Important Indirect Methods of Streamflow Measurement Formulas PDF



Formulas Examples with Units

List of 33

Important Indirect Methods of Streamflow Measurement Formulas

Evaluate Formula

Evaluate Formula (

Evaluate Formula 🕝

Evaluate Formula C

1) Flow Measuring Structures Formulas (7)

1.1) Discharge at Structure Formula

Formula

Example with Units

 $Q_f = k \cdot (H^{n_{system}})$ 35.9632 m³/s = 2 · (3 m^{2.63})

1.2) Free Flow Discharge under Head using Submerged Flow over Weir Formula 🕝

 $Q_1 = \frac{Q_S}{\left(1 - \left(\frac{H_2}{H_1}\right)^{n_{head}}\right)^{0.385}} \left| \quad \left| \quad 20.0067\,\text{m}^3/\text{s} \right. = \frac{19\,\text{m}^3/\text{s}}{\left(1 - \left(\frac{5\,\text{m}}{10.01\,\text{m}}\right)^{2.99\,\text{m}}\right)^{0.385}} \right|$

1.3) Head over Weir given Discharge Formula 🕝

Example with Units

 $H = \left(\frac{Q_f}{k}\right)^{\frac{1}{n_{system}}} \left| \quad 2.8002 \, \text{m} \right| = \left(\frac{30.0 \, \text{m}^3/\text{s}}{2}\right)^{\frac{1}{2.63}}$

1.4) Submerged Flow over Weir using Villemonte Formula Formula 🕝

Formula

Example with Units

 $Q_{S} = Q_{1} \cdot \left(1 - \left(\frac{H_{2}}{H_{1}}\right)^{n_{head}}\right)^{0.385} \left| \quad | \quad | 18.9937 \, \text{m}^{3}/\text{s} \right| = 20 \, \text{m}^{3}/\text{s} \cdot \left(1 - \left(\frac{5 \, \text{m}}{10.01 \, \text{m}}\right)^{2.99 \, \text{m}}\right)^{0.385} \right|$

2) Slope Area Method Formulas 🕝

2.1) Eddy Loss Formula 🕝

Formula

$$h_{e} = (h_{1} - h_{2}) + (\frac{V_{1}^{2}}{2 \cdot g} - \frac{V_{2}^{2}}{2 \cdot g}) - h_{f}$$

Example with Units

$$15.9694 = \left(50_{\text{m}} - 20_{\text{m}}\right) + \left(\frac{10_{\text{m/s}}^{2}}{2 \cdot 9.8_{\text{m/s}^{2}}} - \frac{9_{\text{m/s}}^{2}}{2 \cdot 9.8_{\text{m/s}^{2}}}\right) - 15$$

2.2) Frictional Loss Formula

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

$$30.4334 = \left(50 \,\mathrm{m} - 20 \,\mathrm{m}\right) + \left(\frac{10 \,\mathrm{m/s}^2}{2 \cdot 9.8 \,\mathrm{m/s}^2} - \frac{9 \,\mathrm{m/s}^2}{2 \cdot 9.8 \,\mathrm{m/s}^2}\right) - 0.536$$

2.3) Head loss in Reach Formula C

Formula

$$h_1 = Z_1 + y_1 + \left(\frac{V_1^2}{2 \cdot g}\right) - Z_2 - y_2 - \frac{V_2^2}{2 \cdot g}$$

Example with Units

$$2.4694 \,\mathrm{m} = 11.5 \,\mathrm{m} + 14 \,\mathrm{m} + \left(\frac{10 \,\mathrm{m/s}^2}{2 \cdot 9.8 \,\mathrm{m/s^2}}\right) - 11 \,\mathrm{m} - 13 \,\mathrm{m} - \frac{9 \,\mathrm{m/s}^2}{2 \cdot 9.8 \,\mathrm{m/s^2}}$$

2.4) Non Uniform Flow Formulas

2.4.1) Area of Channel with known Conveyance of Channel at Section 1 Formula 🗂

Formula Example with Units
$$A_{1} = \frac{K_{1} \cdot n}{R_{1}^{\frac{2}{3}}} \qquad 494.221 \, m^{2} = \frac{1824 \cdot 0.412}{1.875 \, m^{\frac{2}{3}}}$$

Evaluate Formula C

Evaluate Formula

Evaluate Formula

Evaluate Formula [

2.4.2) Area of Channel with known Conveyance of Channel at Section 2 Formula 🕝

Example with Units

Evaluate Formula (

 $A_2 = \frac{K_2 \cdot n}{R_2^{\frac{2}{3}}}$ $477.7378 \, m^2 = \frac{1738 \cdot 0.412}{1.835 \, m^{\frac{2}{3}}}$

