Stream Flow

- Rainfall has an effect on stream flow and hydraulics tends to measure the relationship between rainfall and stream flow.
- The aim of measuring stream flow is mainly in establishing a stage discharge relationship.

A:Water Stage Measurements

Stage is water surface elevation ……

- Methods Water Stage Measurements:

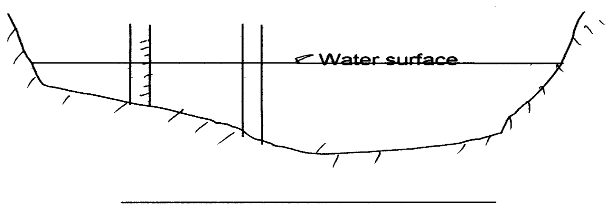
a. Non recording stream gage: a. Staff b. Wire (String) c. Crest staff

b. Recording stream gage: 1. Float type 2. Digital gage

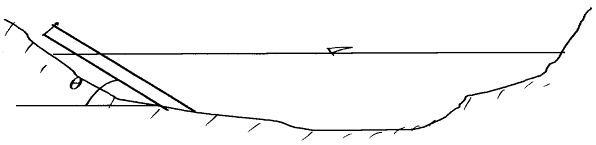
a. Manual Gages (Non recording)

1) Sectioned Staff Gages:

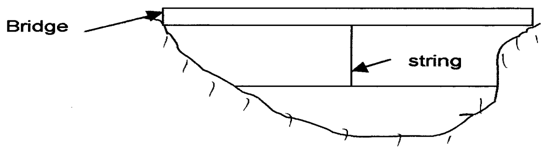
- A series of posts each overlapping.
- The height above a certain datum is measured.
- The stage is usually related to height above mean sea level (msl).



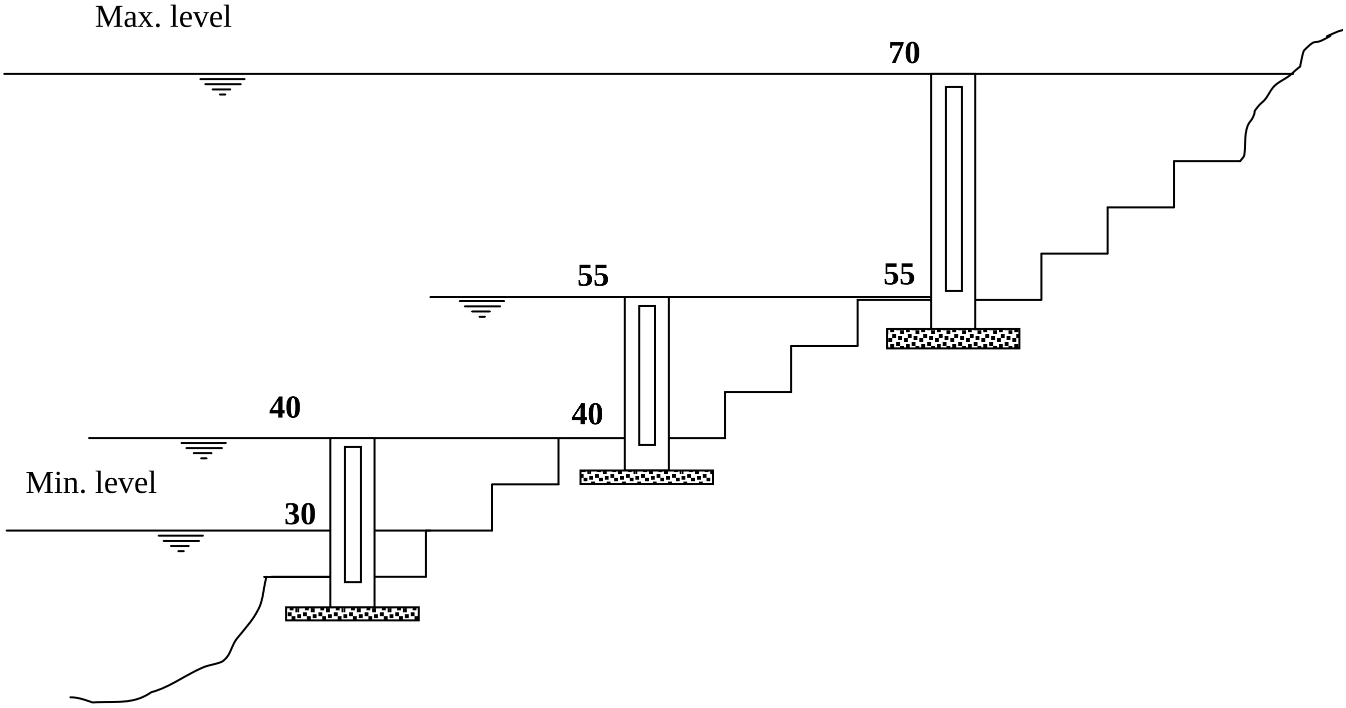
b) Inclined Gauges: The gauge is inclined to a certain angle to measure water stages.



