Important Seepage Analysis Formulas PDF

Formulas
Examples
with Units

List of 52
Important Seepage Analysis Formulas

1) Factor of Steady Seepage Along the Slope Formulas

1.1) Angle of Inclination given Saturated Unit Weight Formula

Evaluate Formula

Formula

$$i = acos\left(\frac{W_{prism}}{\gamma \cdot z \cdot b}\right)$$

Example with Units

$$52.8223° = acos\left(\frac{0.62\,kN}{18\,kN/m^3 \cdot 3\,m \cdot 0.019\,m}\right)$$

1.2) Angle of Inclination given Shear Strength and Submerged Unit Weight Formula

Evaluate Formula

Formula

$$i = atan\left(\frac{\gamma' \cdot \tan\left(\left(\varphi\right)\right)}{\gamma_{sat} \cdot \left(\frac{\tau_f}{\zeta_{soil}}\right)}\right)$$

Example with Units

$$80.0709° = atan\left(\frac{5.01\,N/m^3 \cdot \tan\left(\left(46°\right)\right)}{32.24\,N/m^3 \cdot \left(\frac{20\,Pa}{0.71\,kN/m^2}\right)}\right)$$

1.3) Angle of Inclination given Vertical Stress and Saturated Unit Weight Formula

Evaluate Formula

Formula

$$i = acos\left(\frac{\sigma_z}{\gamma \cdot z}\right)$$

Example with Units

$$89.9987° = acos\left(\frac{1.2\,Pa}{18\,kN/m^3 \cdot 3\,m}\right)$$

1.4) Depth of Prism given Effective Normal Stress Formula

Evaluate Formula

Formula

$$z = \frac{\sigma'}{\left(\gamma_{saturated} - \gamma_{water}\right) \cdot \left(\cos\left(\frac{i \cdot \pi}{180}\right)\right)^2}$$

Example with Units

$$11.8651\,m = \frac{24.67\,kN/m^2}{\left(11.89\,kN/m^3 - 9.81\,kN/m^3\right) \cdot \left(\cos\left(\frac{64° \cdot 3.1416}{180}\right)\right)^2}$$

1.5) Depth of Prism given Normal Stress and Saturated Unit Weight Formula

Evaluate Formula

Formula

$$z = \frac{\sigma_n}{\gamma_{saturated} \cdot \left(\cos\left(\frac{i \cdot \pi}{180}\right)\right)^2}$$

Example with Units

$$6.5088\,m = \frac{77.36\,kN/m^2}{11.89\,kN/m^3 \cdot \left(\cos\left(\frac{64° \cdot 3.1416}{180}\right)\right)^2}$$

1.6) Depth of Prism given Saturated Unit Weight Formula

Evaluate Formula

Formula

$$z = \frac{W_{prism}}{\gamma_{sat} \cdot b \cdot \cos\left(\frac{i \cdot \pi}{180}\right)}$$

Example with Units

$$1012.3381\,m = \frac{0.62\,kN}{32.24\,N/m^3 \cdot 0.019\,m \cdot \cos\left(\frac{64° \cdot 3.1416}{180}\right)}$$

1.7) Depth of Prism given Shear Stress and Saturated Unit Weight Formula

Evaluate Formula

Formula

$$z = \frac{\zeta_{soil}}{\gamma_{saturated} \cdot \cos\left(\frac{i \cdot \pi}{180}\right) \cdot \sin\left(\frac{i \cdot \pi}{180}\right)}$$

Example with Units

$$3.0637\,m = \frac{0.71\,kN/m^2}{11.89\,kN/m^3 \cdot \cos\left(\frac{64° \cdot 3.1416}{180}\right) \cdot \sin\left(\frac{64° \cdot 3.1416}{180}\right)}$$

1.8) Depth of Prism given Submerged Unit Weight and Effective Normal Stress Formula

Evaluate Formula

Formula

$$z = \frac{\sigma'}{\gamma_S \cdot \left(\cos\left(\frac{i \cdot \pi}{180}\right)\right)^2}$$

Example with Units

$$4.9359\,\text{m} = \frac{24.67\,\text{kN/m}^2}{5.00\,\text{kN/m}^3 \cdot \left(\cos\left(\frac{64° \cdot 3.1416}{180}\right)\right)^2}$$

1.9) Depth of Prism given Upward Force Formula

Evaluate Formula

Formula

$$z = \frac{\sigma_n - F_u}{\gamma_S \cdot \left(\cos\left(\frac{i \cdot \pi}{180}\right)\right)^2}$$

