Indirect Methods of Streamflow Measurement Formulas

List of 33 Indirect Methods of Streamflow Measurement Formulas

Indirect Methods of Streamflow Measurement

Flow Measuring Structures

1) Discharge at Structure

Open Calculator

fx $$Q_f = k \cdot \left(H^{n_{system}}\right)$$

ex $$35.96325 \text{m}^3/\text{s} = 2 \cdot \left((3\text{m})^{2.63}\right)$$

2) Free Flow Discharge under Head using Submerged Flow over Weir

Open Calculator

fx $$Q_1 = \frac{Q_s}{\left(1 - \left(\frac{H_2}{H_1}\right)^{n}_{\{head\}}\right)^{0.385}}$$

ex $$20.00667 \text{m}^3/\text{s} = \frac{19 \text{m}^3/\text{s}}{\left(1 - \left(\frac{5\text{m}}{10.01\text{m}}\right)^{2.99\text{m}}\right)^{0.385}}$$

3) Head over Weir given Discharge

Open Calculator

$$H = \left(\frac{Q_f}{k}\right)^{\frac{1}{n_{system}}}$$

$$2.800161\text{m} = \left(\frac{30.0\text{m}^3/\text{s}}{2}\right)^{\frac{1}{2.63}}$$

4) Submerged Flow over Weir using Villemonte Formula

Open Calculator

$$Q_s = Q_1 \cdot \left(1 - \left(\frac{H_2}{H_1}\right)^{n}\_\{head\}\right)^{0.385}$$

$$18.99366\text{m}^3/\text{s} = 20\text{m}^3/\text{s} \cdot \left(1 - \left(\frac{5\text{m}}{10.01\text{m}}\right)^{2.99\text{m}}\right)^{0.385}$$

Slope-Area Method

5) Eddy Loss

Open Calculator

$$h_e = (h_1 - h_2) + \left(\frac{V_1^2}{2 \cdot g} - \frac{V_2^2}{2 \cdot g}\right) - h_f$$

$$15.96939 = (50\text{m} - 20\text{m}) + \left(\frac{(10\text{m/s})^2}{2 \cdot 9.8\text{m/s}^2} - \frac{(9\text{m/s})^2}{2 \cdot 9.8\text{m/s}^2}\right) - 15$$

6) Frictional Loss

Open Calculator

$$h_f = (h_1 - h_2) + \left(\frac{V_1^2}{2 \cdot g} - \frac{V_2^2}{2 \cdot g} \right) - h_e$$

$$30.43339 = (50m - 20m) + \left(\frac{(10m/s)^2}{2 \cdot 9.8m/s^2} - \frac{(9m/s)^2}{2 \cdot 9.8m/s^2} \right) - 0.536$$

7) Head loss in Reach

Open Calculator

$$h_l = Z_1 + y_1 + \left(\frac{V_1^2}{2 \cdot g} \right) - Z_2 - y_2 - \frac{V_2^2}{2 \cdot g}$$

$$2.469388m = 11.5m + 14m + \left(\frac{(10m/s)^2}{2 \cdot 9.8m/s^2} \right) - 11m - 13m - \frac{(9m/s)^2}{2 \cdot 9.8m/s^2}$$

Non-Uniform Flow

8) Area of Channel with known Conveyance of Channel at Section 1

Open Calculator

$$A_1 = \frac{K_1 \cdot n}{R_1^{\frac{2}{3}}}$$

$$494.221m^2 = \frac{1824 \cdot 0.412}{(1.875m)^{\frac{2}{3}}}$$

9) Area of Channel with known Conveyance of Channel at Section 2

Open Calculator

fx $$A_2 = \frac{K_2 \cdot n}{R_2^{\frac{2}{3}}}$$

ex $$477.7378\text{m}^2 = \frac{1738 \cdot 0.412}{(1.835\text{m})^{\frac{2}{3}}}$$

10) Average Conveyance of Channel for Non-Uniform Flow

Open Calculator

fx $$K_{avg} = \sqrt{K_1 \cdot K_2}$$

ex $$1780.481 = \sqrt{1824 \cdot 1738}$$

11) Average Energy Slope given Average Conveyance for Non-Uniform Flow

Open Calculator

fx $$S_{favg} = \frac{Q^2}{K^2}$$

ex $$0.140625 = \frac{(3.0\text{m}^3/\text{s})^2}{(8)^2}$$

12) Average Energy Slope given Frictional Loss

Open Calculator

fx $$S_{favg} = \frac{h_f}{L}$$

ex $$0.15 = \frac{15}{100\text{m}}$$

13) Conveyance of Channel at End Sections at 1

Open Calculator

$$K_1 = \left(\frac{1}{n}\right) \cdot A_1 \cdot R_1^{\frac{2}{3}}$$

$$1823.184 = \left(\frac{1}{0.412}\right) \cdot 494\text{m}^2 \cdot (1.875\text{m})^{\frac{2}{3}}$$