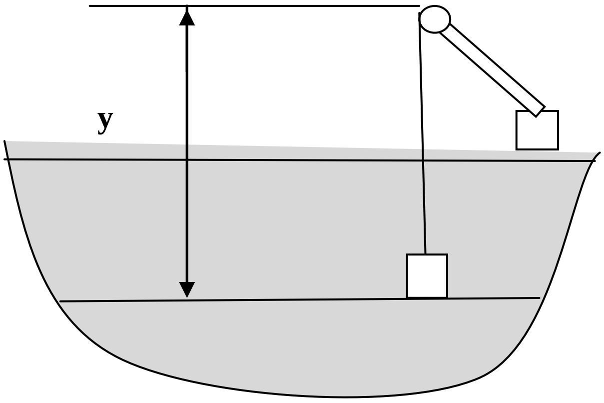
In some cases, it may be impossible to have stage gauges. The following arrangement can be used:



2) Single or Series of Vertical Gages:

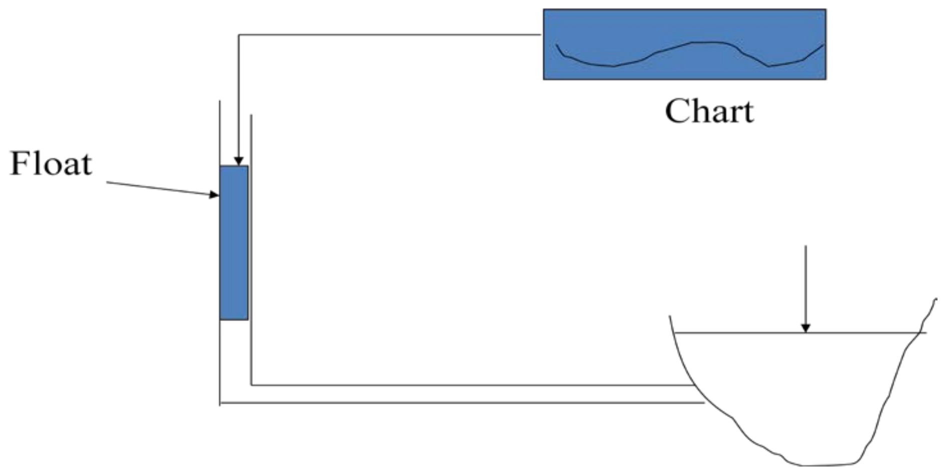


3) Suspended - weight (Wire (String)): A certain datum level is on the bridge and a string having a weight electrically connected is lowered to the water surface to get the depth of water surface.