2.4.3) Average Conveyance of Channel for Non-Uniform Flow Formula [Evaluate Formula

Formula Example $K_{avg} = \sqrt{K_1 \cdot K_2}$ $1780.4808 = \sqrt{1824 \cdot 1738}$

Evaluate Formula

2.4.4) Average Energy Slope given Average Conveyance for Non-Uniform Flow Formula (

 $S_{\text{favg}} = \frac{Q^2}{\kappa^2} \left[0.1406 = \frac{3.0 \,\text{m}^3/\text{s}^2}{8^2} \right]$

2.4.5) Average Energy Slope given Frictional Loss Formula 🕝

Formula Example with Units $S_{favg} = \frac{h_f}{L} \qquad 0.15 = \frac{15}{100\,\mathrm{m}}$

Evaluate Formula

2.4.6) Conveyance of Channel at End Sections at 1 Formula C

Formula

Example with Uni $K_1 = \left(\frac{1}{n}\right) \cdot A_1 \cdot R_1^{\frac{2}{3}}$ $1823.1843 = \left(\frac{1}{0.412}\right) \cdot 494 \, m^2 \cdot 1.875 \, m^{\frac{2}{3}}$ Evaluate Formula (

2.4.7) Conveyance of Channel at End Sections at 2 Formula C

Example with Units $K_2 = \left(\frac{1}{n}\right) \cdot A_2 \cdot R_2^{\frac{2}{3}} \qquad 1738.9539 = \left(\frac{1}{0.412}\right) \cdot 478 \, \text{m}^2 \cdot 1.835 \, \text{m}^{\frac{2}{3}}$ Evaluate Formula C

2.4.8) Conveyance of Channel for Non-Uniform Flow for End Section Formula C

 $K_2 = \frac{K_{avg}^2}{K_1}$ $1737.0614 = \frac{1780^2}{1824}$

Evaluate Formula (

2.4.9) Conveyance of Channel for Non-Uniform Flow for End Sections Formula

Formula Example
$$K_{1} = \frac{K_{avg}^{2}}{K_{2}} \qquad 1823.015 = \frac{1780^{2}}{1738}$$

2.4.10) Conveyance of Channel given Discharge in Non-Uniform Flow Formula

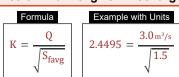
Evaluate Formula (

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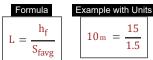
2.4.11) Discharge in Non-Uniform Flow by Conveyance Method Formula



2.4.12) Frictional Loss given Average Energy Slope Formula

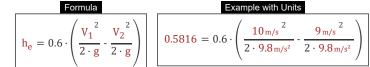


2.4.13) Length of Reach given Average Energy Slope for Non-Uniform Flow Formula



2.4.14) Eddy Loss Formulas 🗂

2.4.14.1) Eddy Loss for Abrupt Contraction Channel Transition Formula



2.4.14.2) Eddy Loss for Abrupt Expansion Channel Transition Formula

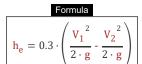


2.4.14.3) Eddy Loss for Gradual Contraction Channel Transition Formula C

$$h_{e} = 0.1 \cdot \left(\frac{{V_{1}}^{2}}{2 \cdot g} - \frac{{V_{2}}^{2}}{2 \cdot g} \right) \qquad 0.0969 = 0.1 \cdot \left(\frac{10 \, \text{m/s}}{2 \cdot 9.8 \, \text{m/s}^{2}} - \frac{9 \, \text{m/s}}{2 \cdot 9.8 \, \text{m/s}^{2}} \right)$$

Example with Units
$$\frac{10 \, \text{m/s}^2}{10 \, \text{m/s}^2} = \frac{9 \, \text{m}}{10 \, \text{m/s}^2}$$

Evaluate Formula (



 $h_{e} = 0.3 \cdot \left(\frac{V_{1}^{2}}{2 \cdot g} - \frac{V_{2}^{2}}{2 \cdot g} \right) \left| \quad 0.2908 = 0.3 \cdot \left(\frac{10 \, \text{m/s}^{2}}{2 \cdot 9.8 \, \text{m/s}^{2}} - \frac{9 \, \text{m/s}^{2}}{2 \cdot 9.8 \, \text{m/s}^{2}} \right) \right|$

