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Earth Dam and Gravity Dam Formulas

Calculators! Examples! Conversions!

List of 34 Earth Dam and Gravity Dam Formulas

Earth Dam and Gravity Dam

Earth dam

Coefficient of permiability of earth dam

1) Coefficient of Permeability given Maximum and Minimum Permeability for Earth Dam

Open Calculator

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

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

2) Coefficient of Permeability given Quantity of Seepage in Length of Dam

Open Calculator

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

ex $$4.646465\text{cm/s} = \frac{0.46\text{m}^3\text{/s} \cdot 4}{2 \cdot 6.6\text{m} \cdot 3\text{m}}$$

3) Coefficient of Permeability Given Seepage Discharge in Earth Dam

Open Calculator

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

$$0.291952\text{cm/s} = \frac{0.46\text{m}^3/\text{s}}{2.02 \cdot 13\text{m}^2 \cdot 6\text{s}}$$

4) Maximum Permeability given Coefficient of Permeability for Earth Dam

Open Calculator

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

$$0.007692\text{m}^2 = \frac{(10\text{cm/s})^2}{1.3\text{H/m}}$$

5) Minimum Permeability given Coefficient of Permeability for Earth Dam

Open Calculator

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

$$1.013171\text{H/m} = \frac{(10\text{cm/s})^2}{0.00987\text{m}^2}$$

Quantity of seepage

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

Open Calculator

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

ex $$6.333333\text{m} = \frac{0.95\text{m}^3/\text{s} \cdot 4}{2 \cdot 10\text{cm/s} \cdot 3\text{m}}$$

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

Open Calculator

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

ex $$2.878788\text{m} = \frac{0.95\text{m}^3/\text{s} \cdot 4}{2 \cdot 6.6\text{m} \cdot 10\text{cm/s}}$$

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

Open Calculator

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

ex $$4.168421 = \frac{10\text{cm/s} \cdot 2 \cdot 6.6\text{m} \cdot 3\text{m}}{0.95\text{m}^3/\text{s}}$$

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

Open Calculator

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

ex $$1.919192 = \frac{0.95\text{m}^3/\text{s} \cdot 4}{6.6\text{m} \cdot 10\text{cm/s} \cdot 3\text{m}}$$

10) Quantity of Seepage in Length of Dam under Consideration

Open Calculator

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

ex $$0.99\text{m}^3/\text{s} = \frac{10\text{cm/s} \cdot 2 \cdot 6.6\text{m} \cdot 3\text{m}}{4}$$

11) Seepage Discharge in Earth Dam

Open Calculator

fx $$Q_s = k \cdot i \cdot A_{cs} \cdot t$$

ex $$15.756\text{m}^3/\text{s} = 10\text{cm/s} \cdot 2.02 \cdot 13\text{m}^2 \cdot 6\text{s}$$

Slope protection

12) Fetch given Height of Waves for Fetch more than 20 miles

Open Calculator

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

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

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

Open Calculator

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

ex $$6.5\text{m} = \frac{20\text{m/s} - 7}{2}$$

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

Open Calculator

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

ex $$4.967505\text{m} = 0.17 \cdot (20\text{m/s} \cdot 44\text{m})^{0.5} + 2.5 - (44\text{m})^{0.25}$$

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

Open Calculator

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

ex $$5.043015\text{m} = 0.17 \cdot (20\text{m/s} \cdot 44\text{m})^{0.5}$$

16) Velocity when Wave Heights between 1 and 7 feet

Open Calculator

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

ex $$31.4\text{m/s} = 7 + 2 \cdot 12.2\text{m}$$

Wind velocity

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

Open Calculator

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

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

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

Open Calculator

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

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

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

Open Calculator

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

$$19.72301\text{m/s} = \left(\left(\frac{\left(\frac{12.2\text{m}}{0.4\text{m}}\right) - 0.75}{1.5}\right) \cdot (2 \cdot [g])\right)^{0.5}$$

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

Open Calculator

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

$$20.95875\text{m/s} = \left(\frac{12.2\text{m}}{\frac{44\text{m} \cdot \cos(30^\circ)}{1400 \cdot 0.98\text{m}}}\right)^{\frac{1}{2}}$$