b. Recording Gauges

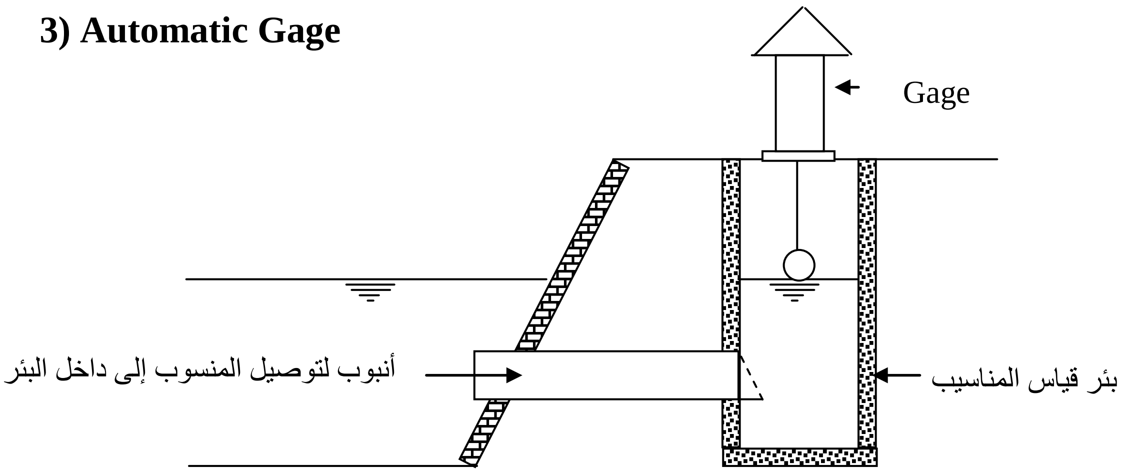
1) Float Gauge: Float movement fluctuates with change in stage and this is recorded by a chart. In hydrologic measurements, both the big and low flows are measured within the chart.



2) Digital Recorders

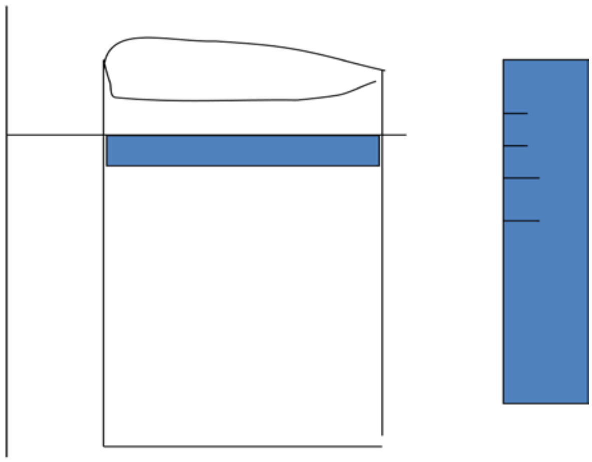
- They have clocks and used when for example hourly measurements are desired usually where stages do not increase and decrease steeply.
- The recorder should be placed at a height more than the expected peak stage.
- To know the maximum stage expected, an ordinary gauge can be used for some time.

3) Automatic Gage



4) Crest Gauges

- They only measure peak flows.
- It is a cylindrical tube sealed below with only a few holes to allow the water to enter the tube.
- A ground cork fixed in the tube floats up and is held by surface tension when stage increases.
- It stays at maximum stage until the reading is taken and let loose.



B. Methods of Velocity Measurments:

1. Velocity of float : $V_{av} = C\ V_c$
2. Current meters : $V_{av} = a + b\ N$

$$Q = \Sigma q_i = \Sigma v_i a_i$$

1. Velocity of float

في هذه الطريقة يتم اختيار مقطع من النهر ليس فيه انحناءات قدر الإمكان ثم يتم رمي طوافة في خط مركز النهر ثم حساب الفترة الزمنية التي تقطعها الطوافة من المقطع Aالى المقطع B ثم حساب السرعة بالمعادلة التالية:

$V_c = L/t$

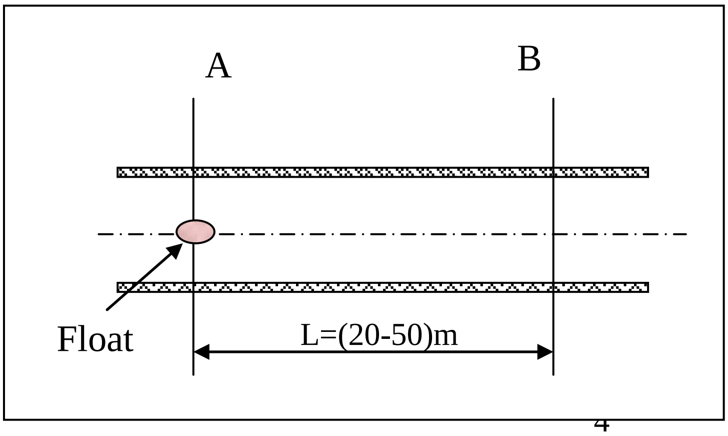
$V_m = C * Vc$

Where:

V_m=mean velocity,(m/sec.);