Example with Units

$$4.8959\,\text{m} = \frac{77.36\,\text{kN/m}^2 - 52.89\,\text{kN/m}^2}{5.00\,\text{kN/m}^3 \cdot \left(\cos\left(\frac{64° \cdot 3.1416}{180}\right)\right)^2}$$

1.10) Depth of Prism given Upward Force due to Seepage Water Formula

Evaluate Formula

Formula

$$z = \frac{F_u}{\gamma_{water} \cdot \left(\cos\left(\frac{i \cdot \pi}{180}\right)\right)^2}$$

Example with Units

$$5.3935\,\text{m} = \frac{52.89\,\text{kN/m}^2}{9.81\,\text{kN/m}^3 \cdot \left(\cos\left(\frac{64° \cdot 3.1416}{180}\right)\right)^2}$$

1.11) Depth of Prism given Vertical Stress and Saturated Unit Weight Formula

Evaluate Formula

Formula

$$z = \frac{\sigma_{zkp}}{\gamma_{saturated} \cdot \cos\left(\frac{i \cdot \pi}{180}\right)}$$

Example with Units

$$4.4584\,\text{m} = \frac{53\,\text{kPa}}{11.89\,\text{kN/m}^3 \cdot \cos\left(\frac{64° \cdot 3.1416}{180}\right)}$$

1.12) Saturated Unit Weight given Effective Normal Stress Formula

Evaluate Formula

Formula

$$\gamma_{saturated} = \gamma_{water} + \left(\frac{\sigma'}{z \cdot \left(\cos\left(\frac{i \cdot \pi}{180}\right)\right)^2}\right)$$

Example with Units

$$18.0365\,\text{kN/m}^3 = 9.81\,\text{kN/m}^3 + \left(\frac{24.67\,\text{kN/m}^2}{3\,\text{m} \cdot \left(\cos\left(\frac{64° \cdot 3.1416}{180}\right)\right)^2}\right)$$

1.13) Saturated Unit Weight given Factor of Safety Formula

Evaluate Formula

Formula

$$\gamma_{saturated} = \frac{\gamma_S \cdot \tan\left(\frac{\Phi_i \cdot \pi}{180}\right)}{F_s \cdot \tan\left(\frac{i \cdot \pi}{180}\right)}$$

Example with Units

$$2.3124\,\text{kN/m}^3 = \frac{5.00\,\text{kN/m}^3 \cdot \tan\left(\frac{82.87° \cdot 3.1416}{180}\right)}{2.8 \cdot \tan\left(\frac{64° \cdot 3.1416}{180}\right)}$$

1.14) Saturated Unit Weight given Normal Stress Component Formula

Evaluate Formula

Formula

$$\gamma_{saturated} = \frac{\sigma_n}{z \cdot \left(\cos\left(\frac{i \cdot \pi}{180}\right)\right)^2}$$

Example with Units

$$25.7965\,\text{kN/m}^3 = \frac{77.36\,\text{kN/m}^2}{3\,\text{m} \cdot \left(\cos\left(\frac{64° \cdot 3.1416}{180}\right)\right)^2}$$

1.15) Saturated Unit Weight given Shear Strength Formula

Evaluate Formula

Formula

$$\gamma_{saturated} = \frac{\gamma_S \cdot \zeta_{soil} \cdot \tan\left(\frac{\Phi_i \cdot \pi}{180}\right)}{\tau_f \cdot \tan\left(\frac{i \cdot \pi}{180}\right)}$$

Example with Units

$$0.9344\,\text{kN/m}^3 = \frac{5.00\,\text{kN/m}^3 \cdot 0.71\,\text{kN/m}^2 \cdot \tan\left(\frac{82.87° \cdot 3.1416}{180}\right)}{4.92\,\text{kN/m}^2 \cdot \tan\left(\frac{64° \cdot 3.1416}{180}\right)}$$

1.16) Saturated Unit Weight given Shear Stress Component Formula

Evaluate Formula

Formula

$$\gamma_{saturated} = \frac{\zeta_{soil}}{z \cdot \cos\left(\frac{i \cdot \pi}{180}\right) \cdot \sin\left(\frac{i \cdot \pi}{180}\right)}$$

Example with Units

$$12.1426\,\text{kN/m}^3 = \frac{0.71\,\text{kN/m}^2}{3\,\text{m} \cdot \cos\left(\frac{64° \cdot 3.1416}{180}\right) \cdot \sin\left(\frac{64° \cdot 3.1416}{180}\right)}$$

