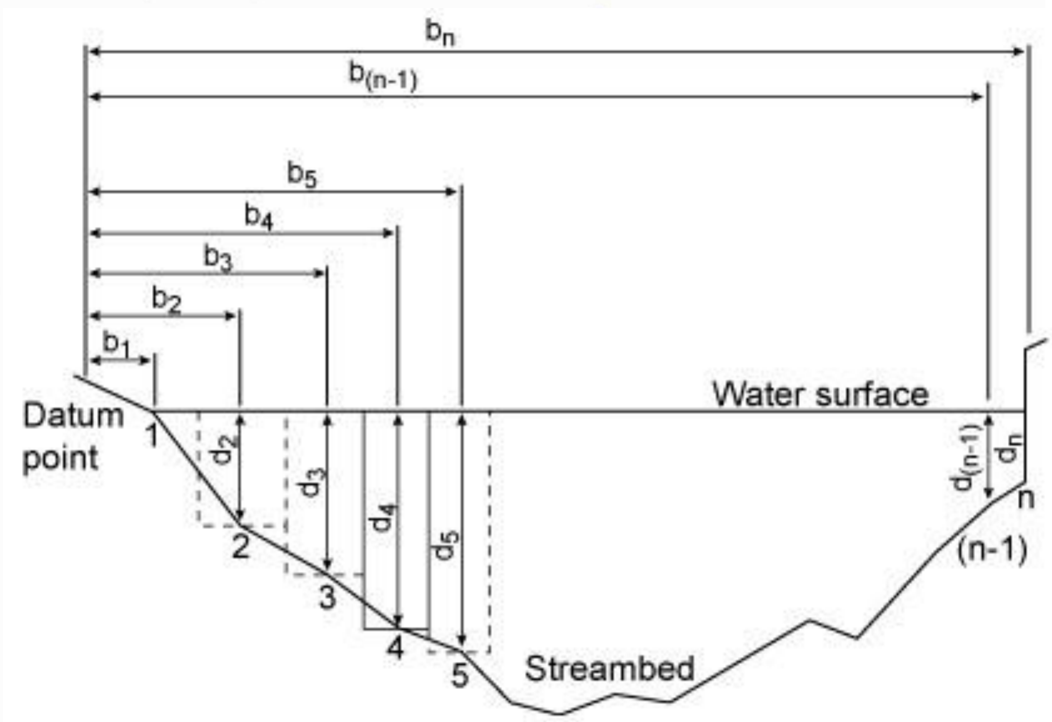
Processing Field Data and Calculation of Discharge

Mid Section Method of Estimating Discharge:-

In this Method, the stream cross section is divided into subsections. At the center of each of these subsections (called vertical), a depth and velocity measurement is made and the distance from a datum point is determined.

1) — 1, 2, 3 ---- n are observation verticals
2) — $b_1, b_2, b_3 ---- b_n$ Distance in feet or meters from the initial point to the observation vertical.
3) — $d_1, d_2, d_3, ---- d_n$ depth of water in ft or meters at the observation vertical.



$$q_1 = v_1 \left[\frac{b_2 - b_1}{2} \right] d_1$$

$\vdots$

$$q_n = V_n \left[\frac{b_n - b_{n-1}}{2} \right] d_n$$

The total discharge

$$\boxed{Q = q_1 + q_2 + q_3 \text{ ----- } + q_n}.$$

Essential Requirement for Good discharge Measurement

The essential requirement for good discharge measurement are :-

1) — Keep the current meter clean and properly oiled to reduce the friction losses.

2) — The stream cross section should be subdivided into as small sections as possible (15–20 sub-sections). If this requirement causes verticals to be less than 0.15m, then increase the space accordingly.

3) — use the average of velocities at 0.2 and 0.8 at the depth when the depth is greater than 0.6 m otherwise take a single measurement at 0.6 times the depth.

4) — Keeping the meter clean of floating materials by raising the meter out of water to let the debris pass by.

5) — Read and record the river stage from an auxiliary staff gauge periodically during the discharge measurement.

6)— If the river stage begins to change by greater than 5% the procedure may be speeded up by:-

(a) Decreasing the points of measurment of current meter

(b) Reducing the number of verticals.

Example 5.1

Example 5.2

Example 5.1

Compute the stream flow for the measurement data given below columns 1 to 5 of table 5.1 below. Take the meter rating from equation. V = a + b N with a = 0.03 and b = 0.66

Solution

As V = a + b N

So, V = 0.03 + 0.66 N (V is in m/s and N is in revolutions/s). Using this the following calculations in columns 6 to 11 of Table 5.1 below are made. Find the discharge using Mid-Section method.