14) Conveyance of Channel at End Sections at 2

Open Calculator

$$K_2 = \left(\frac{1}{n}\right) \cdot A_2 \cdot R_2^{\frac{2}{3}}$$

$$1738.954 = \left(\frac{1}{0.412}\right) \cdot 478\text{m}^2 \cdot (1.835\text{m})^{\frac{2}{3}}$$

15) Conveyance of Channel for Non-Uniform Flow for End Section

Open Calculator

$$K_2 = \frac{K_{avg}^2}{K_1}$$

$$1737.061 = \frac{(1780)^2}{1824}$$

16) Conveyance of Channel for Non-Uniform Flow for End Sections

Open Calculator

$$K_1 = \frac{K_{avg}^2}{K_2}$$

$$1823.015 = \frac{(1780)^2}{1738}$$

17) Conveyance of Channel given Discharge in Non-Uniform Flow

Open Calculator

fx $$K = \frac{Q}{\sqrt{S_{favg}}}$$

ex $$2.44949 = \frac{3.0\text{m}^3/\text{s}}{\sqrt{1.5}}$$

18) Discharge in Non-Uniform Flow by Conveyance Method

Open Calculator

fx $$Q = K \cdot \sqrt{S_{favg}}$$

ex $$9.797959\text{m}^3/\text{s} = 8 \cdot \sqrt{1.5}$$

19) Frictional Loss given Average Energy Slope

Open Calculator

fx $$h_f = S_{favg} \cdot L$$

ex $$150 = 1.5 \cdot 100\text{m}$$

20) Length of Reach given Average Energy Slope for Non-Uniform Flow

Open Calculator

fx $$L = \frac{h_f}{S_{favg}}$$

ex $$10\text{m} = \frac{15}{1.5}$$

Eddy Loss

21) Eddy Loss for Abrupt Contraction Channel Transition

Open Calculator

fx $$h_e = 0.6 \cdot \left(\frac{V_1^2}{2 \cdot g} - \frac{V_2^2}{2 \cdot g} \right)$$

ex $$0.581633 = 0.6 \cdot \left(\frac{(10\text{m/s})^2}{2 \cdot 9.8\text{m/s}^2} - \frac{(9\text{m/s})^2}{2 \cdot 9.8\text{m/s}^2} \right)$$

22) Eddy Loss for Abrupt Expansion Channel Transition

Open Calculator

fx $$h_e = 0.8 \cdot \left(\frac{V_1^2}{2 \cdot g} - \frac{V_2^2}{2 \cdot g} \right)$$

ex $$0.77551 = 0.8 \cdot \left(\frac{(10\text{m/s})^2}{2 \cdot 9.8\text{m/s}^2} - \frac{(9\text{m/s})^2}{2 \cdot 9.8\text{m/s}^2} \right)$$

23) Eddy Loss for Gradual Contraction Channel Transition

Open Calculator

fx $$h_e = 0.1 \cdot \left(\frac{V_1^2}{2 \cdot g} - \frac{V_2^2}{2 \cdot g} \right)$$

ex $$0.096939 = 0.1 \cdot \left(\frac{(10\text{m/s})^2}{2 \cdot 9.8\text{m/s}^2} - \frac{(9\text{m/s})^2}{2 \cdot 9.8\text{m/s}^2} \right)$$

24) Eddy Loss for Gradual Expansion Channel Transition

Open Calculator

fx $$h_e = 0.3 \cdot \left(\frac{V_1^2}{2 \cdot g} - \frac{V_2^2}{2 \cdot g} \right)$$

ex $$0.290816 = 0.3 \cdot \left(\frac{(10\text{m/s})^2}{2 \cdot 9.8\text{m/s}^2} - \frac{(9\text{m/s})^2}{2 \cdot 9.8\text{m/s}^2} \right)$$

25) Eddy Loss for Non-uniform Flow

Open Calculator

fx $$h_e = K_e \cdot \left(\frac{V_1^2}{2 \cdot g} - \frac{V_2^2}{2 \cdot g} \right)$$

ex $$0.95 = 0.98 \cdot \left(\frac{(10\text{m/s})^2}{2 \cdot 9.8\text{m/s}^2} - \frac{(9\text{m/s})^2}{2 \cdot 9.8\text{m/s}^2} \right)$$

Uniform Flow

26) Area of Channel with known Conveyance of Channel

Open Calculator

fx $$A = \frac{K}{r_H^{\frac{2}{3}}} \cdot \left(\frac{1}{n} \right)$$

ex $$40.66151\text{m}^2 = \frac{8}{(0.33\text{m})^{\frac{2}{3}}} \cdot \left(\frac{1}{0.412} \right)$$

