Important Culverts Formulas PDF

Formulas
Examples
with Units

List of 16
Important Culverts Formulas

1) Culverts on Subcritical Slopes Formulas

1.1) Bed Slope using Mannings Equation Formula

Evaluate Formula

Formula

$$S = \left(\frac{v_m}{\sqrt{2.2 \cdot \frac{r_h^{\frac{4}{3}}}{n \cdot n}}} \right)^2$$

Example with Units

$$0.0127 = \left(\frac{10\,\text{m/s}}{\sqrt{2.2 \cdot \frac{0.609\,\text{m}^{\frac{4}{3}}}{0.012 \cdot 0.012}}} \right)^2$$

1.2) Entrance Loss Coefficient given Head on Entrance using Mannings formula Formula

Evaluate Formula

Formula

$$K_e = \left(\frac{H_{in} - h}{\frac{2.2 \cdot S \cdot \frac{r_h^{\frac{4}{3}}}{(n \cdot n)}}{2 \cdot [g]}} \right) - 1$$

Example with Units

$$0.8499 = \left(\frac{10.647\,\text{m} - 1.2\,\text{m}}{\frac{2.2 \cdot 0.0127 \cdot \frac{0.609\,\text{m}^{\frac{4}{3}}}{(0.012 \cdot 0.012)}}{2 \cdot 9.8066\,\text{m/s}^2}} \right) - 1$$

1.3) Entrance Loss Coefficient using formula for Head on Entrance measured from Bottom of Culvert Formula

Evaluate Formula

Formula

$$K_e = \left(\frac{H_{in} - h}{v_m \cdot \frac{v_m}{2 \cdot [g]}} \right) - 1$$

Example with Units

$$0.8529 = \left(\frac{10.647\,\text{m} - 1.2\,\text{m}}{10\,\text{m/s} \cdot \frac{10\,\text{m/s}}{2 \cdot 9.8066\,\text{m/s}^2}} \right) - 1$$

1.4) Head on Entrance measured from Bottom of Culvert Formula

Evaluate Formula

Formula

$$H_{in} = \left(K_e + 1\right) \cdot \left(v_m \cdot \frac{v_m}{2 \cdot [g]}\right) + h$$

Example with Units

$$10.6324\,\text{m} = \left(0.85 + 1\right) \cdot \left(10\,\text{m/s} \cdot \frac{10\,\text{m/s}}{2 \cdot 9.8066\,\text{m/s}^2}\right) + 1.2\,\text{m}$$

1.5) Head on Entrance measured from Bottom of Culvert using Mannings formula Formula

Evaluate Formula

Formula

$$H_{in} = \left(K_e + 1\right) \cdot \left(\frac{2.2 \cdot S \cdot \frac{r_h^{\frac{4}{3}}}{n \cdot n}}{2 \cdot [g]}\right) + h$$

Example with Units

$$10.6473\,\text{m} = \left(0.85 + 1\right) \cdot \left(\frac{2.2 \cdot 0.0127 \cdot \frac{0.609\,\text{m}^{\frac{4}{3}}}{0.012 \cdot 0.012}}{2 \cdot 9.8066\,\text{m/s}^2}\right) + 1.2\,\text{m}$$

1.6) Manning's Formula for Hydraulic Radius given Velocity of Flow in Culverts Formula

Evaluate Formula

Formula

$$r_h = \left(\frac{v_m}{\sqrt{2.2 \cdot \frac{S}{n \cdot n}}}\right)^{\frac{2}{3}}$$

Example with Units

$$0.8018\,\text{m} = \left(\frac{10\,\text{m/s}}{\sqrt{2.2 \cdot \frac{0.0127}{0.012 \cdot 0.012}}}\right)^{\frac{2}{3}}$$

1.7) Manning's Formula for Roughness Coefficient given Velocity of Flow in Culverts Formula

Evaluate Formula

Formula

$$n = \frac{\sqrt{2.2 \cdot S \cdot r_h^{\frac{4}{3}}}}{v_m}$$

Example with Units

$$0.012 = \frac{\sqrt{2.2 \cdot 0.0127 \cdot 0.609\,\text{m}^{\frac{4}{3}}}}{10\,\text{m/s}}$$

1.8) Normal Depth of Flow given Head on Entrance measured from Bottom of Culvert Formula

Evaluate Formula

Formula

$$h = H_{in} - \left(K_e + 1\right) \cdot \left(v_m \cdot \frac{v_m}{2 \cdot [g]}\right)$$

Example with Units

$$1.2146\,\text{m} = 10.647\,\text{m} - \left(0.85 + 1\right) \cdot \left(10\,\text{m/s} \cdot \frac{10\,\text{m/s}}{2 \cdot 9.8066\,\text{m/s}^2}\right)$$

1.9) Normal Depth of Flow given Head on Entrance measured from Bottom using Mannings formula Formula

Evaluate Formula

Formula

$$h = H_{in} - \left(K_e + 1\right) \cdot \left(\frac{2.2 \cdot S \cdot \frac{r_h^{\frac{4}{3}}}{\left(n \cdot n\right)}}{2 \cdot [g]}\right)$$

Example with Units

$$1.1997\,\text{m} = 10.647\,\text{m} - \left(0.85 + 1\right) \cdot \left(\frac{2.2 \cdot 0.0127 \cdot \frac{0.609\,\text{m}^{\frac{4}{3}}}{\left(0.012 \cdot 0.012\right)}}{2 \cdot 9.8066\,\text{m/s}^2}\right)$$

1.10) Velocity of Flow given Head on Entrance measured from Bottom of Culvert Formula

