College of Agriculture Engineering Sciences

Soil and Water Dept. (Principle of Irrigation)

3rd stage Lecture (5)

2023-2024

What is Canal Irrigation

An irrigation canal is an artificial canal that is the main waterway that brings irrigation water from a water source such as a lake, river, or stream, to the area to be irrigated.

They can be lined with concrete, brick, stone, or a flexible membrane to prevent seepage and erosion

While measuring the discharge of a river or canal, one has to measure:

1) **The average velocity of flow**
2) **The area of cross-section and**

The method consists of estimating the average flow velocity (V), and measuring the area of the cross-section, called the 'wetted cross-section' (A). The discharge (Q) can be calculated by the following formula:

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$$Q = V * A$$

Where: Q is the Discharge in $\boldsymbol{m^3/s}$, V is the Average Flow Velocity in m/s, and A is the area in $\boldsymbol{m^2}$ of the Wetted area of the Cross-section.

1) **The Average Velocity of Flow**

METHODS OF MEASURING THE AVERAGE VELOCITY OF FLOW

1.1. Surface floats
1.2. Current meter
1.3. Double floats
1.4. Velocity rods

1.1. Surface floats

This method is used as a quick and easy way to estimate water discharge in a canal. However, this method is not very accurate and errors of at least 10% can be expected.

To estimate the average flow velocity, the flow velocity of the water at the surface, the surface velocity, Vs, is first determined.

The surface velocity is determined by measuring the time it takes for a floating object, such as a stick or bottle, to travel through a previously measured distance.

Average flow velocity

To measure the surface velocity, Vs, the selected length, L, is divided by the travel time, t:

where:

$$Vs = L / t$$

Vs= is the Surface Velocity (m/s)

L= is the distance in meters between points A and B

t= is the Travel time in seconds between points A and B

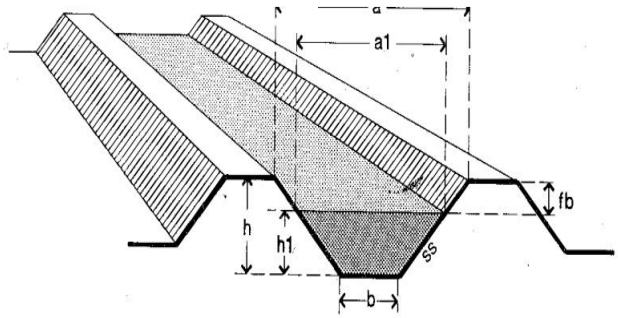
For most irrigation canals this reduction factor is about 0.75 The average velocity is therefore found from:

$$V = 0.75 * Vs$$

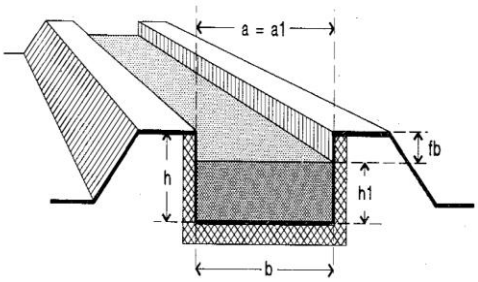
2) Area of the wetted cross-section

Various shapes and sizes of canals can be used to transport the water discharge, but the most commonly used shape is a trapezoidal cross-section. However, rectangular and circular shapes are also used for lined canals.

Trapezoidal canal



Rectangular canal



Calculating the area of the wetted cross-section

For trapezoidal canals, the equation is as follows

$$\boldsymbol{A = \frac{(b+a_1)}{2}\ h_1}$$

where:

A= is area of wetted cross-section (m^2), b= is bed width (m)

$\boldsymbol{a_1}$ = is surface water width (m), $\boldsymbol{h_1}$ = is head of water (m).

For rectangular canals the equation is as follows

$$\boldsymbol{A = a_1 * h_1}$$

Calculating the area of the wetted cross-section irregular shapes

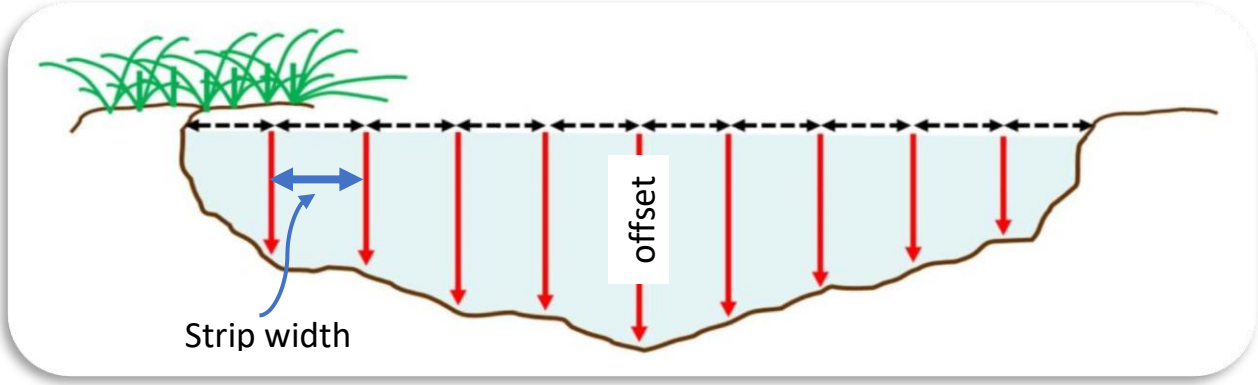
if the shape of the canal are not geometric but they have irregular shapes we have two formula to calculate the wetted cross-section area:

