Important Gradually Varied Flow in Channels Formulas PDF

Formulas
Examples
with Units

List of 36
Important Gradually Varied Flow in Channels Formulas

1) Area of Section given Energy Gradient Formula

Evaluate Formula

Formula

$$S = \left(Q_{eg}^{2} \cdot \frac{T}{\left(1 - \left(\frac{i}{m}\right)\right) \cdot ([g])} \right)^{\frac{1}{3}}$$

Example with Units

$$4.0078\,\text{m}^2 = \left(12.5\,\text{m}^3/\text{s}^{2} \cdot \frac{2\,\text{m}}{\left(1 - \left(\frac{2.02}{4}\right)\right) \cdot (9.8066\,\text{m/s}^2)} \right)^{\frac{1}{3}}$$

2) Area of Section given Froude Number Formula

Evaluate Formula

Formula

$$S = \left(\left(Q_f^{2} \cdot \frac{T}{[g] \cdot Fr^{2}} \right) \right)^{\frac{1}{3}}$$

Example with Units

$$3.9978\,\text{m}^2 = \left(\left(177\,\text{m}^3/\text{s}^{2} \cdot \frac{2\,\text{m}}{9.8066\,\text{m/s}^2 \cdot 10^{2}} \right) \right)^{\frac{1}{3}}$$

3) Area of Section given Total Energy Formula

Evaluate Formula

Formula

$$S = \left(\frac{Q_f^{2}}{2 \cdot [g] \cdot \left(E_t - d_f\right)} \right)^{0.5}$$

Example with Units

$$4.0001\,\text{m}^2 = \left(\frac{177\,\text{m}^3/\text{s}^{2}}{2 \cdot 9.8066\,\text{m/s}^2 \cdot (103.13\,\text{J} - 3.3\,\text{m})} \right)^{0.5}$$

4) Bed Slope given Energy Slope of Rectangular channel Formula

Evaluate Formula

Formula

$$S_0 = \frac{S_f}{\left(\frac{C}{d_f}\right)^{\frac{10}{3}}}$$

Example with Units

$$2.7493 = \frac{2.001}{\left(\frac{3\,\text{m}}{3.3\,\text{m}}\right)^{\frac{10}{3}}}$$

5) Bed Slope given Slope of Dynamic Equation of Gradually Varied Flow Formula

Evaluate Formula

Formula

$$S_0 = S_f + \left(m \cdot \left(1 - \left(F_{r(d)}^2 \right) \right) \right)$$

Example

$$4.041 = 2.001 + \left(4 \cdot \left(1 - \left(0.7^2 \right) \right) \right)$$

6) Bottom Slope of Channel given Energy Gradient Formula

Evaluate Formula

Formula

$$S_0 = i + S_f$$

Example

$$4.021 = 2.02 + 2.001$$

7) Chezy Formula for Bed Slope given Energy Slope of Rectangular Channel Formula

Evaluate Formula

Formula

$$S_0 = \frac{S_f}{\left(\frac{C}{d_f} \right)^3}$$

Example with Units

$$2.6633 = \frac{2.001}{\left(\frac{3\,\text{m}}{3.3\,\text{m}} \right)^3}$$

8) Chezy Formula for Depth of Flow given Energy Slope of Rectangular Channel Formula

Evaluate Formula

Formula

$$d_f = \frac{C}{\left(\frac{S_f}{S_0} \right)^{\frac{1}{3}}}$$

Example with Units

$$3.7794\,\text{m} = \frac{3\,\text{m}}{\left(\frac{2.001}{4.001} \right)^{\frac{1}{3}}}$$

9) Chezy Formula for Normal Depth given Energy Slope of Rectangular Channel Formula

Evaluate Formula

Formula

$$C = \left(\left(\frac{S_f}{S_0} \right)^{\frac{1}{3}} \right) \cdot d_f$$

Example with Units

$$2.6194\,\text{m} = \left(\left(\frac{2.001}{4.001} \right)^{\frac{1}{3}} \right) \cdot 3.3\,\text{m}$$

