Important Canal Design Formulas PDF

Formulas
Examples
with Units

List of 17
Important Canal Design Formulas

1) Design of Lined Irrigation Channels Formulas

1.1) Area of Trapezoidal Channel Section for Smaller Discharge Formula

Evaluate Formula

Formula

$$A = (B \cdot y) + y^2 \cdot (\theta + \cot(\theta))$$

Example with Units

$$83.2528\,\text{m}^2 = (48\,\text{m} \cdot 1.635\,\text{m}) + 1.635\,\text{m}^2 \cdot (45° + \cot(45°))$$

1.2) Area of Triangular Channel Section for Small Discharges Formula

Evaluate Formula

Formula

$$A = y^2 \cdot (\theta + \cot(\theta))$$

Example with Units

$$4.7728\,\text{m}^2 = 1.635\,\text{m}^2 \cdot (45° + \cot(45°))$$

1.3) Hydraulic Mean Depth of Triangular Section Formula

Evaluate Formula

Formula

$$H = \frac{y^2 \cdot (\theta + \cot(\theta))}{2 \cdot y \cdot (\theta + \cot(\theta))}$$

Example with Units

$$0.8175\,\text{m} = \frac{1.635\,\text{m}^2 \cdot (45° + \cot(45°))}{2 \cdot 1.635\,\text{m} \cdot (45° + \cot(45°))}$$

1.4) Perimeter of Trapezoidal Channel Section for Small Discharges Formula

Evaluate Formula

Formula

$$P = B + (2 \cdot y \cdot \theta + 2 \cdot y \cdot \cot(\theta))$$

Example with Units

$$53.8383\,\text{m} = 48\,\text{m} + (2 \cdot 1.635\,\text{m} \cdot 45° + 2 \cdot 1.635\,\text{m} \cdot \cot(45°))$$

1.5) Perimeter of Triangular Channel Section for Small Discharges Formula

Evaluate Formula

Formula

$$P = 2 \cdot y \cdot (\theta + \cot(\theta))$$

Example with Units

$$5.8383\,\text{m} = 2 \cdot 1.635\,\text{m} \cdot (45° + \cot(45°))$$

2) Design of Non-Scouring Stable Channels having Protected Side Slopes (Shield's Entrainmnet Method) Formulas

2.1) Drag Force Exerted by Flow Formula

Evaluate Formula

Formula

$$F_1 = K_1 \cdot \left(C_D \right) \cdot \left(d^2 \right) \cdot \left(0.5 \right) \cdot \left(\rho_w \right) \cdot \left(V^\circ \right)$$

Example with Units

$$0.0152\,\text{N} = 1.20 \cdot \left(0.47 \right) \cdot \left(6\,\text{mm}^2 \right) \cdot \left(0.5 \right) \cdot \left(1000\,\text{kg/m}^3 \right) \cdot \left(1.5\,\text{m/s} \right)$$

2.2) General Relation between Resisting Shear and Diameter of Particle Formula

Evaluate Formula

Formula

$$\zeta_c = 0.155 + \left(0.409 \cdot \frac{d^2}{\sqrt{1 + 0.77 \cdot d^2}} \right)$$

Example with Units

$$0.0002\,\text{kN/m}^2 = 0.155 + \left(0.409 \cdot \frac{6\,\text{mm}^2}{\sqrt{1 + 0.77 \cdot 6\,\text{mm}^2}} \right)$$

2.3) Manning's Rugosity Coefficient according to Stickler's Formula Formula

Evaluate Formula

Formula

$$n = \left(\frac{1}{24} \right) \cdot \left(d \right)^{\frac{1}{6}}$$

Example with Units

$$0.0178 = \left(\frac{1}{24} \right) \cdot \left(6\,\text{mm} \right)^{\frac{1}{6}}$$

2.4) Resisting Shear against Movement of Particle Formula

Evaluate Formula

Formula

$$\zeta_c = 0.056 \cdot \Gamma_w \cdot d \cdot \left(S_s - 1 \right)$$

Example with Units

$$0.0054\,\text{kN/m}^2 = 0.056 \cdot 9.807\,\text{kN/m}^3 \cdot 6\,\text{mm} \cdot \left(2.65 - 1 \right)$$

2.5) Unprotected Side Slopes Shear Stress Required to Move Single Grain Formula

Evaluate Formula

Formula

$$\zeta c' = \zeta_c \cdot \sqrt{1 - \left(\frac{\sin\left(\theta \right)^2}{\sin\left(\Phi \right)^2} \right)}$$

Example with Units

$$0.0031\,\text{kN/m}^2 = 0.005437\,\text{kN/m}^2 \cdot \sqrt{1 - \left(\frac{\sin\left(45^\circ \right)^2}{\sin\left(60^\circ \right)^2} \right)}$$

3) Kennedy's Theory Formulas

3.1) Kutter's Formula Formula

Evaluate Formula

Formula

$$V = \left(\frac{1}{n} + \frac{23 + \left(\frac{0.00155}{S}\right)}{1 + \left(23 + \left(\frac{0.00155}{S}\right)\right)} \cdot \left(\frac{n}{\sqrt{R}}\right)\right) \cdot \left(\sqrt{R \cdot S}\right)$$