1- **Trapezoidal Rule:**

$$A = strip\ width\left[\left(\frac{1^{st} offset + last\ offset}{2}\right) + \sum other\ offsets\right]$$

2- **Simpson's Rule:**

$$A = \frac{1}{3} strip\ width \left[(1^{st} offset + last\ offset) + 2(\sum odd\ offsets) + 4(\sum even\ offsets) \right]$$



Procedure Measurement Discharge

Equipment:-

1. Measuring tape at least 5 meters long.
2. 4 Stakes.
3. Stopwatch or watch capable of measuring time in seconds.
4. Floating objects such as a bottle or coconut.

Step 1 Select a straight section of the canal at least 10 meters long.

Step 2 Place two stakes, one on each side, at the upstream end of the selected portion of the canal.

Step 3 Measure 10 meters or more along the canal.

Step 4 Place the floating object on the center line of the canal at least 5 m upstream of point A, and start the stopwatch when the object reaches point A.

Step 5 Stop the stopwatch when the floating object reaches point B, and record the time in seconds.

Step 6 Repeat steps 4 and 5 at least four times in order to determine the average time necessary for the object to travel from point A to point B.

Step 7 Measure the following in the selected canal section:

- the canal bed width, b

- the surface water width, a1
- the water depth, h1

Step 8 Calculate the surface velocity, Vs , and then the average flow velocity, V, using the equations

Vs = L / t

Step 9 Calculate the wetted area of cross-section A, using the formula from

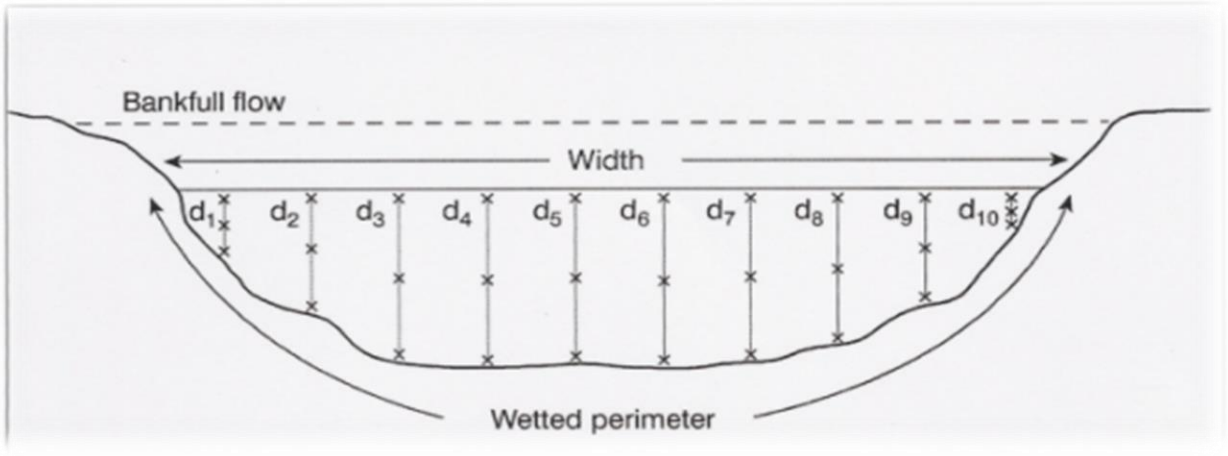
$$\boldsymbol{A = \frac{(b + a_1)}{2}\, h_1}$$

Step 10 Calculate the discharge, Q, in the canal, using the formula from

Q = V A

Example: A straight and uniform portion of a trapezoidal canal was selected. Within this portion a length of 20 m, the average time recorded 58 seconds travel from A to B and the width of base canal equal to 43cm however surface width is 94cm, also the head of water is 0.30m calculate the discharge of this channel by L/s.

Calculate the discharge of those channels if the floating object needs to 52-second travel for 20 meters and use the data on the graphic for calculating the cross-section area:



Calculate the discharge of those channels if the floating object needs to 59-second travel for 35 meters and use the data on the graphic for calculating the cross-section area: