College of Agriculture Engineering Sciences

Soil and Water Dept. (Principle of Irrigation)

3rd stage Lecture (4)

Water Discharge Measurement

2022-2023

What is discharge?

The discharge is the volume of water that is transported each time, and the volumes are expressed in liters (L) or in cubic meters (m^3) [1 m^3 = 1000 L].

and the letter **Q** is commonly used as the symbol for the discharge.

Why do we measurement of water discharge?

- Amount of water delivered to the field.
- To apply the best design for the irrigation system.
- To know the area you should be planting.
- To control the water velocity.

Measuring discharge in open channels (weirs)

Weirs allow hydrologists and engineers a simple method of measuring the water discharge in small to medium-sized streams/rivers or in industrial discharge locations such as furrow channels.

Main Types of Weirs

1. Sharp-Crested

a. Rectangular

b. Triangular

c. Trapezoidal

2. Broad-Crested

a. Rectangular

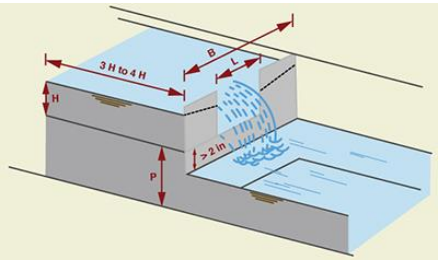
Sharp-Crested Weir Rectangular/Suppressed Discharge

Rectangular and suppressed weirs have the same general discharge equation (below), but differing weir lengths that the water flows over

$$\boldsymbol{Q = \frac{2}{3} C_D \sqrt{2g}\ BH^{\frac{3}{2}}}$$

Where:

- Q= is the volumetric flow rate over the weir or Discharge (m^3/s)
- $\boldsymbol{C_D}$ =is the discharge coefficient usually ranging from 0.60 to 0.62
- H= is the head over the weir (m)
- B= is the width of the contracted notch (rectangular), or the width of the channel (suppressed) (m)
- g= is the acceleration of gravity (9.81 m/s^2)



Example 1:

A rectangular is the width of the contracted notch weir of 0.95 meters long discharging water under a constant head of 400 mm. Find discharge over the weir in liters/s. Assume the coefficient of the discharge as 0.61.

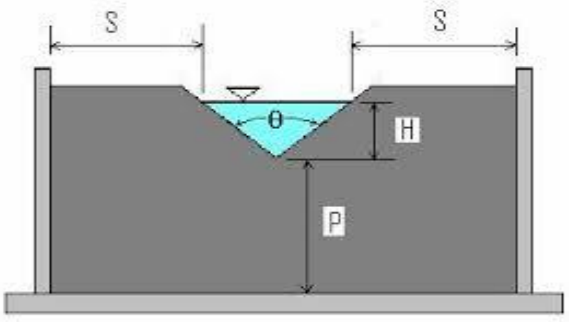
Sharp-Crested Weir V-Notch (Triangular)

- Used in cases of small discharge
- Best weir to measure discharge in an open channel
- Highest accuracy when measuring flow rate (usually +/-2%)

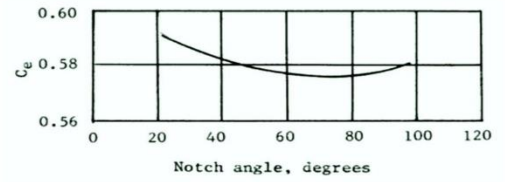
Calculating discharge across a V-Notch weir is more complicated:

$$\boldsymbol{Q = \frac{8}{15} Ce \sqrt{2g}\, tan\left(\frac{\theta}{2}\right) H^{\frac{5}{2}}}$$

Where:



- Q= is discharge or flow over V-Notch weir (m^3/s)
- Ce= can be found using the graphs
- H=is the head flowing through the notch
- θ =(degrees) is the notch angle
- g= is the acceleration of gravity (9.81 m/s^2)

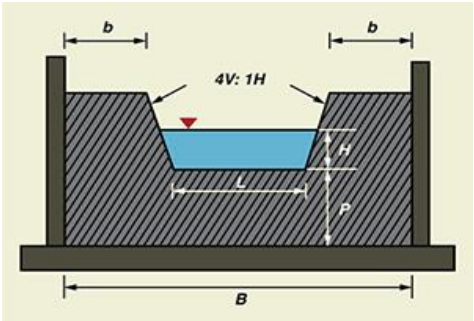


Example 2:

A V-notch weir with 90^0 angle of water under a constant head of 53 cm. calculate the water discharge over the weir in the m^3/s. Assumethe coefficient of discharge as (Ce) is 0.55.

Sharp-Crested Weir (Trapezoidal)

- These weirs are trapezoidal shaped with notch side slopes of 4:1 (vertical:horizontal)
- Combination of a rectangular and triangular weir
- These weirs are commonly used for irrigation
- Used when discharge is too great for a rectangular weir



Discharge for a trapezoidal Weir is calculated as follows:

$$\boldsymbol{Q = \frac{2}{3} C_D \sqrt{2g}\, LH^{\frac{3}{2}}}$$

- Q= is the volumetric flow rate over the weir or Discharge (m^3/s)
- H= is the head over the weir (m)
- L= is the width of the contracted notch (Trapezoidal) (m). Also, L = $\frac{L1+L2}{2}$

Example 3: Calculate the discharge by (m^3/s) in a channel when we use a trapezoidal weir if you know the width of the contracted notch below is equal to 0.4 m and in a surface is 0.6 m and the head of water over the weir is 32 cm.

2- Broad-Crested Weir Discharge

Flow over a broad-crested weir is highly dependent on the weir's geometry.

Simply discharge can be calculated as follows

$$Q = C\ L\ H^n$$

Where:

Q = Volumetric flow rate

C = Constant for the specific weir structure

L = Width of the weir

H = Height of water head upstream in relation to the weir's crest

n = structure variant (usually 3/2 for a horizontal weir) The equation above can also be used for sharp-crested weirs if the design constants are known.