Zuider zee formula

21) Angle of Incidence of Waves by Zuider Zee formula

Open Calculator

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

$$69.30904° = a\cos\left(\frac{15.6\text{m} \cdot (1400 \cdot 0.98\text{m})}{\left((83\text{mi/h})^2\right) \cdot 44\text{m}}\right)$$

22) Height of Wave Action using Zuider Zee Formula

Open Calculator

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

$$12.53659\text{m} = 0.4\text{m} \cdot \left(0.75 + 1.5 \cdot \frac{(20\text{m/s})^2}{2 \cdot [g]}\right)$$

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

Open Calculator

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

$$0.38926\text{m} = \frac{12.2\text{m}}{0.75 + 1.5 \cdot \frac{(20\text{m/s})^2}{2 \cdot [g]}}$$

24) Setup above Pool Level using Zuider Zee Formula

Open Calculator

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

$$11.10936\text{m} = \frac{(20\text{m/s} \cdot 20\text{m/s}) \cdot 44\text{m} \cdot \cos(30^\circ)}{1400 \cdot 0.98\text{m}}$$

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

Open Calculator

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

$$0.892392\text{m} = \frac{(20\text{m/s} \cdot 20\text{m/s}) \cdot 44\text{m} \cdot \cos(30^\circ)}{1400 \cdot 12.2\text{m}}$$

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

Open Calculator

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

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

Gravity Dam

27) Density of Water given Water Pressure in Gravity Dam

Open Calculator

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

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

28) Eccentricity for Vertical Normal Stress at Downstream Face

Open Calculator

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

ex $$19.72667 = \left(1 + \left(\frac{2.5\text{Pa}}{\frac{15\text{N}}{144 \cdot 2.2\text{m}}}\right)\right) \cdot \frac{2.2\text{m}}{6}$$

29) Eccentricity given Vertical Normal Stress at Upstream Face

Open Calculator

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

ex $$-18.993333 = \left(1 - \left(\frac{2.5\text{Pa}}{\frac{15\text{N}}{144 \cdot 2.2\text{m}}}\right)\right) \cdot \frac{2.2\text{m}}{6}$$

30) Total Vertical Force for Vertical Normal Stress at Upstream Face

Open Calculator

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

$$14.99484\text{N} = \frac{2.5\text{Pa}}{\left(\frac{1}{144 \cdot 2.2\text{m}}\right) \cdot \left(1 - \left(\frac{6 \cdot -19}{2.2\text{m}}\right)\right)}$$

31) Total Vertical Force given Vertical Normal Stress at Downstream Face

Open Calculator

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

$$14.99484\text{N} = \frac{2.5\text{Pa}}{\left(\frac{1}{144 \cdot 2.2\text{m}}\right) \cdot \left(1 + \left(\frac{6 \cdot 19}{2.2\text{m}}\right)\right)}$$

32) Vertical Normal Stress at Downstream Face

Open Calculator

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

$$2.500861\text{Pa} = \left(\frac{15\text{N}}{144 \cdot 2.2\text{m}}\right) \cdot \left(1 + \left(\frac{6 \cdot 19}{2.2\text{m}}\right)\right)$$

33) Vertical Normal Stress at Upstream Face

Open Calculator

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

$$2.500861\text{Pa} = \left(\frac{15\text{N}}{144 \cdot 2.2\text{m}}\right) \cdot \left(1 - \left(\frac{6 \cdot -19}{2.2\text{m}}\right)\right)$$

34) Water Pressure in Gravity Dam

Open Calculator

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

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

Variables Used

- 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

- Constant: **[g]**, 9.80665 Meter/Second²
  Gravitational acceleration on Earth
- Function: **acos**, acos(Number)
  Inverse trigonometric cosine function
- Function: **cos**, cos(Angle)
  Trigonometric cosine function
- Function: **sqrt**, sqrt(Number)
  Square root function
- 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/m^3)
  Density Unit Conversion
- Measurement: **Magnetic Permeability** in Henry per Meter (H/m)
  Magnetic Permeability Unit Conversion

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- **Arch Dams Formulas**
- **Buttress Dams Formulas**
- **Earth Dam and Gravity Dam Formulas**

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