DEPARTMENT OF ENVIRONMENTAL, WATER RESOURCES, AND COASTAL ENGINEERING

MILITARY INSTITUTE OF SCIENCE AND TECHNOLOGY

FLUID MECHANICS SESSIONAL

EWCE 262

Experiment No. 5

FLOW OVER A SHARP-CRESTED RECTANGULAR WEIR

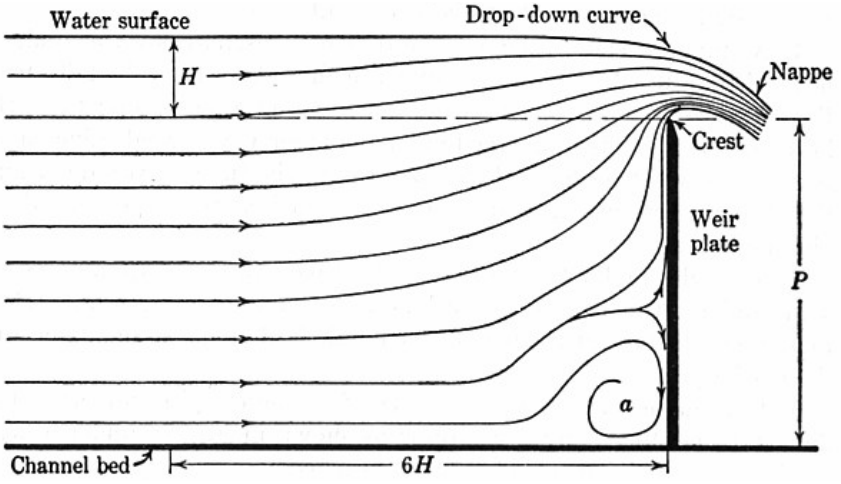
5.1General

A weir is an overflow structure built across an open channel for the purpose of measuring the flow. Weirs are commonly used to measure flow of water, but their use in measurement of other liquids is increasing.

Classified with reference to the shape of the opening through which the liquid flows, weirs may be rectangular, triangular, trapezoidal, circular, parabolic or of any other regular form. The first three forms are most commonly used for measurement of water. Classified with reference to the form of crest (the edge or the top surface with which liquid comes in contact) weirs may be sharp-crested or broad-crested.

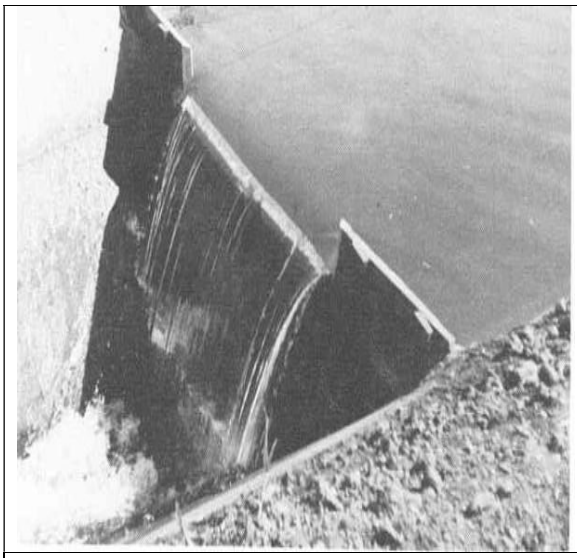
The sharp-crested rectangular weir has a sharp upstream edge so formed that the liquid in passing touches only a line.

The overfalling stream is termed as ‘ nappe’. The nappe of a sharp crested weir as shown in fig is contracted at its under side by the action of the vertical components of the velocity just upstream from the weir. This is called crest contraction. If the sides of the opening also have sharp upstream edge so that the nappe is contracted in width, the weir is said to have end contractions and is usually called a contracted weir.



5.2 Practical application

Shallow rivers are often made navigable by building dams across the river at certain sections over which the water may flow. During a drought little or no water will flow past the dam, but after heavy rains the water flows over the dam, thus converting it into a weir. Also flow through canal is measured by weirs.

	
SHARP-CRESTED RECTANGULAR WEIR	**Haughton Dale Weir**

5.3 Theory

The relationship between discharge and head over the weir can be developed by making the flowing assumptions as to the flow behavior:

1. Upstream of the weir, the flow is uniform and the pressure varies with depth according to the hydrostatic equation $P = \gamma gh$.
2. The free surface remains horizontal as far as the plane of the weir, and all particles passing over the weir move horizontally. (In fact, the free surface drops as it approaches the weir).
3. The pressure throughout the sheet of liquid or nappe, which passes over the crest of the weir, is atmospheric.
4. The effects of viscosity and surface tension are negligible.
5. The upstream approach velocity head is neglected.

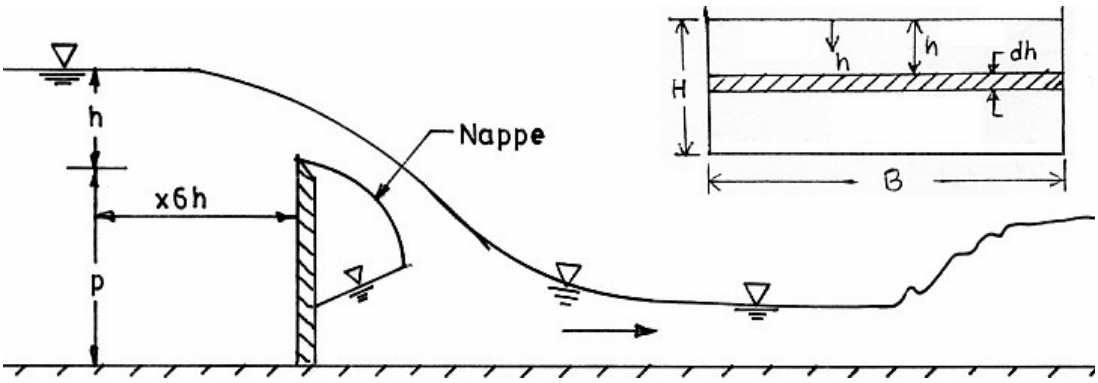


Fig. 2 Flow Over a Sharp-Crested Weir

Now consider the sharp-crested weir in the figure. Let H be the working head and B is the length of the weir.

Let us consider a small horizontal string of thickness dh under a head h. The strip can be considered as an orifice.

Therefore, the theoretical discharge through the strip

dQ_t = area of the strip x velocity (1)

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

Integrating between the limits 0 and H, the total theoretical discharge over the weir is given by

$$Q_t = \frac{2}{3}\sqrt{2g}\ BH^{3/2} \quad (3)$$

Let Q_a be the actual discharge. Then the co-efficient of discharge, C_d, is given by

$$C_d = \frac{Q_a}{Q_t} \quad (4)$$

Therefore,

$$Q_a = \frac{2}{3}C_d\sqrt{2g}\ BH^{3/2} \quad (5)$$

$$= KC_d H^{3/2} \quad (6)$$

where,

$$K = \frac{2}{3}\sqrt{2g}B \quad (7)$$

For a contracted weir, B is equation (5) should be replaced by effective length ($B^{/}$) which is given by

$B^{/} = B - 0.1\ nH$

where n is the number of end contraction.

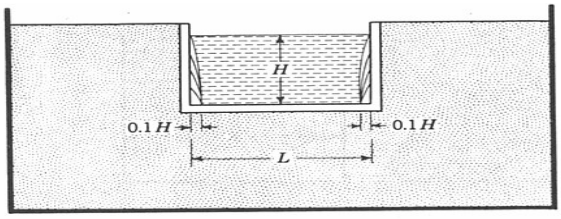


Fig 3 Weir with end contraction

5.4Objectives

1. To find Q_d for the weir
2. To plot Q_a vs. H in a plain graph paper
3. To plot Q_a vs. H in a log-log graph paper and to find (1) the exponent of H and (2) C_d.

5.5Scope

Sharp crested rectangular weirs used for discharge measurement purposes in open channel hydraulics are investigated experimentally. A series of experiments were conducted by measuring discharge and head over the weir for different weir heights for full width weir. It is seen that after a certain weir height, head and discharge relation does not change. Hence a constant weir height is determined. For that height; discharge and head over the weir are measured for variable weir width, starting from the full width weir to slit weir. Description of the discharge coefficient valid for the full range of weir widths and an empirical expression involving dimensionless flow variables is aimed. Experimental data obtained for this purpose and the results of the regression analysis performed are represented.

5.6 Procedure

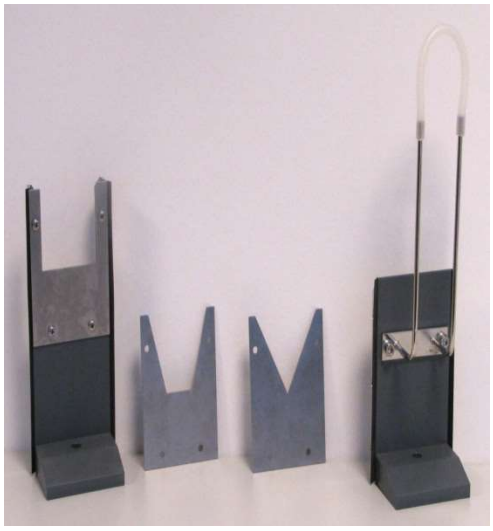
1. -1. Measure the height and length of the weir. Position the weir plate at end side of the approach channel, in a vertical plane, with sharp edge on the upstream side.
2. Allow water to the channel so that water flows over the weir and wait until water surface comes to a steady condition.
3. Set an elevation of zero of the point gauge with reference to the bottom of the channel.
   Carefully set the point gauge on the water surface 4 to 6ft upstream of the weir and take the gauge reading. The water surface may be slightly fluctuating.
4. Take the discharge reading from the flow meter.

5.7. Apparatus

Flow channel, rectangular weir etc.



Flow channel


rectangular weir

Experiment No. 5

FLOW OVER A SHARP-CRESTED WEIR

Experimental Data Sheet

Width of the weir, B = _____

Difference in water level, H = _____

Group No	Actual discharge Q_a	Head,H	Theoretical discharge Q_t	Co-eff. of discharge C_d
1				
2				
3				
4				
5				
6				

Level / Term : **Dept. :**
Reg No. : **Section:**
Group No. : **Date :**

_____
Signature of the Teacher

5.9 Calculation from graph

5.10 Discussion

What are the possible experimental errors?

How did you ventilate the nappe?

Comment on results and nature of the graphs.

5.11 Practice Questions

1. What are the assumptions made in deriving this equation? What is the extent of their validity?

2. Why the pressure distribution over the weir-crest is less than hydrostatic?

3. Why it is necessary to ventilate the space below the nappe ?

4. Discuss the effects of lateral contraction, in case of contracted weir, on the flow over the weir

5. A rectangular sharp crested weir 3.0 ft high extends across a rectangular channel, which is 8.0 ft wide. When the head is 1.20 ft, find the rate of discharge by neglecting the velocity of approach.