1.17) Saturated Unit Weight given Vertical Stress on Prism Formula

Evaluate Formula

Formula

$$\gamma_{saturated} = \frac{\sigma_{zkp}}{z \cdot \cos\left(\frac{i \cdot \pi}{180}\right)}$$

Example with Units

$$17.67\,\text{kN/m}^3 = \frac{53\,\text{kPa}}{3\,\text{m} \cdot \cos\left(\frac{64° \cdot 3.1416}{180}\right)}$$

1.18) Saturated Unit Weight given Weight of Soil Prism Formula

Evaluate Formula

Formula

$$\gamma_{saturated} = \frac{W_{prism}}{z \cdot b \cdot \cos\left(\frac{i \cdot \pi}{180}\right)}$$

Example with Units

$$10.8793\,\text{kN/m}^3 = \frac{0.62\,\text{kN}}{3\,\text{m} \cdot 0.019\,\text{m} \cdot \cos\left(\frac{64° \cdot 3.1416}{180}\right)}$$

2) Steady State Seepage Analysis Along The Slopes Formulas

2.1) Cohesion of Soil for Steady Seepage along Slope Formula

Evaluate Formula

Formula

$$C = h_c \cdot \left(\left(\gamma_{saturated} \cdot \tan\left(\frac{i \cdot \pi}{180}\right) \cdot \left(\cos\left(\frac{i \cdot \pi}{180}\right)\right)^2\right) - \left(\gamma_S \cdot \tan\left(\frac{\varphi \cdot \pi}{180}\right) \cdot \left(\cos\left(\frac{i \cdot \pi}{180}\right)\right)^2\right)\right)$$

Example with Units

$$0.1633\,\text{kPa} = 1.01\,\text{m} \cdot \left(\left(11.89\,\text{kN/m}^3 \cdot \tan\left(\frac{64° \cdot 3.1416}{180}\right) \cdot \left(\cos\left(\frac{64° \cdot 3.1416}{180}\right)\right)^2\right) - \left(5.00\,\text{kN/m}^3 \cdot \tan\left(\frac{46° \cdot 3.1416}{180}\right) \cdot \left(\cos\left(\frac{64° \cdot 3.1416}{180}\right)\right)^2\right)\right)$$

2.2) Cohesion of Soil given Saturated Unit Weight Formula

Evaluate Formula

Formula

$$C = \left(F_s \cdot \gamma_{saturated} \cdot z \cdot \cos\left(\frac{i \cdot \pi}{180}\right) \cdot \sin\left(\frac{i \cdot \pi}{180}\right)\right) - \left(\gamma_S \cdot z \cdot \tan\left(\frac{\varphi \cdot \pi}{180}\right) \cdot \left(\cos\left(\frac{i \cdot \pi}{180}\right)\right)^2\right)$$

Example with Units

$$1.7365\,\text{kPa} = \left(2.8 \cdot 11.89\,\text{kN/m}^3 \cdot 3\,\text{m} \cdot \cos\left(\frac{64° \cdot 3.1416}{180}\right) \cdot \sin\left(\frac{64° \cdot 3.1416}{180}\right)\right) - \left(5.00\,\text{kN/m}^3 \cdot 3\,\text{m} \cdot \tan\left(\frac{46° \cdot 3.1416}{180}\right) \cdot \left(\cos\left(\frac{64° \cdot 3.1416}{180}\right)\right)^2\right)$$

2.3) Critical Depth given Saturated Unit Weight Formula

Evaluate Formula

Formula

$$h_c = \frac{C}{\left(\gamma_{saturated} \cdot \tan\left(\frac{i \cdot \pi}{180}\right) \cdot \left(\cos\left(\frac{i \cdot \pi}{180}\right)\right)^2\right) - \left(\gamma_S \cdot \tan\left(\frac{\varphi \cdot \pi}{180}\right) \cdot \left(\cos\left(\frac{i \cdot \pi}{180}\right)\right)^2\right)}$$

Example with Units

$$7.8539\,\text{m} = \frac{1.27\,\text{kPa}}{\left(11.89\,\text{kN/m}^3 \cdot \tan\left(\frac{64° \cdot 3.1416}{180}\right) \cdot \left(\cos\left(\frac{64° \cdot 3.1416}{180}\right)\right)^2\right) - \left(5.00\,\text{kN/m}^3 \cdot \tan\left(\frac{46° \cdot 3.1416}{180}\right) \cdot \left(\cos\left(\frac{64° \cdot 3.1416}{180}\right)\right)^2\right)}$$

2.4) Effective Normal Stress given Factor of Safety Formula

Evaluate Formula

Formula

$$\sigma' = \frac{F_s}{\frac{\tan\left(\frac{\Phi_i \cdot \pi}{180}\right)}{\zeta_{soil}}}$$

Example with Units

$$78.7358\,\text{kN/m}^2 = \frac{2.8}{\frac{\tan\left(\frac{82.87° \cdot 3.1416}{180}\right)}{0.71\,\text{kN/m}^2}}$$

2.5) Effective Normal Stress given Saturated Unit Weight Formula

Evaluate Formula

Formula

$$\sigma' = \left(\left(\gamma_{saturated} - \gamma_{water} \right) \cdot z \cdot \left(\cos\left(\frac{i \cdot \pi}{180} \right) \right)^2 \right)$$

Example with Units

$$6.2376\,\text{kN/m}^2 = \left(\left(11.89\,\text{kN/m}^3 - 9.81\,\text{kN/m}^3 \right) \cdot 3\,\text{m} \cdot \left(\cos\left(\frac{64° \cdot 3.1416}{180} \right) \right)^2 \right)$$

2.6) Effective Normal Stress given Submerged Unit Weight Formula

Evaluate Formula

Formula

$$\sigma' = \left(\gamma_S \cdot z \cdot \left(\cos\left(\frac{i \cdot \pi}{180} \right) \right)^2 \right)$$

Example with Units

$$14.9943\,\text{kN/m}^2 = \left(5.00\,\text{kN/m}^3 \cdot 3\,\text{m} \cdot \left(\cos\left(\frac{64° \cdot 3.1416}{180} \right) \right)^2 \right)$$

2.7) Effective Normal Stress given Upward Force due to Seepage Water Formula

Evaluate Formula

Formula

$$\sigma' = \sigma_n - F_u$$

Example with Units

$$24.47\,\text{kN/m}^2 = 77.36\,\text{kN/m}^2 - 52.89\,\text{kN/m}^2$$

2.8) Factor of Safety for Cohesive Soil given Saturated Unit Weight Formula

Evaluate Formula

Formula

$$F_s = \frac{c' + \left(\gamma' \cdot z \cdot \tan\left(\left(\varphi \right) \right) \cdot \left(\cos\left(\left(i \right) \right) \right)^2 \right)}{\gamma_{sat} \cdot z \cdot \cos\left(\left(i \right) \right) \cdot \sin\left(\left(i \right) \right)}$$

Example with Units

$$0.1834 = \frac{4\,\text{Pa} + \left(5.01\,\text{N/m}^3 \cdot 3\,\text{m} \cdot \tan\left(\left(46° \right) \right) \cdot \left(\cos\left(\left(64° \right) \right) \right)^2 \right)}{32.24\,\text{N/m}^3 \cdot 3\,\text{m} \cdot \cos\left(\left(64° \right) \right) \cdot \sin\left(\left(64° \right) \right)}$$

2.9) Factor of Safety given Effective Normal Stress Formula

Evaluate Formula

Formula

$$F_s = \frac{\sigma' \cdot \tan\left(\frac{\varphi \cdot \pi}{180} \right)}{\zeta_{soil}}$$

Example with Units

$$0.4869 = \frac{24.67\,\text{kN/m}^2 \cdot \tan\left(\frac{46° \cdot 3.1416}{180} \right)}{0.71\,\text{kN/m}^2}$$

2.10) Factor of Safety given Submerged Unit Weight Formula

Evaluate Formula

Formula

$$F_s = \frac{\gamma_S \cdot \tan\left(\frac{\Phi_i \cdot \pi}{180} \right)}{\gamma_{saturated} \cdot \tan\left(\frac{i \cdot \pi}{180} \right)}$$

Example with Units

$$0.5446 = \frac{5.00\,\text{kN/m}^3 \cdot \tan\left(\frac{82.87° \cdot 3.1416}{180} \right)}{11.89\,\text{kN/m}^3 \cdot \tan\left(\frac{64° \cdot 3.1416}{180} \right)}$$

2.11) Inclined Length of Prism given Saturated Unit Weight Formula

Evaluate Formula

Formula

$$b = \frac{W_{prism}}{\gamma_{saturated} \cdot z \cdot \cos\left(\frac{i \cdot \pi}{180} \right)}$$

Example with Units

$$0.0174\,\text{m} = \frac{0.62\,\text{kN}}{11.89\,\text{kN/m}^3 \cdot 3\,\text{m} \cdot \cos\left(\frac{64° \cdot 3.1416}{180} \right)}$$

2.12) Normal Stress Component given Effective Normal Stress Formula

Evaluate Formula

Formula

$$\sigma_n = \sigma' + F_u$$

Example with Units

$$77.56\,\text{kN/m}^2 = 24.67\,\text{kN/m}^2 + 52.89\,\text{kN/m}^2$$

2.13) Normal Stress Component given Saturated Unit Weight Formula

Evaluate Formula

Formula

$$\sigma_n = \left(\gamma_{saturated} \cdot z \cdot \left(\cos\left(\frac{i \cdot \pi}{180} \right) \right)^2 \right)$$

Example with Units

$$35.6564\,\text{kN/m}^2 = \left(11.89\,\text{kN/m}^3 \cdot 3\,\text{m} \cdot \left(\cos\left(\frac{64° \cdot 3.1416}{180} \right) \right)^2 \right)$$

2.14) Normal Stress Component given Submerged Unit Weight and Depth of Prism Formula

Evaluate Formula

Formula

$$\sigma_n = F_u + \left(y_S \cdot z \cdot \left(\cos\left(\frac{i \cdot \pi}{180} \right) \right)^2 \right)$$

Example with Units

$$67.8843\,\text{kN/m}^2 = 52.89\,\text{kN/m}^2 + \left(5.00\,\text{kN/m}^3 \cdot 3\,\text{m} \cdot \left(\cos\left(\frac{64° \cdot 3.1416}{180} \right) \right)^2 \right)$$

2.15) Saturated Unit Weight given Critical Depth Formula

Evaluate Formula

Formula

$$\gamma_{saturated} = \frac{\left(\frac{C_{eff}}{h_c} \right) - \left(y_S \cdot \tan\left(\frac{\varphi \cdot \pi}{180} \right) \cdot \left(\cos\left(\frac{i \cdot \pi}{180} \right) \right)^2 \right)}{\tan\left(\frac{i \cdot \pi}{180} \right) \cdot \left(\cos\left(\frac{i \cdot \pi}{180} \right) \right)^2}$$

Example with Units

$$12.6621\,\text{kN/m}^3 = \frac{\left(\frac{0.32\,\text{kPa}}{1.01\,\text{m}} \right) - \left(5.00\,\text{kN/m}^3 \cdot \tan\left(\frac{46° \cdot 3.1416}{180} \right) \cdot \left(\cos\left(\frac{64° \cdot 3.1416}{180} \right) \right)^2 \right)}{\tan\left(\frac{64° \cdot 3.1416}{180} \right) \cdot \left(\cos\left(\frac{64° \cdot 3.1416}{180} \right) \right)^2}$$

2.16) Saturated Unit Weight given Factor of Safety for Cohesive Soil Formula

Evaluate Formula

Formula

$$\gamma_{saturated} = \frac{C_{eff} + \left(y_S \cdot z \cdot \tan\left(\frac{\Phi_i \cdot \pi}{180} \right) \cdot \left(\cos\left(\frac{i \cdot \pi}{180} \right) \right)^2 \right)}{F_s \cdot z \cdot \cos\left(\frac{i \cdot \pi}{180} \right) \cdot \sin\left(\frac{i \cdot \pi}{180} \right)}$$

Example with Units

$$4.267\,\text{kN/m}^3 = \frac{0.32\,\text{kPa} + \left(5.00\,\text{kN/m}^3 \cdot 3\,\text{m} \cdot \tan\left(\frac{82.87° \cdot 3.1416}{180} \right) \cdot \left(\cos\left(\frac{64° \cdot 3.1416}{180} \right) \right)^2 \right)}{2.8 \cdot 3\,\text{m} \cdot \cos\left(\frac{64° \cdot 3.1416}{180} \right) \cdot \sin\left(\frac{64° \cdot 3.1416}{180} \right)}$$

2.17) Shear Strength given Submerged Unit Weight Formula

Evaluate Formula

Formula

$$\tau_f = \frac{\zeta_{soil} \cdot y_S \cdot \tan\left(\frac{\varphi \cdot \pi}{180} \right)}{\gamma_{saturated} \cdot \tan\left(\frac{i \cdot \pi}{180} \right)}$$

Example with Units

$$0.2146\,\text{kN/m}^2 = \frac{0.71\,\text{kN/m}^2 \cdot 5.00\,\text{kN/m}^3 \cdot \tan\left(\frac{46° \cdot 3.1416}{180} \right)}{11.89\,\text{kN/m}^3 \cdot \tan\left(\frac{64° \cdot 3.1416}{180} \right)}$$

2.18) Shear Stress Component given Saturated Unit Weight Formula

Evaluate Formula

Formula

$$\zeta_{soil} = \left(\gamma_{saturated} \cdot z \cdot \cos\left(\frac{i \cdot \pi}{180} \right) \cdot \sin\left(\frac{i \cdot \pi}{180} \right) \right)$$

