Certificate Course on Participatory Irrigation Management (CCPIM)

Module 11- Water measurement, Water Accounting, Water Audit, and estimation of water losses.

Topic 11.2- Methods of discharge measurements

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Methods of discharge measurements

Topics of module 11

During irrigation season, a WUA needs to take flow measurements at important locations regularly. For example, a WUA needs to know that how much water is received at the head of the canal, or an outlet or water courses.

Water measurement methods

Two methods of water management are:

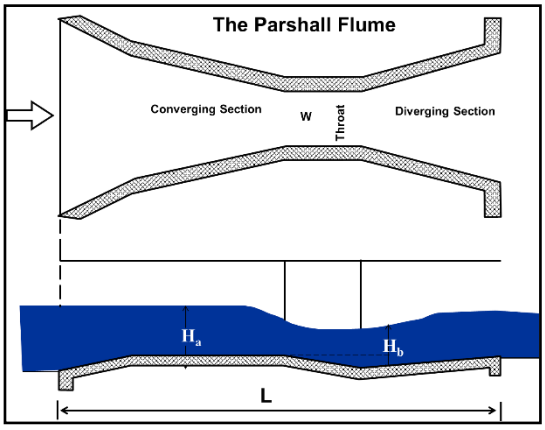
1. Direct method
2. Indirect method

Direct method:

This method of water measurement involves measuring the depth of water passing through a water measuring structure built on canal such as flume or weir or notches etc. The canal gauges painted on the banks of canal may also be included as a water measuring device under this method. Once the depth is measured, the corresponding discharge can be read on a Discharge Depth Table already calibrated for the structure/device by measuring discharges on different depths.

The use of Parshall Flume is immensely popular as a discharge measurement whose plan, longitudinal section and picture is shown below.

Picture 1– Parshall Flume on Canal: Photograph, plan, & longitudinal section



The following are the reasons for the popularity of the Parshall Flume:

1. This structure can measure accurate discharges on very low heads, that is, on canals with flatter slopes.
2. It is a self-cleaning device. It does not permit sand or silt deposition around it and functions well with sand/silt laden discharges.
3. Its discharge measurement range is quite large. The throat of the device can be as small as 7.5 cm and as large as several metres.
4. Under free flow conditions (when downstream flow is not submerged) , a single reading of water depth upstream of the Flume is sufficient to know accurate discharge.

At places where the canal slope is flat and there are no favorable conditions for construction of water measuring structures, discharge is obtained with the

help of canal gauges. This is an exceedingly popular and economical method of finding discharge.

Picture-2 - Discharge measurement from the gauge constructed on canal

At important places, a gauge is painted on a flat concrete strip or masonry column as shown in Picture-2. The zero on the gauge coincides with the bottom of the canal and readings increase towards water surface. Canal gauge reading coinciding with the water surface of canal gives the water depth at that point. A stage discharge table is already calibrated on which the discharges can be read. Although this method is most simple and inexpensive, the major drawback is that the Stage discharge table is dependent upon the cross-sectional area of the Canal which keeps changing due to silting, vegetative growth, and many other factors. So, the stage discharge curve has to be updated at regular intervals to avoid the possibility of error

In this method, wet cross section area (A) and Velocity of flow (V) in the canal are measured. The discharge (Q) of the canal is calculated from the formula:

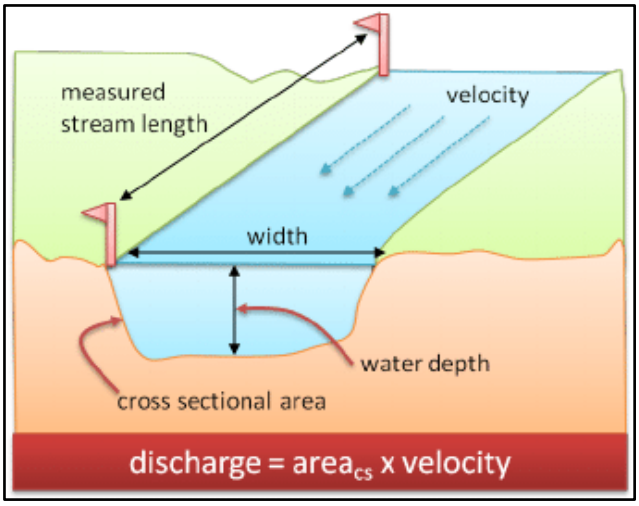
Canal discharge (Q) = velocity of flow (V) X area of wet cross section (A)

Measurement of discharge by indirect method:

In this method, wet cross section area (A) and velocity of flow (V) in the canal are measured. The discharge (Q) of the canal is calculated from the following formula:

Canal discharge (Q) = velocity of flow (V) X area of wet cross section (A)

Picture-3: Indirect method of discharge measurement

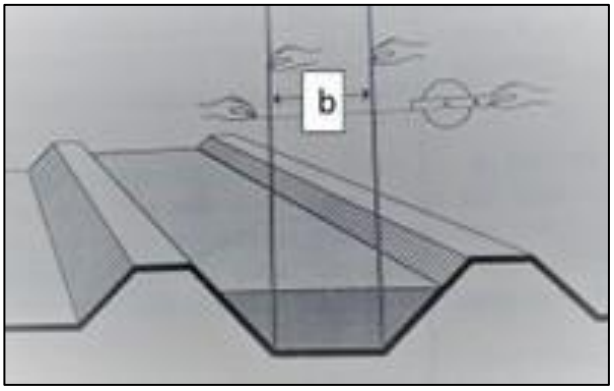


Now the method to determine the wet cross section area and velocity of flow in the canal will be described in detail.