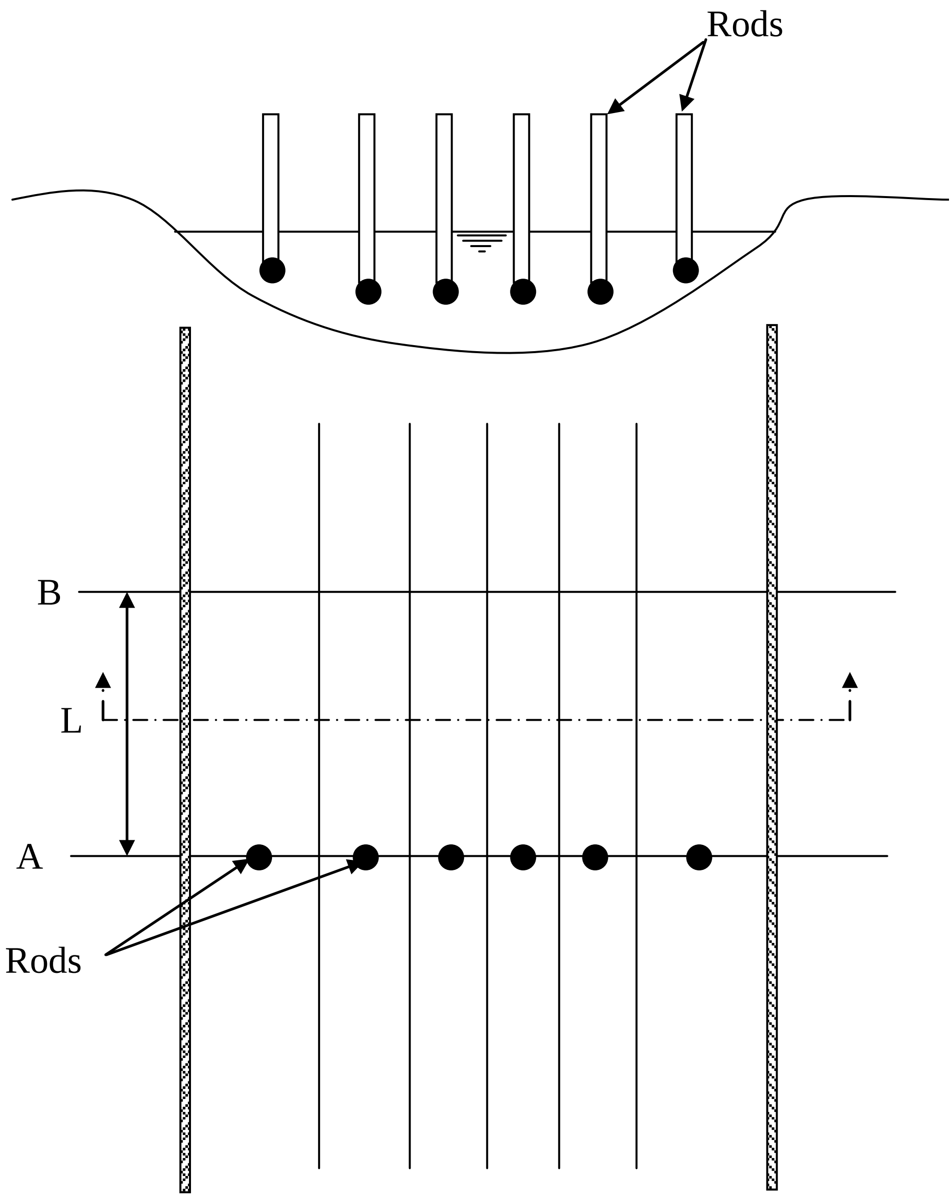
C=Correction Factor

=0.6 or 0.84



2. Rods: are made of tember weighted at the end with a bolt.

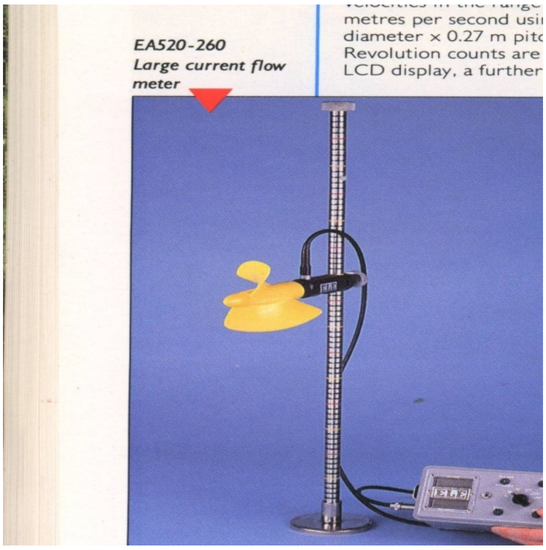
هذه الطريقة ادق من الطريقة السابقة لأن الـ (Rods) سيقيس الـ(mean velocity)



Length=0.92*y

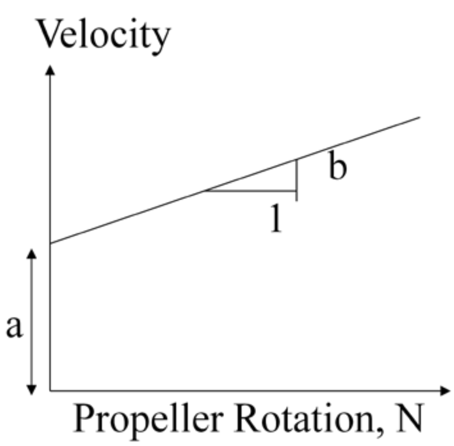
y=water depth,(m).

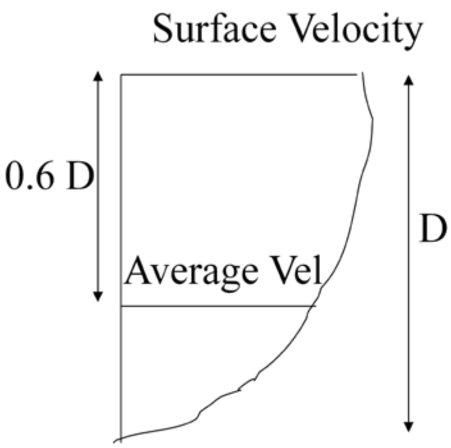
3. Current Meter: It has a propeller which is rotated when water hits it and is connected to magnets which actuates recorders when the propeller rotates. The velocity of water increases the propeller rotation.