Example with Units

$$0.6952\,\text{kN/m}^2 = \left(11.89\,\text{kN/m}^3 \cdot 3\,\text{m} \cdot \cos\left(\frac{64° \cdot 3.1416}{180} \right) \cdot \sin\left(\frac{64° \cdot 3.1416}{180} \right) \right)$$

2.19) Shear Stress given Submerged Unit Weight Formula

Evaluate Formula

Formula

$$\zeta_{soil} = \frac{\tau_f}{y_S \cdot \tan\left(\left(\varphi \right) \right)}{\gamma_{saturated} \cdot \tan\left(\left(i \right) \right)}$$

Example with Units

$$23.165\,\text{kN/m}^2 = \frac{4.92\,\text{kN/m}^2}{\frac{5.00\,\text{kN/m}^3 \cdot \tan\left(\left(46° \right) \right)}{11.89\,\text{kN/m}^3 \cdot \tan\left(\left(64° \right) \right)}}$$

2.20) Stability Number for Failure on Slope with Seepage of Water Formula

Evaluate Formula

Formula

$$S_n = \left(\cos\left(\delta \right) \right)^2 \cdot \left(\tan\left(\delta \right) - \left(\frac{\gamma_b \cdot \tan\left(\Phi_i \right)}{\gamma_{saturated}} \right) \right)$$

Example with Units

$$0.0412 = \left(\cos\left(87° \right) \right)^2 \cdot \left(\tan\left(87° \right) - \left(\frac{6\,\text{kN/m}^3 \cdot \tan\left(82.87° \right)}{11.89\,\text{kN/m}^3} \right) \right)$$

2.21) Stability Number for Failure on Slope without Seepage Water Formula

Evaluate Formula

Formula

$$S_n = (\cos(\delta))^2 \cdot (\tan(\delta) - \tan(\Phi_i))$$

Example with Units

$$0.0304 = (\cos(87°))^2 \cdot (\tan(87°) - \tan(82.87°))$$

2.22) Submerged Unit Weight for Steady Seepage along Slope Formula

Evaluate Formula

Formula

$$y_S = \frac{\left(F_s \cdot \gamma_{saturated} \cdot z \cdot \cos\left(\frac{i \cdot \pi}{180}\right) \cdot \sin\left(\frac{i \cdot \pi}{180}\right)\right) - C}{z \cdot \tan\left(\frac{\Phi_i \cdot \pi}{180}\right) \cdot \left(\cos\left(\frac{i \cdot \pi}{180}\right)\right)^2}$$

Example with Units

$$8.9363\,\text{kN/m}^3 = \frac{\left(2.8 \cdot 11.89\,\text{kN/m}^3 \cdot 3\,\text{m} \cdot \cos\left(\frac{64° \cdot 3.1416}{180}\right) \cdot \sin\left(\frac{64° \cdot 3.1416}{180}\right)\right) - 1.27\,\text{kPa}}{3\,\text{m} \cdot \tan\left(\frac{82.87° \cdot 3.1416}{180}\right) \cdot \left(\cos\left(\frac{64° \cdot 3.1416}{180}\right)\right)^2}$$

2.23) Submerged Unit Weight given Critical Depth and Cohesion Formula

Evaluate Formula

Formula

$$y_S = \frac{\left(\gamma_{saturated} \cdot \tan\left(\frac{i \cdot \pi}{180}\right) \cdot \left(\cos\left(\frac{i \cdot \pi}{180}\right)\right)^2\right) - \left(\frac{C}{h_c}\right)}{-\tan\left(\frac{\Phi_i \cdot \pi}{180}\right) \cdot \left(\cos\left(\frac{i \cdot \pi}{180}\right)\right)^2}$$

Example with Units

$$40.6381\,\text{kN/m}^3 = \frac{\left(11.89\,\text{kN/m}^3 \cdot \tan\left(\frac{64° \cdot 3.1416}{180}\right) \cdot \left(\cos\left(\frac{64° \cdot 3.1416}{180}\right)\right)^2\right) - \left(\frac{1.27\,\text{kPa}}{1.01\,\text{m}}\right)}{-\tan\left(\frac{82.87° \cdot 3.1416}{180}\right) \cdot \left(\cos\left(\frac{64° \cdot 3.1416}{180}\right)\right)^2}$$

2.24) Submerged Unit Weight given Effective Normal Stress Formula

Evaluate Formula

Formula

$$y_S = \frac{\sigma'}{z \cdot \left(\cos\left(\frac{i \cdot \pi}{180}\right)\right)^2}$$