10) Depth of Flow given Energy Slope of Rectangular channel Formula

Evaluate Formula

Formula

$$d_f = \frac{C}{\left(\frac{S_f}{S_0} \right)^{\frac{3}{10}}}$$

Example with Units

$$3.6932\,\text{m} = \frac{3\,\text{m}}{\left(\frac{2.001}{4.001} \right)^{\frac{3}{10}}}$$

11) Depth of Flow given Total Energy Formula

Evaluate Formula

Formula

$$d_f = E_t - \left(\frac{Q_f^2}{2 \cdot [g] \cdot S^2} \right)$$

Example with Units

$$3.7939\,\text{m} = 103.13\,\text{J} - \left(\frac{177\,\text{m}^3/\text{s}^2}{2 \cdot 9.8066\,\text{m/s}^2 \cdot 4.01\,\text{m}^2} \right)$$

12) Discharge given Energy Gradient Formula

Evaluate Formula

Formula

$$Q_{eg} = \left(\left(\left(1 - \left(\frac{i}{m}\right)\right) \cdot \frac{[g] \cdot S^3}{T}\right)\right)^{0.5}$$

Example with Units

$$12.5102\,\text{m}^3/\text{s} = \left(\left(\left(1 - \left(\frac{2.02}{4}\right)\right) \cdot \frac{9.8066\,\text{m/s}^2 \cdot 4.01\,\text{m}^2{}^3}{2\,\text{m}}\right)\right)^{0.5}$$

13) Discharge given Froude Number Formula

Evaluate Formula

Formula

$$Q_f = \frac{Fr}{\sqrt{\frac{T}{[g] \cdot S^3}}}$$

Example with Units

$$177.8123\,\text{m}^3/\text{s} = \frac{10}{\sqrt{\frac{2\,\text{m}}{9.8066\,\text{m/s}^2 \cdot 4.01\,\text{m}^2{}^3}}}$$

14) Discharge given Total Energy Formula

Evaluate Formula

Formula

$$Q_f = \left(\left(E_t - d_f\right) \cdot 2 \cdot [g] \cdot S^2\right)^{0.5}$$

Example with Units

$$177.4395\,\text{m}^3/\text{s} = \left(\left(103.13\,\text{J} - 3.3\,\text{m}\right) \cdot 2 \cdot 9.8066\,\text{m/s}^2 \cdot 4.01\,\text{m}^2{}^2\right)^{0.5}$$

15) Energy Gradient given Bed Slope Formula

Evaluate Formula

Formula

$$i = S_0 - S_f$$

Example

$$2 = 4.001 - 2.001$$

16) Energy Gradient given Slope Formula

Evaluate Formula

Formula

$$i = \left(1 - \left(Q_{eg}^2 \cdot \frac{T}{[g] \cdot S^3}\right)\right) \cdot m$$

Example with Units

$$2.0232 = \left(1 - \left(12.5\,\text{m}^3/\text{s}^2 \cdot \frac{2\,\text{m}}{9.8066\,\text{m/s}^2 \cdot 4.01\,\text{m}^2{}^3}\right)\right) \cdot 4$$

17) Froude Number given Slope of Dynamic Equation of Gradually Varied Flow Formula

Evaluate Formula

Formula

$$F_{r(d)} = \sqrt{1 - \left(\frac{S_0 - S_f}{m}\right)}$$

Example

$$0.7071 = \sqrt{1 - \left(\frac{4.001 - 2.001}{4}\right)}$$

18) Froude Number given Top Width Formula

Evaluate Formula

Formula

$$Fr = \sqrt{Q_f^2 \cdot \frac{T}{[g] \cdot S^3}}$$

Example with Units

$$9.9543 = \sqrt{177\,m^3/s^2 \cdot \frac{2\,m}{9.8066\,m/s^2 \cdot 4.01\,m^2^3}}$$

