Important Earth Dam and Gravity Dam Formulas PDF

Formulas
Examples
with Units

List of 34
Important Earth Dam and Gravity Dam Formulas

1) Earth dam Formulas

1.1) Coefficient of permiability of earth dam Formulas

1.1.1) Coefficient of Permeability given Maximum and Minimum Permeability for Earth Dam Formula

Evaluate Formula

Formula

$$k = \sqrt{K_o \cdot \mu_r}$$

Example with Units

$$11.3274\,\mathrm{cm/s} = \sqrt{0.00987\,\mathrm{m^2} \cdot 1.3\,\mathrm{H/m}}$$

1.1.2) Coefficient of Permeability given Quantity of Seepage in Length of Dam Formula

Evaluate Formula

Formula

$$k = \frac{Q_t \cdot N}{B \cdot H_L \cdot L}$$

Example with Units

$$4.6465\,\mathrm{cm/s} = \frac{0.46\,\mathrm{m^3/s} \cdot 4}{2 \cdot 6.6\,\mathrm{m} \cdot 3\,\mathrm{m}}$$

1.1.3) Coefficient of Permeability Given Seepage Discharge in Earth Dam Formula

Evaluate Formula

Formula

$$k = \frac{Q_t}{i \cdot A_{cs} \cdot t}$$

Example with Units

$$0.292\,\mathrm{cm/s} = \frac{0.46\,\mathrm{m^3/s}}{2.02 \cdot 13\,\mathrm{m^2} \cdot 6\,\mathrm{s}}$$

1.1.4) Maximum Permeability given Coefficient of Permeability for Earth Dam Formula

Evaluate Formula

Formula

$$K_o = \frac{k^2}{\mu_r}$$

Example with Units

$$0.0077\,\mathrm{m^2} = \frac{\left(10\,\mathrm{cm/s}\right)^2}{1.3\,\mathrm{H/m}}$$

1.1.5) Minimum Permeability given Coefficient of Permeability for Earth Dam Formula

Evaluate Formula

Formula

$$\mu_r = \frac{k^2}{K_o}$$

Example with Units

$$1.0132\,\mathrm{H/m} = \frac{\left(10\,\mathrm{cm/s}\right)^2}{0.00987\,\mathrm{m^2}}$$

1.2) Quantity of seepage Formulas

1.2.1) Head difference between Headwater and Tail Water given Quantity of Seepage in Length of Dam Formula

Evaluate Formula

Formula	Example with Units
$H_L = \frac{Q \cdot N}{B \cdot k \cdot L}$	$6.3333\,\text{m} = \frac{0.95\,\text{m}^3/\text{s} \cdot 4}{2 \cdot 10\,\text{cm/s} \cdot 3\,\text{m}}$

1.2.2) Length of Dam to which Flow Net applies given Quantity of Seepage in Length of Dam Formula

Evaluate Formula

Formula	Example with Units
$L = \frac{Q \cdot N}{B \cdot H_L \cdot k}$	$2.8788\,\text{m} = \frac{0.95\,\text{m}^3/\text{s} \cdot 4}{2 \cdot 6.6\,\text{m} \cdot 10\,\text{cm/s}}$

1.2.3) Number of Equipotential Drops of Net given Quantity of Seepage in Length of Dam Formula

Evaluate Formula

Formula	Example with Units
$N = \frac{k \cdot B \cdot H_L \cdot L}{Q}$	$4.1684 = \frac{10\,\text{cm/s} \cdot 2 \cdot 6.6\,\text{m} \cdot 3\,\text{m}}{0.95\,\text{m}^3/\text{s}}$

1.2.4) Number of Flow Channels of Net Water given Quantity of Seepage in Length of Dam Formula

Evaluate Formula

Formula	Example with Units
$B = \frac{Q \cdot N}{H_L \cdot k \cdot L}$	$1.9192 = \frac{0.95\,\text{m}^3/\text{s} \cdot 4}{6.6\,\text{m} \cdot 10\,\text{cm/s} \cdot 3\,\text{m}}$

1.2.5) Quantity of Seepage in Length of Dam under Consideration Formula

Evaluate Formula

Formula	Example with Units
$Q = \frac{k \cdot B \cdot H_L \cdot L}{N}$	$0.99\,\text{m}^3/\text{s} = \frac{10\,\text{cm/s} \cdot 2 \cdot 6.6\,\text{m} \cdot 3\,\text{m}}{4}$

1.2.6) Seepage Discharge in Earth Dam Formula

Evaluate Formula

Formula	Example with Units
$Q_s = k \cdot i \cdot A_{cs} \cdot t$	$15.756\,\text{m}^3/\text{s} = 10\,\text{cm/s} \cdot 2.02 \cdot 13\,\text{m}^2 \cdot 6\,\text{s}$

1.3) Slope protection Formulas

1.3.1) Fetch given Height of Waves for Fetch more than 20 miles Formula

Evaluate Formula

Formula

$$F = \frac{\left(\frac{h_a}{0.17}\right)^2}{V_w}$$

Example with Units

$$257.5087\,\mathrm{m} = \frac{\left(\frac{12.2\,\mathrm{m}}{0.17}\right)^2}{20\,\mathrm{m/s}}$$

1.3.2) Height of Wave from Trough to Crest given Velocity between 1 and 7 feet Formula

Evaluate Formula

Formula

$$h_a = \frac{V_w - 7}{2}$$

Example with Units

$$6.5\,\mathrm{m} = \frac{20\,\mathrm{m/s} - 7}{2}$$

1.3.3) Molitor-Stevenson equation for Height of Waves for Fetch less than 20 miles Formula

Evaluate Formula

Formula

$$h_a = 0.17 \cdot \left(V_w \cdot F\right)^{0.5} + 2.5 - F^{0.25}$$

Example with Units

$$4.9675\,\mathrm{m} = 0.17 \cdot \left(20\,\mathrm{m/s} \cdot 44\,\mathrm{m}\right)^{0.5} + 2.5 - 44\,\mathrm{m}^{0.25}$$

1.3.4) Molitor-Stevenson equation for Height of Waves for Fetch more than 20 miles Formula

Evaluate Formula

Formula

$$h_a = 0.17 \cdot \left(V_w \cdot F\right)^{0.5}$$

Example with Units

$$5.043\,\mathrm{m} = 0.17 \cdot \left(20\,\mathrm{m/s} \cdot 44\,\mathrm{m}\right)^{0.5}$$

1.3.5) Velocity when Wave Heights between 1 and 7 feet Formula

Evaluate Formula

Formula

$$V_w = 7 + 2 \cdot h_a$$

Example with Units

$$31.4\,\mathrm{m/s} = 7 + 2 \cdot 12.2\,\mathrm{m}$$

1.4) Wind velocity Formulas

1.4.1) Wind Velocity given Height of Waves for Fetch less than 20 miles Formula

Evaluate Formula

Formula

$$V_w = \frac{\left(\frac{h_a}{0.17}\right)^2}{F}$$

Example with Units

$$117.0494\,\mathrm{m/s} = \frac{\left(\frac{12.2\,\mathrm{m}}{0.17}\right)^2}{44\,\mathrm{m}}$$

1.4.2) Wind Velocity given Height of Waves for Fetch more than 20 miles Formula

Evaluate Formula

Formula

$$V_w = \frac{\left(\frac{h_a - \left(2.5 - F^{0.25}\right)}{0.17}\right)^2}{F}$$

Example with Units

$$118.5028\,\text{m/s} = \frac{\left(\frac{12.2\,\text{m} - \left(2.5 - 44\,\text{m}^{0.25}\right)}{0.17}\right)^2}{44\,\text{m}}$$

1.4.3) Zuider Zee Formula for Wind Velocity given Height of Wave Action Formula

Evaluate Formula

Formula

$$V_w = \left(\left(\frac{\left(\frac{h_a}{H}\right) - 0.75}{1.5}\right) \cdot \left(2 \cdot [g]\right)\right)^{0.5}$$

Example with Units

$$19.723\,\text{m/s} = \left(\left(\frac{\left(\frac{12.2\,\text{m}}{0.4\,\text{m}}\right) - 0.75}{1.5}\right) \cdot \left(2 \cdot 9.8066\,\text{m/s}^2\right)\right)^{0.5}$$

1.4.4) Zuider Zee Formula for Wind Velocity given Setup above Pool Level Formula

Evaluate Formula

Formula

$$V_w = \left(\frac{h_a}{\frac{F \cdot \cos(\theta)}{1400 \cdot d}}\right)^{\frac{1}{2}}$$

Example with Units

$$20.9587\,\text{m/s} = \left(\frac{12.2\,\text{m}}{\frac{44\,\text{m} \cdot \cos(30°)}{1400 \cdot 0.98\,\text{m}}}\right)^{\frac{1}{2}}$$

1.5) Zuider zee formula Formulas

1.5.1) Angle of Incidence of Waves by Zuider Zee formula Formula

Evaluate Formula

Formula

$$\theta = acos\left(\frac{h \cdot (1400 \cdot d)}{\left(V^2\right) \cdot F}\right)$$

Example with Units

$$69.309° = acos\left(\frac{15.6\,\text{m} \cdot (1400 \cdot 0.98\,\text{m})}{\left(83\,\text{mi/h}^2\right) \cdot 44\,\text{m}}\right)$$