Example with Units

$$8.2265\,\text{kN/m}^3 = \frac{24.67\,\text{kN/m}^2}{3\,\text{m} \cdot \left(\cos\left(\frac{64° \cdot 3.1416}{180}\right)\right)^2}$$

2.25) Submerged Unit Weight given Factor of Safety Formula

Evaluate Formula

Formula

$$y_S = \frac{F_s}{\frac{\tan\left(\frac{\Phi_i \cdot \pi}{180}\right)}{\gamma_{saturated} \cdot \tan\left(\frac{i \cdot \pi}{180}\right)}}$$

Example with Units

$$25.709\,\text{kN/m}^3 = \frac{2.8}{\frac{\tan\left(\frac{82.87° \cdot 3.1416}{180}\right)}{11.89\,\text{kN/m}^3 \cdot \tan\left(\frac{64° \cdot 3.1416}{180}\right)}}$$

2.26) Submerged Unit Weight given Shear Strength Formula

Evaluate Formula

Formula

$$y_S = \frac{\frac{\tau_f}{\zeta_{soil}}}{\frac{\tan((\Phi_i))}{\gamma_{saturated} \cdot \tan((i))}}$$

Example with Units

$$21.1312\,\text{kN/m}^3 = \frac{\frac{4.92\,\text{kN/m}^2}{0.71\,\text{kN/m}^2}}{\frac{\tan((82.87°))}{11.89\,\text{kN/m}^3 \cdot \tan((64°))}}$$

2.27) Submerged Unit Weight given Upward Force Formula

Evaluate Formula

Formula

$$y_S = \frac{\sigma_n - F_u}{z \cdot \left(\cos\left(\frac{i \cdot \pi}{180}\right)\right)^2}$$

Example with Units

$$8.1598\,\text{kN/m}^3 = \frac{77.36\,\text{kN/m}^2 - 52.89\,\text{kN/m}^2}{3\,\text{m} \cdot \left(\cos\left(\frac{64° \cdot 3.1416}{180}\right)\right)^2}$$

2.28) Unit Weight of Water given Effective Normal Stress Formula

Evaluate Formula

Formula

$$\gamma_{water} = \gamma_{saturated} - \left(\frac{\sigma'}{z \cdot \left(\cos\left(\frac{i \cdot \pi}{180} \right) \right)^2} \right)$$

Example with Units

$$3.6635\,\text{kN/m}^3 = 11.89\,\text{kN/m}^3 - \left(\frac{24.67\,\text{kN/m}^2}{3\,\text{m} \cdot \left(\cos\left(\frac{64^\circ \cdot 3.1416}{180} \right) \right)^2} \right)$$

2.29) Unit Weight of Water given Upward Force due to Seepage Water Formula

Evaluate Formula

Formula

$$\gamma_{water} = \frac{F_u}{z \cdot \left(\cos\left(\frac{i \cdot \pi}{180} \right) \right)^2}$$

Example with Units

$$17.6367\,\text{kN/m}^3 = \frac{52.89\,\text{kN/m}^2}{3\,\text{m} \cdot \left(\cos\left(\frac{64^\circ \cdot 3.1416}{180} \right) \right)^2}$$

2.30) Upward Force due to Seepage Water Formula

Evaluate Formula

Formula

$$F_u = \left(\gamma_{water} \cdot z \cdot \left(\cos\left(\frac{i \cdot \pi}{180} \right) \right)^2 \right)$$

Example with Units

$$29.4188\,\text{kN/m}^2 = \left(9.81\,\text{kN/m}^3 \cdot 3\,\text{m} \cdot \left(\cos\left(\frac{64^\circ \cdot 3.1416}{180} \right) \right)^2 \right)$$

2.31) Upward Force due to Seepage Water given Effective Normal Stress Formula

Evaluate Formula

Formula

$$F_u = \sigma_n - \sigma'$$

Example with Units

$$52.69\,\text{kN/m}^2 = 77.36\,\text{kN/m}^2 - 24.67\,\text{kN/m}^2$$

2.32) Upward Force due to Seepage Water given Submerged Unit Weight Formula

Evaluate Formula

Formula

$$F_u = \sigma_n - \left(y_S \cdot z \cdot \left(\cos\left(\frac{i \cdot \pi}{180} \right) \right)^2 \right)$$

Example with Units

$$62.3657\,\text{kN/m}^2 = 77.36\,\text{kN/m}^2 - \left(5.00\,\text{kN/m}^3 \cdot 3\,\text{m} \cdot \left(\cos\left(\frac{64^\circ \cdot 3.1416}{180} \right) \right)^2 \right)$$