27) Conveyance of Channel

Open Calculator

fx $$K = \left(\frac{1}{n}\right) \cdot A \cdot r_H^{\frac{2}{3}}$$

ex $$13.90892 = \left(\frac{1}{0.412}\right) \cdot 12.0\text{m}^2 \cdot (0.33\text{m})^{\frac{2}{3}}$$

28) Conveyance of Channel given Energy Slope

Open Calculator

fx $$K = \sqrt{\frac{Q^2}{S_f}}$$

ex $$8.017837 = \sqrt{\frac{(3.0\text{m}^3/\text{s})^2}{0.140}}$$

29) Discharge for Uniform Flow given Energy Slope

Open Calculator

fx $$Q = K \cdot \sqrt{S_f}$$

ex $$2.993326\text{m}^3/\text{s} = 8 \cdot \sqrt{0.140}$$

30) Energy Slope for Uniform Flow

Open Calculator

fx $$S_f = \frac{Q^2}{K^2}$$

ex $$0.140625 = \frac{(3.0\text{m}^3/\text{s})^2}{(8)^2}$$

31) Frictional Loss given Energy Slope

Open Calculator

fx $$h_f = S_f \cdot L$$

ex $$14 = 0.140 \cdot 100m$$

32) Hydraulic Radius given Conveyance of Channel for Uniform Flow

Open Calculator

fx $$r_H = \left(\frac{K}{\left(\frac{1}{n}\right) \cdot A}\right)^{\frac{3}{2}}$$

ex $$0.143949m = \left(\frac{8}{\left(\frac{1}{0.412}\right) \cdot 12.0m^2}\right)^{\frac{3}{2}}$$

33) Length of Reach by Manning's Formula for Uniform Flow

Open Calculator

fx $$L = \frac{h_f}{S_f}$$

ex $$107.1429m = \frac{15}{0.140}$$

Variables Used

- **A** Cross-Sectional Area *(Square Meter)*
- **A_1** Area of Channel Section 1 *(Square Meter)*
- **A_2** Area of Channel Section 2 *(Square Meter)*
- **g** Acceleration due to Gravity *(Meter per Square Second)*
- **H** Head over Weir *(Meter)*
- **h_1** Height above Datum at Section 1 *(Meter)*
- **H_1** Upstream Water Surface Elevation *(Meter)*
- **h_2** Height above Datum at Section 2 *(Meter)*
- **H_2** Downstream Water Surface Elevation *(Meter)*
- **h_e** Eddy Loss
- **h_f** Frictional Loss
- **h_l** Head Loss in Reach *(Meter)*
- **k** System Constant k
- **K** Conveyance Function
- **K_1** Conveyance of Channel at End Sections at (1)
- **K_2** Conveyance of Channel at End Sections at (2)
- **K_{avg}** Average Conveyance of Channel
- **K_e** Eddy Loss Coefficient
- **L** Reach *(Meter)*
- **n** Manning’s Roughness Coefficient
- **n_{head}** Exponent of Head *(Meter)*
- **n_{system}** System Constant n
- **Q** Discharge *(Cubic Meter per Second)*

- Q_1 Free Flow Discharge under Head H1 *(Cubic Meter per Second)*
- Q_f Flow Discharge *(Cubic Meter per Second)*
- Q_s Submerged Discharge *(Cubic Meter per Second)*
- R_1 Hydraulics Radius of Channel Section 1 *(Meter)*
- R_2 Hydraulics Radius of Channel Section 2 *(Meter)*
- r_H Hydraulic Radius *(Meter)*
- S_f Energy Slope
- S_{favg} Average Energy Slope
- V_1 Mean Velocity at End Sections at (1) *(Meter per Second)*
- V_2 Mean Velocity at End Sections at (2) *(Meter per Second)*
- y_1 Height above Channel Slope at 1 *(Meter)*
- y_2 Height above Channel Slope at 2 *(Meter)*
- Z_1 Static Heads at End Sections at (1) *(Meter)*
- Z_2 Static Head at End Sections at (2) *(Meter)*

Constants, Functions, Measurements used

- Function: **sqrt**, sqrt(Number)
  A square root function is a function that takes a non-negative number as an input and returns the square root of the given input number.
- Measurement: **Length** in Meter (m)
  Length Unit Conversion
- Measurement: **Area** in Square Meter (m²)
  Area Unit Conversion
- Measurement: **Speed** in Meter per Second (m/s)
  Speed Unit Conversion
- Measurement: **Acceleration** in Meter per Square Second (m/s²)
  Acceleration Unit Conversion
- Measurement: **Volumetric Flow Rate** in Cubic Meter per Second (m³/s)
  Volumetric Flow Rate Unit Conversion

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- **Area-Velocity and Ultrasonic Method of Streamflow Measurement Formulas**
- **Discharge Measurements Formulas**
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