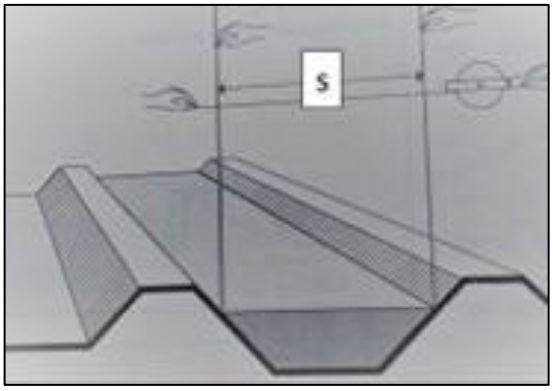
I. Measure bed width (b) of canal as shown in Picture-4 below

II. Measure surface water width (s) of canal as shown in Picture-5 below

Picture-4: Measuring bed width (b)

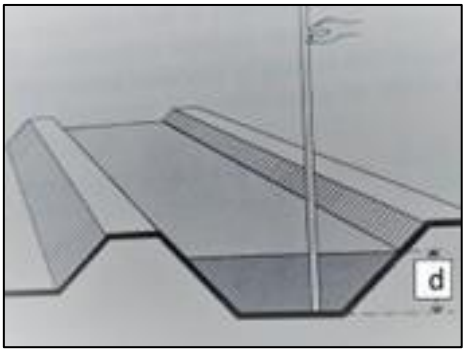


Picture-5: Measuring surface width (s)



III. Measure water depth (d) of canal as shown in Picture-6 below

Picture-6: Measuring surface width (d)



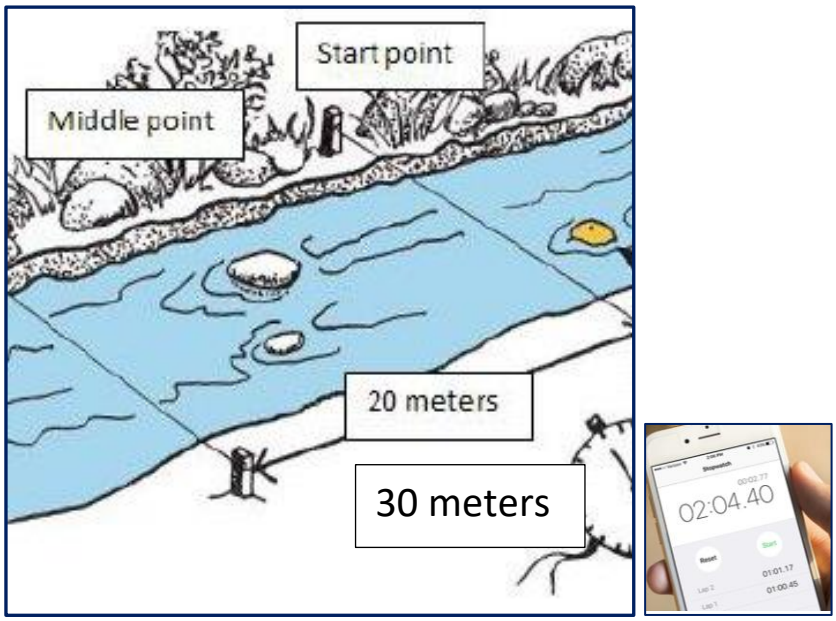
IV. Wetted cross section of the canal (A) A=((b+s)/2)*d (Add b and s. Divide by 2 to get average width and multiply average width by depth to get wetted cross-sectional area of canal)

Steps to measure flow velocity (V) and Calculate Discharge (Q)

Select a straight reach of not less than 30-meter canal length with uniform cross-sectional area

1. Take a float (piece of wood, leaf) and leave it in the stream 1 or 2 meter before the starting point.
2. Note the travel time of float in covering total distance in seconds from start to end point. Divide the distance travelled with time to get surface velocity (m/s).
3. Repeat the above experiment 3-4 times and calculate surface velocity each time. Compute average surface velocity.
4. Multiply this average surface velocity by a factor 0.8 to obtain average velocity of flow in the canal in m/s
5. Calculate the discharge (Q) by multiplying the wetted cross-sectional area (A) with velocity (V)

Picture-7: Measuring flow velocity of canal by float method



Use mobile for counting time

Exercise on canal discharge measurement

Experiment details: A straight reach of 30 meter is selected for discharge measurement in a canal.

A small plastic ball was used as a float to determine the surface velocity. This was repeated 4 times and the time recorded each time are given below:

52 seconds; 51 seconds; 53 seconds; 52 seconds

The measurements taken to calculate the wetted cross-sectional area of canal:

Bed width: 1.0 meter; Surface water width:1.3 m and Depth: 0.45 meters

Find out the Discharge of the canal.

Solution:

Step-1: Calculate the average travel time

(52+51+53+52)/4= 52 second

Step-2: Calculate the surface velocity

Distance travelled/time=30/52= 0.58 m/s

Step-3: Calculate the average flow velocity by multiplying surface velocity with 0.80

Hence average flow velocity - 0.58X0.80=0.46 m/s

Step-4: Calculate wet cross-section area A= $(1.0 + 1.3)/2$*0.45=0.52 sq meter

Step-5: Discharge (Q) is given by V X A

Hence Q=0.46*0.52=0.24m^3/sec or 240 l/sec

The canal discharge is 0.24 cumec or 240 l/sec or 8.5 cusec (1 cusec=28.3 l/sec)

Do it yourself

If the canal reach of 20 meter is selected and all other data remains the same, what will be the discharge of the Canal.