1.5.2) Height of Wave Action using Zuider Zee Formula Formula

Evaluate Formula

Formula

$$h_a = H \cdot \left(0.75 + 1.5 \cdot \frac{V_w^2}{2 \cdot [g]}\right)$$

Example with Units

$$12.5366\,\text{m} = 0.4\,\text{m} \cdot \left(0.75 + 1.5 \cdot \frac{20\,\text{m/s}^2}{2 \cdot 9.8066\,\text{m/s}^2}\right)$$

1.5.3) Height of Wave from Trough to Crest given Height of Wave Action by Zuider Zee Formula Formula

Evaluate Formula

Formula

$$H = \frac{h_a}{0.75 + 1.5 \cdot \frac{V_w^2}{2 \cdot [g]}}$$

Example with Units

$$0.3893\,\text{m} = \frac{12.2\,\text{m}}{0.75 + 1.5 \cdot \frac{20\,\text{m/s}^2}{2 \cdot 9.8066\,\text{m/s}^2}}$$

1.5.4) Setup above Pool Level using Zuider Zee Formula Formula

Evaluate Formula

Formula

$$h_a = \frac{(V_w \cdot V_w) \cdot F \cdot \cos(\theta)}{1400 \cdot d}$$

Example with Units

$$11.1094\,\text{m} = \frac{(20\,\text{m/s} \cdot 20\,\text{m/s}) \cdot 44\,\text{m} \cdot \cos(30°)}{1400 \cdot 0.98\,\text{m}}$$

1.5.5) Zuider Zee formula for Average depth of Water given Setup above Pool level Formula

Evaluate Formula

Formula

$$d = \frac{(V_w \cdot V_w) \cdot F \cdot \cos(\theta)}{1400 \cdot h_a}$$

Example with Units

$$0.8924\,\text{m} = \frac{(20\,\text{m/s} \cdot 20\,\text{m/s}) \cdot 44\,\text{m} \cdot \cos(30°)}{1400 \cdot 12.2\,\text{m}}$$

1.5.6) Zuider Zee Formula for Fetch Length given Setup above Pool Level Formula

Evaluate Formula

Formula

$$F = \frac{h_a}{\frac{(V_w \cdot V_w) \cdot \cos(\theta)}{1400 \cdot d}}$$

Example with Units

$$48.3196\,\text{m} = \frac{12.2\,\text{m}}{\frac{(20\,\text{m/s} \cdot 20\,\text{m/s}) \cdot \cos(30°)}{1400 \cdot 0.98\,\text{m}}}$$

2) Gravity Dam Formulas

2.1) Density of Water given Water Pressure in Gravity Dam Formula

Evaluate Formula

Formula

$$\rho_{Water} = \frac{P_W}{0.5} \cdot \left(H_S^2\right)$$

Example with Units

$$729\,\text{kg/m}^3 = \frac{450\,\text{Pa}}{0.5} \cdot \left(0.9\,\text{m}^2\right)$$

2.2) Eccentricity for Vertical Normal Stress at Downstream Face Formula

Evaluate Formula

Formula

$$e_d = \left(1 + \left(\frac{\sigma_z}{\frac{F_v}{144 \cdot T}}\right)\right) \cdot \frac{T}{6}$$

Example with Units

$$19.7267 = \left(1 + \left(\frac{2.5\,\text{Pa}}{\frac{15\,\text{N}}{144 \cdot 2.2\,\text{m}}}\right)\right) \cdot \frac{2.2\,\text{m}}{6}$$

2.3) Eccentricity given Vertical Normal Stress at Upstream Face Formula

Evaluate Formula

Formula

$$e_u = \left(1 - \left(\frac{\sigma_z}{\frac{F_v}{144 \cdot T}}\right)\right) \cdot \frac{T}{6}$$

Example with Units

$$-18.9933 = \left(1 - \left(\frac{2.5\,\text{Pa}}{\frac{15\,\text{N}}{144 \cdot 2.2\,\text{m}}}\right)\right) \cdot \frac{2.2\,\text{m}}{6}$$

2.4) Total Vertical Force for Vertical Normal Stress at Upstream Face Formula

Evaluate Formula

Formula

$$F_v = \frac{\sigma_z}{\left(\frac{1}{144 \cdot T}\right) \cdot \left(1 - \left(\frac{6 \cdot e_u}{T}\right)\right)}$$

Example with Units

$$14.9948\,\text{N} = \frac{2.5\,\text{Pa}}{\left(\frac{1}{144 \cdot 2.2\,\text{m}}\right) \cdot \left(1 - \left(\frac{6 \cdot -19}{2.2\,\text{m}}\right)\right)}$$