Evaluate Formula

Formula

$$v_m = \sqrt{\left(H_{in} - h\right) \cdot \frac{2 \cdot [g]}{K_e + 1}}$$

Example with Units

$$10.0077\,\text{m/s} = \sqrt{\left(10.647\,\text{m} - 1.2\,\text{m}\right) \cdot \frac{2 \cdot 9.8066\,\text{m/s}^2}{0.85 + 1}}$$

1.11) Velocity of Flow through Mannings Formulas in Culverts Formula

Evaluate Formula

Formula

$$v_m = \sqrt{2.2 \cdot S \cdot \frac{r_h^{\frac{4}{3}}}{n \cdot n}}$$

Example with Units

$$10.0079\,\text{m/s} = \sqrt{2.2 \cdot 0.0127 \cdot \frac{0.609\,\text{m}^{\frac{4}{3}}}{0.012 \cdot 0.012}}$$

2) Entrance and Exit Submerged Formulas

2.1) Entrance Loss Coefficient given Velocity of Flow Fields Formula

Evaluate Formula

Formula

$$K_e = 1 - \left(\frac{H_f - \frac{\left(\left(v_m \cdot n \right)^2 \right) \cdot l}{2.21 \cdot r_h^{1.33333}}}{v_m \cdot \frac{v_m}{2 \cdot [g]}} \right)$$

Example with Units

$$0.85 = 1 - \left(\frac{0.8027\,\text{m} - \frac{\left(\left(10\,\text{m/s} \cdot 0.012 \right)^2 \right) \cdot 3\,\text{m}}{2.21 \cdot 0.609\,\text{m}^{1.33333}}}{10\,\text{m/s} \cdot \frac{10\,\text{m/s}}{2 \cdot 9.8066\,\text{m/s}^2}} \right)$$

2.2) Head Loss in Flow Formula

Evaluate Formula

Formula

$$H_f = \left(1 - K_e \right) \cdot \left(v_m \cdot \frac{v_m}{2 \cdot [g]} \right) + \frac{\left(\left(v_m \cdot n \right)^2 \right) \cdot l}{2.21 \cdot r_h^{1.33333}}$$

Example with Units

$$0.8027\,\text{m} = \left(1 - 0.85 \right) \cdot \left(10\,\text{m/s} \cdot \frac{10\,\text{m/s}}{2 \cdot 9.8066\,\text{m/s}^2} \right) + \frac{\left(\left(10\,\text{m/s} \cdot 0.012 \right)^2 \right) \cdot 3\,\text{m}}{2.21 \cdot 0.609\,\text{m}^{1.33333}}$$

2.3) Hydraulic Radius of Culvert given Velocity of Flow Fields Formula

Evaluate Formula

Formula

$$r_h = \left(\frac{\left(\left(v_m \cdot n \right)^2 \right) \cdot l}{2.21 \cdot \left(H_f - \left(1 - K_e \right) \cdot \left(v_m \cdot \frac{v_m}{2 \cdot [g]} \right) \right)} \right)^{0.75}$$

Example with Units

$$0.6085\,\text{m} = \left(\frac{\left(\left(10\,\text{m/s} \cdot 0.012 \right)^2 \right) \cdot 3\,\text{m}}{2.21 \cdot \left(0.8027\,\text{m} - \left(1 - 0.85 \right) \cdot \left(10\,\text{m/s} \cdot \frac{10\,\text{m/s}}{2 \cdot 9.8066\,\text{m/s}^2} \right) \right)} \right)^{0.75}$$

2.4) Length of Culvert given Velocity of Flow Fields Formula

Evaluate Formula

Formula

$$l = \frac{H_f - \left(1 - K_e\right) \cdot \left(v_m \cdot \frac{v_m}{2 \cdot [g]}\right)}{\frac{\left(\left(v_m \cdot n\right)^2\right)}{2.21 \cdot r_h^{1.33333}}}$$

Example with Units

$$3.0036\,\text{m} = \frac{0.8027\,\text{m} - \left(1 - 0.85\right) \cdot \left(10\,\text{m/s} \cdot \frac{10\,\text{m/s}}{2 \cdot 9.8066\,\text{m/s}^2}\right)}{\frac{\left(\left(10\,\text{m/s} \cdot 0.012\right)^2\right)}{2.21 \cdot 0.609\,\text{m}^{1.33333}}}$$

2.5) Velocity of Flow Fields Formula

Evaluate Formula

Formula

$$v_m = \sqrt{\frac{H_f}{\frac{1 - K_e}{\left(2 \cdot [g]\right)} + \frac{\left(\left(n\right)^2\right) \cdot l}{2.21 \cdot r_h^{1.33333}}}}$$

Example with Units

$$10.0003\,\text{m/s} = \sqrt{\frac{0.8027\,\text{m}}{\frac{1 - 0.85}{\left(2 \cdot 9.8066\,\text{m/s}^2\right)} + \frac{\left(\left(0.012\right)^2\right) \cdot 3\,\text{m}}{2.21 \cdot 0.609\,\text{m}^{1.33333}}}}$$

Variables used in list of Culverts Formulas above

- **h** Normal Depth of Flow *(Meter)*
- H_f Head Loss of Friction *(Meter)*
- H_{in} Total Head at Entrance of Flow *(Meter)*
- K_e Entrance Loss Coefficient
- **l** Length of Culverts *(Meter)*
- **n** Manning's Roughness Coefficient
- r_h Hydraulic Radius of Channel *(Meter)*
- **S** Bed Slope of Channel
- v_m Mean Velocity of Culverts *(Meter per Second)*

Constants, Functions, Measurements used in list of Culverts 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: **Speed** in Meter per Second (m/s)
  Speed Unit Conversion

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