Table 5.1 Computations for Current Meter Observations

Distance from bank	Depth (m)	Meter Depth	Revolutions	Time	N	Velocity at point	Mean in vertical	Width of sub-section	Area	Discharge
(m)	(m)	(m)		(Sec)	(Rev/s)	(m/s)	(m/s)	(m)	(m^2)	(m^3/s)
(1)	(2)	(3)	(4)	(5)	(6)	(7)= a+bN	(8)	(9)	(10)=(2)x(9)	(11)= (8) x (10)
0.60	0.30	0.18	10	50	0.20	0.162	0.162	0.60	0.18	0.03
1.20	1.05	0.84	22	55	0.40	0.294	0.384	0.60	0.63	0.242
		0.21	35	52	0.67	0.474				
1.80	1.56	1.26	28	53	0.53	0.379	0.432	0.60	0.94	0.404
		0.3	40	58	0.69	0.485				
2.70	1.89	1.5	32	58	0.55	0.394	0.460	0.60	1.134	0.521
		0.39	45	60	0.75	0.525				
3.30	1.32	1.15	28	45	0.62	0.441	0.472	0.60	0.792	0.374
		0.27	33	46	0.72	0.503				
3.90	0.66	0.39	22	50	0.44	0.320	0.320	0.60	0.396	0.127
4.50	0.24	0.15	12	49	0.24	0.192	0.192	0.60	0.144	0.028
5.10										
								Total	**4.212**	**1.726**

Q=1.726 m³/s

Total area, A= 4.212 m²

Average velocity = V = (Q/A) = (1.726/4.212) = 0.41 m/sec

Average depth (hydraulic depth) "D" = AREA / TOP WIDTH

= 4.212/4.2 = 1.6028 m

Example 5.2

From the data given in columns '1' to '4' of the table 5.2 below, find discharge.

Table 5.2 Calculation of Discharge

Distance from bank	Depth(m)	Mean Velocity	Width of sub-section	Area	Discharge
(m)	(m)	(m/s)	(m)	(m²)	(m³/s)
0.00	0.00	1.00	0.00	0.00	0.00
2.00	0.50	2.50	2.00	1.00	2.50
5.00	2.00	3.00	4.50	9.00	27.00
8.00	2.50	3.00	6.00	15.00	45.00
11.00	2.40	3.00	6.00	14.40	43.20
14.00	1.50	3.00	4.00	6.00	18.00
17.00	1.00	3.50	2.00	2.00	7.00
21.00	0.50	2.00	1.00	0.50	1.00
			Total	**47.90**	**143.70**

Q=143.7 m³/s

(ii) Chemical Gauging Method (Dilution Method)

* This method is particularly useful when plenty of turbulence exists in the flow and the measurment of discharge by current meter is not feasible.
* The situation may include a weir, or a fall, a sharp bent or turbine. A reach in which hydraulic jump is taking place is the most appropriate.
* In this method one section is selected upstream and other at downstream end of the reach of Channel.
* The upstream section is called the "dosing Section" & downstream end is called "Sampling Section".
* At dosing Section some Soluble chemical Salt made up to a Known Concentration is fed into the stream at a measured rate. By the time the flow reaches the sampling section the salt Solution is properly mixed with the whole flow. Sample of of water are drawn from the Sampling Section from the down stream section and are analyzed for the quantity of Salt. There are two alternatives for injection of chemicals:-

(a) Sudden injection

(b) Injection at Constant Rate.

(a). Sudden Injection:-

* In this method a known volume "V" of the dosing Solution or tracer is added to the stream as rapidly as possible.
* The Concentration at the Sampling point arises rapidly to a peak and then slowly diminishes.
* Samples are then taken at regular intervals of time and chemical Concentration is determined in Laboratory. A concentration - time curve is then drawn. Discharge "Q" is :-

$$Q = \frac{V C_1}{\int_{t_2}^{t_1} (C_2 - C_1)\,dt}$$

V = volume of injected Solution.
C_1 = Concentration of chemical in dozing Solution.
C_2 = Concentration of chemical in water at Sampling point.

(b) Constant rate of Injection:-

In this method the dosing of the chemical or any other tracer has to be Continued at a constant rate. Predetermined rate say "q" until the Concentration of the Chemical is Constant at the Sampling point down stream

The discharge is given as;

$$Q = \frac{q(C_1 - C_2)}{C_2 - C_0}$$

where
C_0 = Concentration of chemical already existing in Flowing Fluid of stream.

Also $$Q = \frac{q\,C_3}{C_2 - C_0}$$

$C_3 = C_1 - C_2$ = Difference in Concentration at dozing and Sampling point

C_2 = Concentration of chemical in water at Sampling point

q = Constant rate of injection of chemical.

C_1 = Concentration of chemical discharge at dozing Section.

Example 5.3:-

A 30 g/l solution of a chemical was discharged into a stream at a Constant rate of 10×10^{-6} m³/sec. The same chemical was not found in Stream water at all. The Concentration of chemical at Sampling Section was found to be 0.005×10^{-6} g/ml. Estimate the stream discharge.

Given data:-

$$q = 10 \times 10^{-6} \frac{m^3}{sec}$$

$$C_1 = 30\ g/l = \frac{30}{1000} = 0.030\ g/ml$$

$$C_2 = 0.005 \times 10^{-6}\ g/ml = 5 \times 10^{-9}\ g/ml$$

$$C_0 = 0$$

$$Q = q\,\frac{(C_1 - C_2)}{C_2 - C_0} = \frac{10 \times 10^{-6} \times (0.03 - 5 \times 10^{-9})}{5 \times 10^{-9}}$$

$$\boxed{Q = 60\ m^3/sec}$$