19) Normal Depth given Energy Slope of Rectangular channel Formula

Evaluate Formula

Formula

$$C = \left(\left(\frac{S_f}{S_0}\right)^{\frac{3}{10}}\right) \cdot d_f$$

Example with Units

$$2.6806\,m = \left(\left(\frac{2.001}{4.001}\right)^{\frac{3}{10}}\right) \cdot 3.3\,m$$

20) Slope of Dynamic Equation of Gradually Varied Flow given Energy Gradient Formula

Evaluate Formula

Formula

$$m = \frac{i}{1 - \left(Q_{eg}^2 \cdot \frac{T}{[g] \cdot S^3}\right)}$$

Example with Units

$$3.9936 = \frac{2.02}{1 - \left(12.5\,m^3/s^2 \cdot \frac{2\,m}{9.8066\,m/s^2 \cdot 4.01\,m^2^3}\right)}$$

21) Slope of Dynamic Equation of Gradually Varied Flows Formula

Evaluate Formula

Formula

$$m = \frac{S_0 - S_f}{1 - \left(F_{r(d)}^2\right)}$$

Example

$$3.9216 = \frac{4.001 - 2.001}{1 - \left(0.7^2\right)}$$

22) Top Width given Energy Gradient Formula

Evaluate Formula

Formula

$$T = \left(\left(1 - \left(\frac{i}{m}\right)\right) \cdot \frac{[g] \cdot S^3}{Q_{eg}^2}\right)$$

Example with Units

$$2.0033\,m = \left(\left(1 - \left(\frac{2.02}{4}\right)\right) \cdot \frac{9.8066\,m/s^2 \cdot 4.01\,m^2^3}{12.5\,m^3/s^2}\right)$$

23) Top Width given Froude Number Formula

Evaluate Formula

Formula

$$T = \frac{Fr^2 \cdot S^3 \cdot [g]}{Q_f^2}$$

Example with Units

$$2.0184\,\text{m} = \frac{10^2 \cdot 4.01\,\text{m}^2{}^3 \cdot 9.8066\,\text{m/s}^2}{177\,\text{m}^3/\text{s}^2}$$

24) Total Energy of Flow Formula

Evaluate Formula

Formula

$$E_t = d_f + \frac{Q_f^2}{2 \cdot [g] \cdot S^2}$$

Example with Units

$$102.6361\,\text{J} = 3.3\,\text{m} + \frac{177\,\text{m}^3/\text{s}^2}{2 \cdot 9.8066\,\text{m/s}^2 \cdot 4.01\,\text{m}^2{}^2}$$

25) Energy Slope Formulas

25.1) Chezy Formula for Energy Slope of Rectangular Channel Formula

Evaluate Formula

Formula

$$S_f = S_0 \cdot \left(\frac{C}{d_f}\right)^3$$

Example with Units

$$3.006 = 4.001 \cdot \left(\frac{3\,\text{m}}{3.3\,\text{m}}\right)^3$$

25.2) Energy Slope given Slope of Dynamic Equation of Gradually Varied Flow Formula

Evaluate Formula

Formula

$$S_f = S_0 - \left(m \cdot \left(1 - \left(F_{r(d)}^2\right)\right)\right)$$

Example

$$1.961 = 4.001 - \left(4 \cdot \left(1 - \left(0.7^2\right)\right)\right)$$

25.3) Energy Slope of Channel given Energy Gradient Formula

Evaluate Formula

Formula

$$S_f = S_0 - i$$

Example

$$1.981 = 4.001 - 2.02$$

25.4) Energy Slope of Rectangular channel Formula

Evaluate Formula

Formula

$$S_f = S_0 \cdot \left(\frac{C}{d_f}\right)^{\frac{10}{3}}$$

Example with Units

$$2.912 = 4.001 \cdot \left(\frac{3\,\text{m}}{3.3\,\text{m}}\right)^{\frac{10}{3}}$$

26) Wide Rectangular Channel Formulas

26.1) Bed Slope of Channel given Slope of Dynamic Equation of Gradually Varied Flow Formula

Evaluate Formula

Formula

$$S_0 = \frac{m}{\left(1 - \left(\left(\frac{y}{d_f}\right)^{\frac{10}{3}}\right)\right) \frac{}{} \left(1 - \left(\left(\frac{h_c}{d_f}\right)^3\right)\right)}$$