Evaluate Formula

Evaluate Formula (

2.4.14.5) Eddy Loss for Non-uniform Flow Formula C

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

Example with Units $h_{e} = K_{e} \cdot \left(\frac{V_{1}^{2}}{2 \cdot g} - \frac{V_{2}^{2}}{2 \cdot g} \right) \left| \quad 0.95 = 0.98 \cdot \left(\frac{10 \, \text{m/s}^{2}}{2 \cdot 9.8 \, \text{m/s}^{2}} - \frac{9 \, \text{m/s}^{2}}{2 \cdot 9.8 \, \text{m/s}^{2}} \right) \right|$

2.4.14) Uniform Flow Formulas (

2.4.14.1) Area of Channel with known Conveyance of Channel Formula C



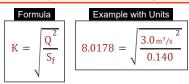
Example with Units $A = \frac{K}{r^{\frac{2}{3}}} \cdot \left(\frac{1}{n}\right) \left| 40.6615 \,\mathrm{m}^2 \right| = \frac{8}{0.33 \,\mathrm{m}^{\frac{2}{3}}} \cdot \left(\frac{1}{0.412}\right)$ Evaluate Formula (

2.4.14.2) Conveyance of Channel Formula C

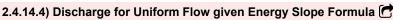
Formula
$$K = \left(\frac{1}{n}\right) \cdot A \cdot r_{H}^{\frac{2}{3}}$$

Example with Units $K = \left(\frac{1}{n}\right) \cdot A \cdot r_{H}^{\frac{2}{3}} \left| 13.9089 = \left(\frac{1}{0.412}\right) \cdot 12.0 \,\mathrm{m}^{2} \cdot 0.33 \,\mathrm{m}^{\frac{2}{3}} \right|$

2.4.14.3) Conveyance of Channel given Energy Slope Formula C



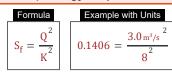
Evaluate Formula (





Example with Units $2.9933\,\mathrm{m}^3/\mathrm{s} = 8 \cdot \sqrt{0.140}$ Evaluate Formula (

2.4.14.5) Energy Slope for Uniform Flow Formula [7]



Evaluate Formula

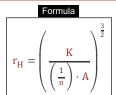
2.4.14.6) Frictional Loss given Energy Slope Formula 🕝

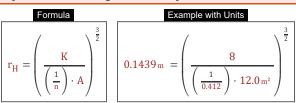


Formula Example with Units $h_f = S_f \cdot L \qquad 14 = 0.140 \cdot 100 \, \mathrm{m}$

Evaluate Formula (

2.4.14.7) Hydraulic Radius given Conveyance of Channel for Uniform Flow Formula 🕝





Evaluate Formula (

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

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

Example with Units $L = \frac{h_f}{S_f} \qquad 107.1429 \, \text{m} = \frac{15}{0.140}$ Evaluate Formula 🕝

Variables used in list of Indirect Methods of Streamflow Measurement Formulas above

- A Cross-Sectional Area (Square Meter)
- A₁ Area of Channel Section 1 (Square Meter)
- A₂ Area of Channel Section 2 (Square Meter)
- g Acceleration due to Gravity (Meter per Square Second)
- **H** Head over Weir (Meter)
- h₁ Height above Datum at Section 1 (Meter)
- H₁ Upstream Water Surface Elevation (Meter)
- h₂ Height above Datum at Section 2 (Meter)
- H₂ Downstream Water Surface Elevation (Meter)
- h_e Eddy Loss
- h_f Frictional Loss
- **h**_I Head Loss in Reach (Meter)
- k System Constant k
- K Conveyance Function
- K₁ Conveyance of Channel at End Sections at (1)
- K₂ Conveyance of Channel at End Sections at (2)
- Kavg Average Conveyance of Channel
- Ke 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)
- Q₁ 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)
- R₁ Hydraulics Radius of Channel Section 1 (Meter)

Constants, Functions, Measurements used in list of Indirect Methods of Streamflow Measurement Formulas above

- Functions: 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

- R₂ Hydraulics Radius of Channel Section 2 (Meter)
- r_H Hydraulic Radius (Meter)
- S_f Energy Slope
- S_{favq} Average Energy Slope
- V₁ Mean Velocity at End Sections at (1) (Meter per Second)
- V₂ Mean Velocity at End Sections at (2) (Meter per Second)
- y₁ Height above Channel Slope at 1 (Meter)
- y₂ Height above Channel Slope at 2 (Meter)
- Z₁ Static Heads at End Sections at (1) (Meter)
- Z₂ Static Head at End Sections at (2) (Meter)

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