Discharge Measurement:-

Stream discharge represents the runoff phase of the hydrologic cycle. Stream discharge can be measured more accurately than other components of hydrologic cycle such as precipitation, evaporation, infiltration etc.

In this section methods of measurements of discharge are described. Methods of determining discharge can be classified as

(1) — Velocity Area Method
(2) — Measurement by Permanent structures
(3) — chemical gauging Method.

(1) Velocity Area Method:-

In these methods, certain instruments are used to observe the velocity in the stream and the discharge is calculated from the data thus obtained.

* Discharge is the product of cross-sectional area and velocity of water

$$Q = V * A$$

where; Q = discharge m^3/sec
V = Velocity / Mean flow velocity m/sec
A = Area of Cross Section of flow

This needs measurement of mean velocity of flow and the flow cross-sectional area. The channel is subdivided into sub-sections, the mean velocity and the area of flow is measured at each subsection and finally the total discharge is the sum of the discharge through these subsections.

$$Q = q_1 + q_2 + q_3 + \cdots q_i$$

where Q is total discharge and q_i is the discharge through a subsection "i" of the stream.

Finding Mean Velocity :-

The velocity in the velocity area Method can be found by

(a) Current Meter
(b) Pitot tube
(c) Floats.

(a) Current Meter :-

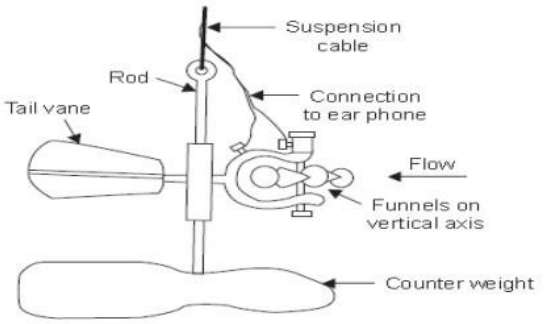
* A current meter is an instrument used to measure velocity of water in open channels or streams. One of the most commonly used current meter is the price meter. This type of current meter is used by US Geological Survey.

It consists of six conical cups rotating about a vertical axis. Electric contacts driven by the cups close a circuit through a battery and a wire of supporting cable cause a click in headphones worn by the operator for each 5 or 10 revolutions of cups.

For shallow depths wading (depth measurement by rods) is done and for measurement in deep water the meter is suspended from a cable. The meter reader is either in a boat or on a bridge. The velocity of water is given as;

$$\boxed{V = a + bN}$$

where "N" is the number of revolutions per second of cups and "a" and "b" are the coefficients for a given current meter.



Using stream gauging cable car

From Bridge

Following steps are adopted to take measurements by the current meter.

→ Measuring Depth of flow (Sounding)

* The depth is measured by a rigid rod called wading rod or by a sounding weight suspended from a cable. The cable is controlled either by a reel fixed on a pulley or by a hand line of a bridge.
* The wading rod is placed in the stream so that the base rests on the stream bed and the depth of water is read on the graduated main rod.

A Sounding weight also known as Coulomb's weight is suspended below the current meter. The weights offers minimum resistance to flowing water and have sufficient weight not to be taken away by the water.

The reading is taken when the weights just touch the water surface - These are further lowered till these touch the base of the channel - The reading of reel is taken again - the difference of these readings gives the depth of flow.

→ Methods of Measuring Average Velocity :-

There are four alternatives for current meter readings.

(i) — Single point Method
(ii) — Two point Method
(iii) — Multiple point Method
(iv) — Direct Integration Method.

(1) — Single Point Method :-

* The current meter is placed at 0.6 of depth of the stream to find mean velocity.
* This is Least time Consuming Method.
* This is done when the depth of flow is less than 1m.
* The average velocity is denoted as $V = V_{0.6d}$
* $V_{0.6d}$ represents velocity at 0.6 of depth.

(ii) — Two point Method :-

* The current meter is placed at two points.
* First the reading is taken at 0.2 of depth and then at 0.8 of the depth.
* This is more accurate than single point method.
* The average velocity is mean of the velocity at 0.2 depth and that at 0.8 depth i.e.,

$$V = (V_{0.2d} + V_{0.8d})/2$$

(iii) — Multiple Point Method :-

* Current meter is placed at different points
* Velocity at each point is measured and then mean of these velocities is taken.
* this method is accurate but very time Consuming.

(iv) Direct Integration Method :-

* this method is same as Multiple point method.
* In this method it is essential that the worker should be an experienced person.
* The current meter is lowered from the surface to the bed of stream with the uniform velocity and from bed of channel to the surface with the same velocity.
* The number of revolutions made by the propeller is recorded and divinding it by time consumed in this operation gives the mean velocity directly.

Factors for Selecting Method of Measuring velocity:-

Choice of the method to be used for measuring average velocity is governed by the following factors :-

(a) Degree of accuracy is required

(b) Time available

(c) Behavior of the stream — The behavior of flow in channel is also an important factor i-e in case of unsteady flow where the discharge is changing the measurements as that in floods etc we have to use the quickest method.

(b) Pitot tube:-

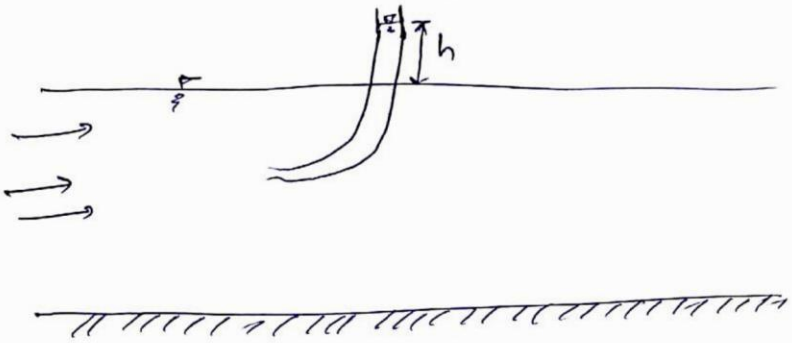
* A pitot tube can also be used for measurment of velocity in order to calculate discharge in Laboratory or very small streams.

* However the use of pitot tube may not be recommended for rivers due to following reasons:-
  - → Supporting the pitot tube is very difficult when the channel is very wide and deep.
  - → The head generated by a pitot tube in open channel is very small due to very low velocities and therefore discharge cannot be accurately measured.
  - → The use of pitot tube is recommeded for estimating discharge in labortory and small channels.

The formula for Calculating velocity is :-

$$V = (2gh)^{0.5}$$

Where "h" is water height in tube above surface of water. It is the velocity head.



(c) Floats:-

This method consists of putting a float in the channel and noting the time and distance covered by the float, the velocity will be equal to the distance traveled in a unit time.

$$V = \frac{S}{t}$$

Where "S" is distance covered by float in time "t".

A straight reach of the channel is selected where the depth is nearly uniform.