ventilated Condition			Non-Ventilated Condition		
	Qa (cm3/sec)	H (cm)	Qt (cm3/sec)	C_d	H (cm)	Qt (cm3/sec)	C_d
1	500	2.70			2.35		
2	600	3.10			2.65		
3	700	3.30			2.90		
4	800	3.60			3.10		
5	900	3.90			3.40		
6	1000	4.10			3.70		
7	1100	4.60			3.90		
8	1200	4.80			4.20		
9	1300	4.90			4.40		
10	1400	5.40			4.70		
Ave.							

8. Assignments

i. What is difference between Notch and Weir?
ii. Discuss the effects of ventilation on the flow over the weir.


Head
Measurement
Point
Drawdown
Crest
Maximum Head, H
Nappe
Minimum
Crest Height
2-3H
Ventilation
3-4H
Minimum
Weir plate
Channel floor