The number of rotations are measured and correlated to velocity using the formula:

- $v = a + bN$ where N is the rotation of the propeller (revolutions per sec {rps})
- a and b are coefficients determined by calibration in an experimental flume.





- Considering the velocity profile with depth, average value of velocity can be obtained at 0.6 of the depth. i.e. V = average velocity is at about 0.6 D.

- An alternative of using the 0.6 D velocity is to take 0.2 and 0.8 velocities and obtain the averages.
- The latter method is more accurate but in a shallow cross-section, the velocity at 0.2 D may be difficult to measure so use a single value at 0.6 D.

C. Method of Discharge Measurements:

1. Velocity – Area Method;

2. Dilution Method.

3. Moving Boat Method: for large rivers

4. Chemical gagging: concentration of Chemical tracer

5. Ultrasonic:

6. Indirect Methods:

Measure flow depth (y) to get Q by :

*** Flow measured structures: such as weirs, orifices, …**

*** Slope-area methods: such as Chezy , Manning , Hayzen**

1. Determination of Discharges by Velocity – Area Method;

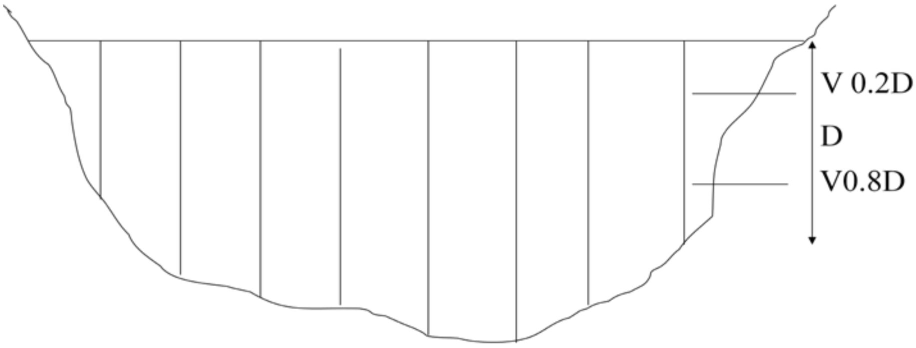
تستند هذه الطريقة بشكل مباشر على تطبيق معادلة الأستمرارية عند مقطع القناة فبعد أن يتم تحديد المقطع العرضي للقناة يتم حساب معدل سرعة الجريان باستعمال احدى الطرق المعروفة لحساب السرعة ثم تطبق المعادلة التالية لحساب التصريف:

$Q=A*V$ continuity equ.

$V_{av} = V0.6$ for shallow stream ; depth < 3 m

$V_{av} = (V0.8 + V0.2)/2$ for moderate stream

$V_{av} = C\ V0.5$ for deep stream –flood flow



Average Discharge = V x area of Segment

- First divide the cross-section of the stream into vertical sections such that no section carries more than 10 % of the total flow.
- Take soundings to determine various depths. The sections are of a known width and so the discharge can be calculated if the velocities are taken along the 0.2 D and 0.8 D or 0.6 D alone.
- Flow in one segment,

q = average velocity (v_{av}) x area of segment (a_i).

- Area of each segment can be calculated using the trapezoidal formula.
- Total discharge, Q is equal to:

Summation (Average velocity x area of segments)

$$\mathbf{Q} = \sum_{i=1}^{n}(q_i) = \sum_{i=1}^{n}(V_i\, A_i)$$

Discharge Measurements Using Floats

- Any floatable substance eg. a tennis ball is placed at a point and the time(t) it takes it to move a known distance is noted.
- d/t gives the average surface velocity of the water.
- The surface velocity (Vs) is equal to 1.2(average Velocity, V) ie. Vs = 1.2V and V = 0.8 Vs.
- The cross-sectional area of flow is then multiplied by the average velocity to get the flow rate.

Q = average velocity (v_{av}) x area (A)