

College of Agriculture Engineering Sciences
Soil and Water Dept. (Principle of Irrigation)
3rd stage Lecture (5)
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What is Canal Irrigation

An irrigation canal is an artificial channel 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 m^3/s , V is the Average Flow Velocity in m/s, and A is the area in 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, V_s , 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, V_s , the selected length, L , is divided by the travel time, t :

where:

$$V_s = L / t$$

V_s = 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

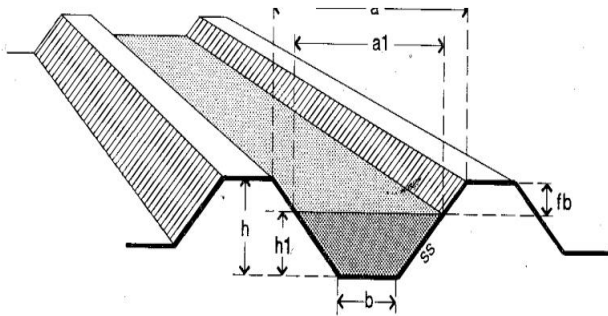
For most irrigation canals this reduction factor is about 0.75 The average velocity is therefore found from:

$$V = 0.75 * V_s$$

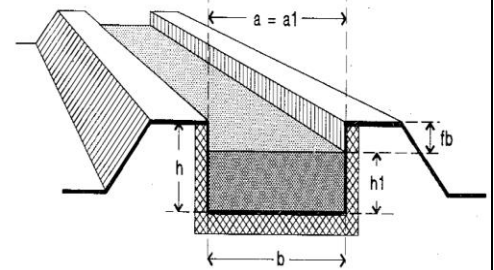
2) Area of the wetted cross-section

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

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

where:

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

a_1 = is surface water width (m), h_1 = is head of water (m).

For rectangular canals the equation is as follows

$$A = a_1 * h_1$$

Calculating the area of the wetted cross-section irregular shapes

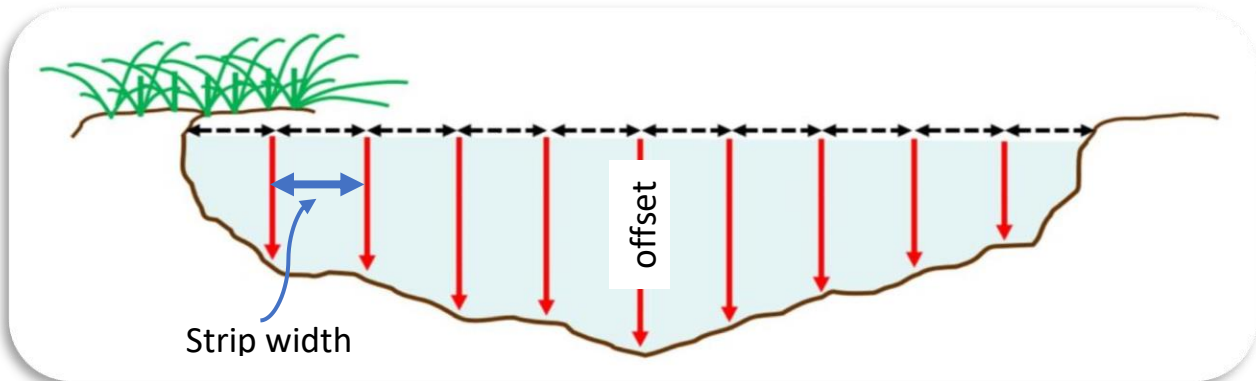
if the shape of the canal are not geometric but they have irregular shapes we have two formula to calculate the wetted cross-section area:

1- Trapezoidal Rule:

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

2- Simpson's Rule:

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



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, a_1
- the water depth, h_1

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

$$V_s = L / t$$

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

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

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.