FLUID MECHANICS AND HYDRAULICS

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Flow Over Weirs

Weir

A structure, used to dam up a stream or river, over which the water flows, is called a weir. The conditions of flow, in the case of a weir, are practically the same as those of a rectangular notch. That is why, a notch is, sometimes, called as a weir and *vice versa*.

Difference between weir and Notch

The only difference between a notch and a weir is that the notch is of a small size and the weir is of a bigger one. Moreover, a notch is usually made in a plate, whereas a weir is usually made of masonry or concrete.

Types of weirs

There are many types of weirs depending upon their shape, nature of discharge, width of crest and nature of crest. But the following are important from the subject point of view :

1. *According to the shape :*
   (*a*) Rectangular weir, and
   (*b*) Cippoletti weir.
2. *According to the nature of discharge* :
   (*a*) Ordinary weir, and
   (*b*) Submerged or drowned weir.
3. *According to the width of crest :*
   (*a*) Narrow-crested weir, and
   (*b*) Broad-crested weir.
4. *According to the nature of crest :*
   (*a*) Sharp-crested weir, and
   (*b*) Ogee weir.

Discharge over a rectangular Weir

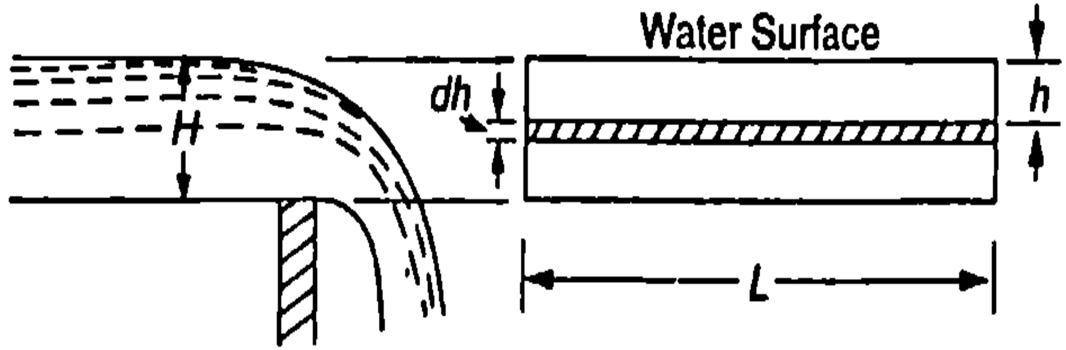

Fig. 12·1. Rectangular weir.

Consider a rectangular weir over which the water is flowing as shown in Fig. 12·1.

Let H = Height of the water above the crest of the weir,

L = Length of the weir, and

C_d = Coefficient of discharge.

Let us consider a horizontal strip of water of thickness dh at a depth h from the water surface as shown in Fig. 12·1.

$\therefore$ Area of strip $= L.dh$ . . .(*i*)

We know that the theoretical velocity of water through the strip

$$= \sqrt{2gh} \quad \ldots(ii)$$

$\therefore$ Discharge through the strip,

$$dq = C_d \times \text{Area of strip} \times \text{Theoretical velocity}$$

$$= C_d \,.\, L.\, dh\, \sqrt{2gh} \quad \ldots(iii)$$

The total discharge, over the weir, may be found out by integrating the above equation within the limits 0 and H.

$$\therefore \qquad Q = \int_0^H C_d\, L.dh \sqrt{2gh}$$

$$= C_d . L \sqrt{2g} \int_0^H h^{1/2}\, dh$$

$$= C_d . L \sqrt{2g} \left[\frac{h^{3/2}}{\frac{3}{2}} \right]_0^H$$

$$= \frac{2}{3} \times C_d . L \sqrt{2g} \left[h^{3/2} \right]_0^H$$

$$= \frac{2}{3} \times C_d . L \sqrt{2g} \times H^{3/2}$$

Note : Sometimes, the limits of integration, in the above equation, are from H_1 to H_2 (*i.e.*, the liquid level is at a height of H_1 above the top of the weir and H_2 above the bottom of the weir) instead of 0 and H. Then the discharge over such a weir will be given by the equation :

$$Q = \frac{2}{3} \times C_d . L\sqrt{2g} \left(H_2^{3/2} - H_1^{3/2}\right).$$

Example 12·1. *A rectangular weir of 4·5 metres long has a 300 mm head of water. Determine the discharge over the weir, if coefficient of discharge is 0·6.*

Solution. Given : $L = 4{\cdot}5$ m; $H = 300$ mm $= 0{\cdot}3$ m and $C_d = 0{\cdot}6$.

We know that the discharge over the weir,

$$Q = \frac{2}{3} \times C_d . L\sqrt{2g} \times H^{3/2}.$$

$$= \frac{2}{3} \times 0{\cdot}6 \times 4{\cdot}5 \sqrt{2 \times 9{\cdot}81} \times (0{\cdot}3)^{3/2} \text{ m}^3/\text{s}$$

$$= 7{\cdot}972 \times 0{\cdot}164 = 1{\cdot}31 \text{ m}^3/\text{s} = 1310 \text{ litres/s}$$ **Ans.**

Example 12·2. *A weir of 8 m long is to be built across a rectangular channel to discharge a flow of 9 m³/s. If the maximum depth of water on the upstream side of the weir is to be 2 m, what should be the height of the weir ? Adopt $C_d = 0{\cdot}62$.*

Solution. Given : $L = 8$ m; $Q \div 9$ m³/s; Depth of water = 2 m and $C_d = 0{\cdot}62$.

Let $\qquad H$ = Height of water above the sill of the weir.

We know that the discharge over the weir (Q),

$$9 = \frac{2}{3} \times C_d . L\sqrt{2g}\ H^{3/2}$$

$$= \frac{2}{3} \times 0{\cdot}62 \times 8\sqrt{2 \times 9{\cdot}81} \times H^{5/2} = 14{\cdot}65\, H^{5/2}$$

$$H^{3/2} = 9/14{\cdot}65 = 0{\cdot}614 \quad \text{or} \quad H = 0{\cdot}72 \text{ m}$$

Therefore height of weir should be 2·0 – 0·72 = 1·28 m **Ans.**