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Culverts Formulas

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List of 16 Culverts Formulas

Culverts

Culverts on Subcritical Slopes

1) Bed Slope using Mannings Equation

Open Calculator

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

ex $$0.01268 = \left(\frac{10\text{m/s}}{\sqrt{2.2 \cdot \frac{(0.609\text{m})^{\frac{4}{3}}}{0.012 \cdot 0.012}}} \right)^2$$

2) Entrance Loss Coefficient given Head on Entrance using Mannings formula

Open Calculator

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

$$0.84994 = \left(\frac{10.647\text{m} - 1.2\text{m}}{\frac{2.2 \cdot 0.0127 \cdot \frac{(0.609\text{m})^{\frac{4}{3}}}{(0.012 \cdot 0.012)}}{2 \cdot [g]}} \right) - 1$$

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

Open Calculator

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

$$0.852868 = \left(\frac{10.647\text{m} - 1.2\text{m}}{10\text{m/s} \cdot \frac{10\text{m/s}}{2 \cdot [g]}} \right) - 1$$

4) Head on Entrance measured from Bottom of Culvert

Open Calculator

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

ex $$10.63237\text{m} = (0.85 + 1) \cdot \left(10\text{m/s} \cdot \frac{10\text{m/s}}{2 \cdot [g]} \right) + 1.2\text{m}$$

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

Open Calculator

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

ex $$10.64731\text{m} = (0.85 + 1) \cdot \left(\frac{2.2 \cdot 0.0127 \cdot \frac{(0.609\text{m})^{\frac{4}{3}}}{0.012 \cdot 0.012}}{2 \cdot [g]} \right) + 1.2\text{m}$$

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

Open Calculator

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

ex $$0.801762\text{m} = \left(\frac{10\text{m/s}}{\sqrt{2.2 \cdot \frac{0.0127}{0.012 \cdot 0.012}}} \right)^{\frac{2}{3}}$$

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

Open Calculator

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

ex $$0.012009 = \frac{\sqrt{2.2 \cdot 0.0127 \cdot (0.609\text{m})^{\frac{4}{3}}}}{10\text{m/s}}$$

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

Open Calculator

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

ex $$1.214625\text{m} = 10.647\text{m} - (0.85 + 1) \cdot \left(10\text{m/s} \cdot \frac{10\text{m/s}}{2 \cdot [g]}\right)$$

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

Open Calculator

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

ex $$1.199693\text{m} = 10.647\text{m} - (0.85 + 1) \cdot \left(\frac{2.2 \cdot 0.0127 \cdot \frac{(0.609\text{m})^{\frac{4}{3}}}{(0.012 \cdot 0.012)}}{2 \cdot [g]}\right)$$

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

Open Calculator

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

ex $$10.00775 \text{m/s} = \sqrt{(10.647 \text{m} - 1.2 \text{m}) \cdot \frac{2 \cdot [g]}{0.85 + 1}}$$

11) Velocity of Flow through Mannings Formulas in Culverts

Open Calculator

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

ex $$10.00791 \text{m/s} = \sqrt{2.2 \cdot 0.0127 \cdot \frac{(0.609 \text{m})^{\frac{4}{3}}}{0.012 \cdot 0.012}}$$

Entrance and Exit Submerged

12) Entrance Loss Coefficient given Velocity of Flow Fields

Open Calculator

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

ex $$0.849991 = 1 - \left(\frac{0.8027\text{m} - \frac{\left((10\text{m/s} \cdot 0.012)^2\right) \cdot 3\text{m}}{2.21 \cdot (0.609\text{m})^{1.33333}}}{10\text{m/s} \cdot \frac{10\text{m/s}}{2 \cdot [g]}} \right)$$

13) Head Loss in Flow

Open Calculator

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

ex $$0.802655\text{m} = (1 - 0.85) \cdot \left(10\text{m/s} \cdot \frac{10\text{m/s}}{2 \cdot [g]} \right) + \frac{\left((10\text{m/s} \cdot 0.012)^2\right) \cdot 3\text{m}}{2.21 \cdot (0.609\text{m})^{1.33333}}$$

14) Hydraulic Radius of Culvert given Velocity of Flow Fields

Open Calculator

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

ex
$$0.608456\text{m} = \left(\frac{\left((10\text{m/s} \cdot 0.012)^2 \right) \cdot 3\text{m}}{2.21 \cdot \left(0.8027\text{m} - (1 - 0.85) \cdot \left(10\text{m/s} \cdot \frac{10\text{m/s}}{2 \cdot [g]} \right) \right)} \right)^{0.75}$$

15) Length of Culvert given Velocity of Flow Fields

Open Calculator

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

ex
$$3.003585\text{m} = \frac{0.8027\text{m} - (1 - 0.85) \cdot \left(10\text{m/s} \cdot \frac{10\text{m/s}}{2 \cdot [g]} \right)}{\frac{\left((10\text{m/s} \cdot 0.012)^2 \right)}{2.21 \cdot (0.609\text{m})^{1.33333}}}$$

16) Velocity of Flow Fields

Open Calculator

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

$$10.00028\text{m/s} = \sqrt{\frac{0.8027\text{m}}{\frac{1-0.85}{(2\cdot[g])} + \frac{\left((0.012)^2\right)\cdot 3\text{m}}{2.21\cdot(0.609\text{m})^{1.33333}}}}$$

Variables Used

- **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

- Constant: **[g]**, 9.80665 Meter/Second²
  Gravitational acceleration on Earth
- Function: **sqrt**, sqrt(Number)
  Square root function
- Measurement: **Length** in Meter (m)
  Length Unit Conversion
- Measurement: **Speed** in Meter per Second (m/s)
  Speed Unit Conversion

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