Example with Units

$$1.5364\,\text{m/s} = \left(\frac{1}{0.0177} + \frac{23 + \left(\frac{0.00155}{0.000333}\right)}{1 + \left(23 + \left(\frac{0.00155}{0.000333}\right)\right)} \cdot \left(\frac{0.0177}{\sqrt{2.22\,\text{m}}}\right)\right) \cdot \left(\sqrt{2.22\,\text{m} \cdot 0.000333}\right)$$

3.2) R G Kennedy Equation for Critical Velocity Formula

Evaluate Formula

Formula

$$V^{\circ} = 0.55 \cdot m \cdot \left(Y^{0.64}\right)$$

Example with Units

$$1.4982\,\text{m/s} = 0.55 \cdot 1.2 \cdot \left(3.6\,\text{m}^{0.64}\right)$$

4) Lacey's Theory Formulas

4.1) Area of Regime Channel Section Formula

Evaluate Formula

Formula

$$A = \left(\frac{Q}{V}\right)$$

Example with Units

$$27.8441\,\text{m}^2 = \left(\frac{35\,\text{m}^3/\text{s}}{1.257\,\text{m/s}}\right)$$

4.2) Bed Slope of Channel Formula

Evaluate Formula

Formula

$$S = \frac{f^{\frac{5}{3}}}{3340 \cdot Q^{\frac{1}{6}}}$$

Example with Units

$$0.0018 = \frac{4.22^{\frac{5}{3}}}{3340 \cdot 35\,\text{m}^3/\text{s}^{\frac{1}{6}}}$$

4.3) Hydraulic Mean Depth for Regime Channel using Lacey's Theory Formula

Evaluate Formula

Formula

$$R = \left(\frac{5}{2}\right) \cdot \left(\frac{(V)^2}{f}\right)$$

Example with Units

$$0.936\,\text{m} = \left(\frac{5}{2}\right) \cdot \left(\frac{(1.257\,\text{m/s})^2}{4.22}\right)$$

4.4) Velocity for Regime Channel using Lacey's Theory Formula

Evaluate Formula

Formula

$$V = \left(\frac{Q \cdot f^2}{140} \right)^{0.166}$$

Example with Units

$$1.2813\,\text{m/s} = \left(\frac{35\,\text{m}^3/\text{s} \cdot 4.22^2}{140} \right)^{0.166}$$

4.5) Wetted Perimeter of Channel Formula

Evaluate Formula

Formula

$$P = 4.75 \cdot \sqrt{Q}$$

Example with Units

$$28.1014\,\text{m} = 4.75 \cdot \sqrt{35\,\text{m}^3/\text{s}}$$

Variables used in list of Canal Design Formulas above

- **A** Area of Channel *(Square Meter)*
- **B** Bed Width of Channel *(Meter)*
- C_D Coefficient of Drag Exerted by Flow
- **d** Diameter of Particle *(Millimeter)*
- **f** Silt Factor
- F_1 Drag Force Exerted by Flow *(Newton)*
- **H** Hydraulic Mean Depth of Triangular Section *(Meter)*
- K_1 Factor Depending on Shape of Particles
- **m** Critical Velocity Ratio
- **n** Rugosity Coefficient
- **P** Perimeter of Channel *(Meter)*
- **Q** Discharge for Regime Channel *(Cubic Meter per Second)*
- **R** Hydraulic Mean Depth in Meters *(Meter)*
- **S** Bed Slope of Channel
- S_s Specific Gravity of Particles
- **V** Velocity of Flow in Meter *(Meter per Second)*
- V° Velocity Flow at Bottom of Channel *(Meter per Second)*
- **y** Depth of Canal with Trapezoidal Cross Section *(Meter)*
- **Y** Water Depth in Channel *(Meter)*
- Γ_w Unit Weight of Water *(Kilonewton per Cubic Meter)*
- ζ_c Resisting Shear against Movement of Particle *(Kilonewton per Square Meter)*
- $\zeta c'$ Critical Shear Stress on Horizontal Bed *(Kilonewton per Square Meter)*
- **θ** Side Slope *(Degree)*
- ρ_w Density of Flowing Fluid *(Kilogram per Cubic Meter)*
- **Φ** Angle of Repose of Soil *(Degree)*

Constants, Functions, Measurements used in list of Canal Design Formulas above

- Functions: **cot**, cot(Angle)
  Cotangent is a trigonometric function that is defined as the ratio of the adjacent side to the opposite side in a right triangle.
- Functions: **sin**, sin(Angle)
  Sine is a trigonometric function that describes the ratio of the length of the opposite side of a right triangle to the length of the hypotenuse.
- 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), Millimeter (mm)
  Length Unit Conversion
- Measurement: **Area** in Square Meter (m²)
  Area Unit Conversion
- Measurement: **Speed** in Meter per Second (m/s)
  Speed Unit Conversion
- Measurement: **Force** in Newton (N)
  Force Unit Conversion
- Measurement: **Angle** in Degree (°)
  Angle Unit Conversion
- Measurement: **Volumetric Flow Rate** in Cubic Meter per Second (m³/s)
  Volumetric Flow Rate Unit Conversion
- Measurement: **Density** in Kilogram per Cubic Meter (kg/m³)
  Density Unit Conversion
- Measurement: **Specific Weight** in Kilonewton per Cubic Meter (kN/m³)
  Specific Weight Unit Conversion
- Measurement: **Stress** in Kilonewton per Square Meter (kN/m²)
  Stress Unit Conversion

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