2.33) Vertical Stress on Prism given Saturated Unit Weight Formula

Evaluate Formula

Formula

$$\sigma_{zkp} = \left(\gamma_{saturated} \cdot z \cdot \cos\left(\frac{i \cdot \pi}{180} \right) \right)$$

Example with Units

$$35.6632\,\text{kPa} = \left(11.89\,\text{kN/m}^3 \cdot 3\,\text{m} \cdot \cos\left(\frac{64^\circ \cdot 3.1416}{180} \right) \right)$$

2.34) Weight of Soil Prism given Saturated Unit Weight Formula

Evaluate Formula

Formula

$$W_{prism} = \left(\gamma_{saturated} \cdot z \cdot b \cdot \cos\left(\frac{i \cdot \pi}{180} \right) \right)$$

Example with Units

$$0.6776\,\text{kN} = \left(11.89\,\text{kN/m}^3 \cdot 3\,\text{m} \cdot 0.019\,\text{m} \cdot \cos\left(\frac{64^\circ \cdot 3.1416}{180} \right) \right)$$

Variables used in list of Seepage Analysis Formulas above

- **b** Inclined Length of Prism *(Meter)*
- **c'** Effective Cohesion *(Pascal)*
- **C** Cohesion in Soil as Kilopascal *(Kilopascal)*
- C_{eff} Effective Cohesion in Geotech as Kilopascal *(Kilopascal)*
- F_s Factor of Safety in Soil Mechanics
- F_u Upward Force in Seepage Analysis *(Kilonewton per Square Meter)*
- h_c Critical Depth *(Meter)*
- **i** Angle of Inclination to Horizontal in Soil *(Degree)*
- S_n Stability Number
- T_f Shear Strength of Soil *(Pascal)*
- W_{prism} Weight of Prism in Soil Mechanics *(Kilonewton)*
- γ_S Submerged Unit Weight in KN per Cubic Meter *(Kilonewton per Cubic Meter)*
- **z** Depth of Prism *(Meter)*
- γ Unit Weight of Soil *(Kilonewton per Cubic Meter)*
- γ_b Buoyant Unit Weight *(Kilonewton per Cubic Meter)*
- γ_{sat} Saturated Unit Weight in Newton per Cubic Meter *(Newton per Cubic Meter)*
- $\gamma_{saturated}$ Saturated Unit Weight of Soil *(Kilonewton per Cubic Meter)*
- γ_{water} Unit Weight of Water *(Kilonewton per Cubic Meter)*
- γ' Submerged Unit Weight *(Newton per Cubic Meter)*
- δ Slope of Ground *(Degree)*
- ζ_{soil} Shear Stress in Soil Mechanics *(Kilonewton per Square Meter)*
- σ_n Normal Stress in Soil Mechanics *(Kilonewton per Square Meter)*
- σ_z Vertical Stress at Point *(Pascal)*
- σ_{zkp} Vertical Stress at a Point in Kilopascal *(Kilopascal)*
- σ' Effective Normal Stress in Soil Mechanics *(Kilonewton per Square Meter)*
- τ_f Shear Strength in KN per Cubic Meter *(Kilonewton per Square Meter)*
- φ Angle of Internal Friction *(Degree)*
- Φ_i Angle of Internal Friction of Soil *(Degree)*

Constants, Functions, Measurements used in list of Seepage Analysis Formulas above

- constant(s): **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- 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: **atan**, atan(Number)
  Inverse tan is used to calculate the angle by applying the tangent ratio of the angle, which is the opposite side divided by the adjacent side of the right triangle.
- 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: **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: **tan**, tan(Angle)
  The tangent of an angle is a trigonometric ratio of the length of the side opposite an angle to the length of the side adjacent to an angle in a right triangle.
- Measurement: **Length** in Meter (m)
  Length Unit Conversion
- Measurement: **Pressure** in Pascal (Pa), Kilonewton per Square Meter (kN/m²), Kilopascal (kPa)
  Pressure Unit Conversion
- Measurement: **Force** in Kilonewton (kN)
  Force Unit Conversion
- Measurement: **Angle** in Degree (°)
  Angle Unit Conversion
- Measurement: **Specific Weight** in Kilonewton per Cubic Meter (kN/m³), Newton per Cubic Meter (N/m³)
  Specific Weight Unit Conversion
- Measurement: **Stress** in Kilonewton per Square Meter (kN/m²)
  Stress Unit Conversion

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