2.5) Total Vertical Force given Vertical Normal Stress at Downstream Face Formula

Evaluate Formula

Formula

$$F_v = \frac{\sigma_z}{\left(\frac{1}{144 \cdot T}\right) \cdot \left(1 + \left(\frac{6 \cdot e_d}{T}\right)\right)}$$

Example with Units

$$14.9948\,\text{N} = \frac{2.5\,\text{Pa}}{\left(\frac{1}{144 \cdot 2.2\,\text{m}}\right) \cdot \left(1 + \left(\frac{6 \cdot 19}{2.2\,\text{m}}\right)\right)}$$

2.6) Vertical Normal Stress at Downstream Face Formula

Evaluate Formula

Formula

$$\sigma_z = \left(\frac{F_v}{144 \cdot T}\right) \cdot \left(1 + \left(\frac{6 \cdot e_d}{T}\right)\right)$$

Example with Units

$$2.5009\,\text{Pa} = \left(\frac{15\,\text{N}}{144 \cdot 2.2\,\text{m}}\right) \cdot \left(1 + \left(\frac{6 \cdot 19}{2.2\,\text{m}}\right)\right)$$

2.7) Vertical Normal Stress at Upstream Face Formula

Evaluate Formula

Formula

$$\sigma_z = \left(\frac{F_v}{144 \cdot T}\right) \cdot \left(1 - \left(\frac{6 \cdot e_u}{T}\right)\right)$$

Example with Units

$$2.5009\,\text{Pa} = \left(\frac{15\,\text{N}}{144 \cdot 2.2\,\text{m}}\right) \cdot \left(1 - \left(\frac{6 \cdot -19}{2.2\,\text{m}}\right)\right)$$

2.8) Water Pressure in Gravity Dam Formula

Evaluate Formula

Formula

$$P_W = 0.5 \cdot \rho_{Water} \cdot \left(H_S^{\,2}\right)$$

Example with Units

$$405\,\text{Pa} = 0.5 \cdot 1000\,\text{kg/m}^3 \cdot \left(0.9\,\text{m}^{\,2}\right)$$

Variables used in list of Earth Dam and Gravity Dam Formulas above

- A_{cs} Cross-Sectional Area of Base *(Square Meter)*
- B Number of Beds
- d Water Depth *(Meter)*
- e_d Eccentricity at Downstream
- e_u Eccentricity at Upstream
- F Fetch length *(Meter)*
- F_v Vertical Component of Force *(Newton)*
- h Height of Dam *(Meter)*
- H Wave Height *(Meter)*
- h_a Height of Wave *(Meter)*
- H_L Loss of Head *(Meter)*
- H_S Height of Section *(Meter)*
- i Hydraulic Gradient to Head Loss
- k Coefficient of Permeability of Soil *(Centimeter per Second)*
- K_o Intrinsic Permeability *(Square Meter)*
- L Length of Dam *(Meter)*
- N Equipotential Lines
- P_W Water Pressure in Gravity Dam *(Pascal)*
- Q Quantity of Seepage *(Cubic Meter per Second)*
- Q_s Seepage Discharge *(Cubic Meter per Second)*
- Q_t Discharge from Dam *(Cubic Meter per Second)*
- t Time Taken to Travel *(Second)*
- T Thickness of Dam *(Meter)*
- V Wind Velocity for Freeboard *(Mile per Hour)*
- V_w Wind Velocity *(Meter per Second)*
- θ Theta *(Degree)*
- μ_r Relative Permeability *(Henry per Meter)*
- ρ_{Water} Water Density *(Kilogram per Cubic Meter)*
- σ_z Vertical Stress at a Point *(Pascal)*

Constants, Functions, Measurements used in list of Earth Dam and Gravity Dam Formulas above

- constant(s): **[g]**, 9.80665
  Gravitational acceleration on Earth
- Functions: **acos**, acos(Number)
  The inverse cosine function, is the inverse function of the cosine function. It is the function that takes a ratio as an input and returns the angle whose cosine is equal to that ratio.
- Functions: **cos**, cos(Angle)
  Cosine of an angle is the ratio of the side adjacent to the angle to the hypotenuse of the triangle.
- 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: **Time** in Second (s)
  Time Unit Conversion
- Measurement: **Area** in Square Meter (m²)
  Area Unit Conversion
- Measurement: **Pressure** in Pascal (Pa)
  Pressure Unit Conversion
- Measurement: **Speed** in Centimeter per Second (cm/s), Meter per Second (m/s), Mile per Hour (mi/h)
  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: **Magnetic Permeability** in Henry per Meter (H/m)
  Magnetic Permeability Unit Conversion

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