Example with Units

$$4.191 = \frac{4}{\left(1 - \left(\left(\frac{1.5\,\text{m}}{3.3\,\text{m}}\right)^{\frac{10}{3}}\right)\right) \frac{}{} \left(1 - \left(\left(\frac{1.001\,\text{m}}{3.3\,\text{m}}\right)^3\right)\right)}$$

26.2) Bed Slope of Channel given Slope of Dynamic Equation of GVF through Chezy formula Formula

Evaluate Formula

Formula

$$S_0 = \frac{m}{\left(1 - \left(\left(\frac{y}{d_f}\right)^3\right)\right) \frac{}{} \left(1 - \left(\left(\left(\frac{h_c}{d_f}\right)^3\right)\right)\right)}$$

Example with Units

$$4.2914 = \frac{4}{\left(1 - \left(\left(\frac{1.5\,\text{m}}{3.3\,\text{m}}\right)^3\right)\right) \frac{}{} \left(1 - \left(\left(\left(\frac{1.001\,\text{m}}{3.3\,\text{m}}\right)^3\right)\right)\right)}$$

26.3) Chezy Formula for Critical Depth of Channel given Slope of Dynamic Equation of GVF Formula

Evaluate Formula

Formula

$$H_C = \left(\left(1 - \left(\left(\frac{1 - \left(\left(\frac{y}{d_f}\right)^3\right)}{\frac{m}{S_0}}\right)\right)^{\frac{1}{3}}\right)\right) \cdot d_f$$

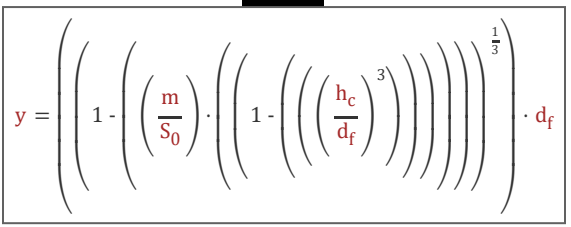
Example with Units

$$0.1065\,\text{m} = \left(\left(1 - \left(\left(\frac{1 - \left(\left(\frac{1.5\,\text{m}}{3.3\,\text{m}}\right)^3\right)}{\frac{4}{4.001}}\right)\right)^{\frac{1}{3}}\right)\right) \cdot 3.3\,\text{m}$$

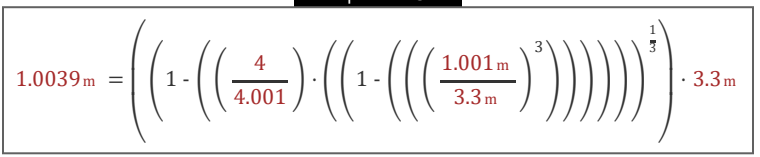
26.4) Chezy Formula for Normal Depth of Channel given Slope of Dynamic Equation of GVF Formula

Evaluate Formula

Formula



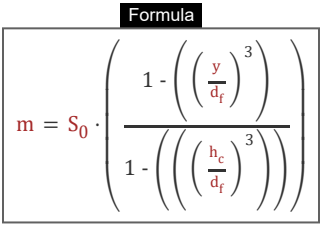
Example with Units



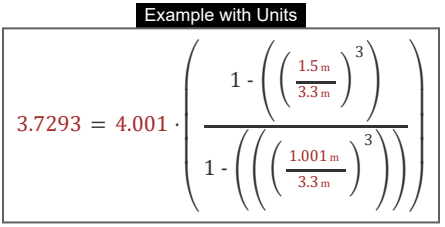
26.5) Chezy Formula for Slope of Dynamic Equation of Gradually Varied Flow Formula

Evaluate Formula

Formula



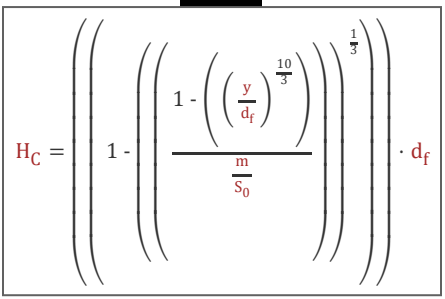
Example with Units



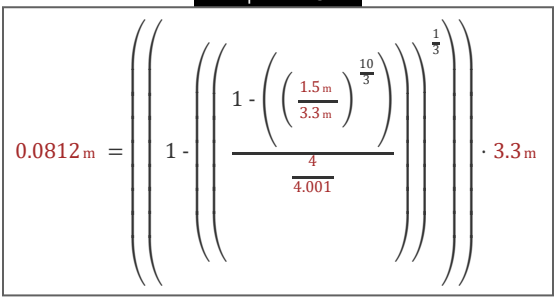
26.6) Critical Depth of Channel given Slope of Dynamic Equation of Gradually Varied Flow Formula

Evaluate Formula

Formula



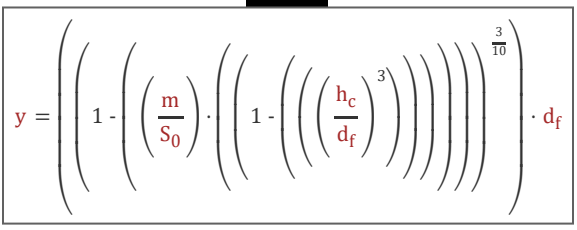
Example with Units



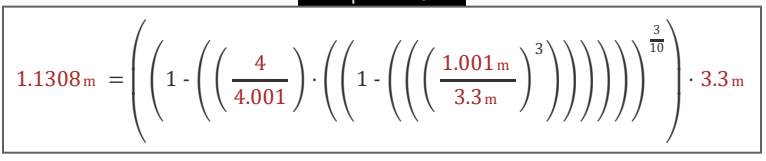
26.7) Normal Depth of Channel given Slope of Dynamic Equation of Gradually Varied Flow Formula

Evaluate Formula

Formula



Example with Units



26.8) Slope of Dynamic Equations of Gradually Varied Flow Formula

Evaluate Formula

Formula

$$m = S_0 \cdot \left(\frac{1 - \left(\left(\frac{y}{d_f} \right)^{\frac{10}{3}} \right)}{1 - \left(\left(\frac{h_c}{d_f} \right)^{3} \right)} \right)$$

Example with Units

$$3.8187 = 4.001 \cdot \left(\frac{1 - \left(\left(\frac{1.5\,\text{m}}{3.3\,\text{m}} \right)^{\frac{10}{3}} \right)}{1 - \left(\left(\frac{1.001\,\text{m}}{3.3\,\text{m}} \right)^{3} \right)} \right)$$

Variables used in list of Gradually Varied Flow in Channels Formulas above

- **C** Critical Depth of Channel *(Meter)*
- d_f Depth of Flow *(Meter)*
- E_t Total Energy in Open Channel *(Joule)*
- $F_{r(d)}$ Froude No by Dynamic Equation
- **Fr** Froude Number
- h_c Critical Depth of Weir *(Meter)*
- H_C Critical Depth of Channel GVF Flow *(Meter)*
- **i** Hydraulic Gradient to Head Loss
- **m** Slope of Line
- Q_{eg} Discharge by Energy Gradient *(Cubic Meter per Second)*
- Q_f Discharge for GVF Flow *(Cubic Meter per Second)*
- **S** Wetted Surface Area *(Square Meter)*
- S_0 Bed Slope of Channel
- S_f Energy Slope
- **T** Top Width *(Meter)*
- **y** Normal Depth *(Meter)*

Constants, Functions, Measurements used in list of Gradually Varied Flow in Channels Formulas above

- constant(s): **[g]**, 9.80665
  Gravitational acceleration on Earth
- 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: **Energy** in Joule (J)
  Energy Unit Conversion
- Measurement: **Volumetric Flow Rate** in Cubic Meter per Second (m³/s)
  Volumetric Flow Rate Unit Conversion

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