Slope Stability Analysis using Culman's Method Formulas

List of 29 Slope Stability Analysis using Culman's Method Formulas

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1) Angle of Inclination given Critical Slope Angle

Open Calculator

fx $$i = (2 \cdot \theta_{cr}) - \varphi_m$$

ex $$64.2° = (2 \cdot 52.1°) - 40°$$

2) Angle of Internal Friction given Angle of Inclination and Slope Angle

Open Calculator

fx
$$\Phi_i = a\tan\left(\left(\left(F_s - \left(\frac{C_s}{\left(\frac{1}{2}\right) \cdot \gamma \cdot H \cdot \left(\frac{\sin\left(\frac{(\theta_i - \theta_{slope}) \cdot \pi}{180}\right)}{\sin\left(\frac{\theta_i \cdot \pi}{180}\right)}\right) \cdot \sin\left(\frac{\theta_{slope} \cdot \pi}{180}\right)}\right)\right)\right) \cdot \tan\left(\frac{\theta_{slope} \cdot \pi}{180}\right)\right)$$

ex
$$88.88139° = a\tan\left(\left(\left(2.8 - \left(\frac{5.0\text{kPa}}{\left(\frac{1}{2}\right) \cdot 18\text{kN/m}^3 \cdot 10\text{m} \cdot \left(\frac{\sin\left(\frac{(36.85° - 36.89°) \cdot \pi}{180}\right)}{\sin\left(\frac{36.85° \cdot \pi}{180}\right)}\right) \cdot \sin\left(\frac{36.89° \cdot \pi}{180}\right)}\right)\right)\right) \cdot \tan\left(\frac{36.89° \cdot \pi}{180}\right.$$

3) Angle of Internal Friction given Effective Normal Stress

Open Calculator

fx $$\Phi_i = a\tan\left(\frac{F_s \cdot \zeta_{soil}}{\sigma_{effn}}\right)$$

ex $$76.87856° = a\tan\left(\frac{2.8 \cdot 250.09\text{MPa}}{163.23\text{MPa}}\right)$$

4) Angle of Mobilized Friction given Critical Slope Angle

Open Calculator

fx $$\varphi_m = (2 \cdot \theta_{cr}) - i$$

ex $$40.2° = (2 \cdot 52.1°) - 64°$$

5) Cohesion of Soil given Angle of Inclination and Slope angle

Open Calculator

fx
$$C_{eff} = \left(F_s - \left(\frac{\tan\left(\frac{\varphi\cdot\pi}{180}\right)}{\tan\left(\frac{\theta\cdot\pi}{180}\right)}\right)\right)\cdot\left(\left(\frac{1}{2}\right)\cdot\gamma\cdot H\cdot\left(\frac{\sin\left(\frac{(i-\theta)\cdot\pi}{180}\right)}{\sin\left(\frac{i\cdot\pi}{180}\right)}\right)\cdot\sin\left(\frac{\theta\cdot\pi}{180}\right)\right)$$

ex
$$0.400929\text{kPa} = \left(2.8 - \left(\frac{\tan\left(\frac{46°\cdot\pi}{180}\right)}{\tan\left(\frac{25°\cdot\pi}{180}\right)}\right)\right)\cdot\left(\left(\frac{1}{2}\right)\cdot 18\text{kN/m}^3\cdot 10\text{m}\cdot\left(\frac{\sin\left(\frac{(64°-25°)\cdot\pi}{180}\right)}{\sin\left(\frac{64°\cdot\pi}{180}\right)}\right)\cdot\sin\left(\frac{25°\cdot\pi}{180}\right)\right)$$

6) Cohesive Force along Slip Plane

Open Calculator

fx $F_c = c_m \cdot L$

ex $1.5\text{kN} = 0.30\text{kN/m}^2 \cdot 5\text{m}$

7) Critical Slope Angle given Angle of Inclination

Open Calculator

fx
$$\theta_{cr} = \frac{i+\varphi_m}{2}$$

ex
$$52° = \frac{64° + 40°}{2}$$

8) Factor of Safety given Angle of Mobilized Friction

Open Calculator

fx
$$F_s = \frac{\tan\left(\frac{\Phi_i\cdot\pi}{180}\right)}{\tan\left(\frac{\varphi_m\cdot\pi}{180}\right)}$$

ex
$$2.072088 = \frac{\tan\left(\frac{82.87°\cdot\pi}{180}\right)}{\tan\left(\frac{40°\cdot\pi}{180}\right)}$$

9) Factor of Safety given Length of Slip Plane

Open Calculator

fx
$$F_s = \left(\frac{c\cdot L}{W_{wedge}\cdot\sin\left(\frac{\theta_{cr}\cdot\pi}{180}\right)}\right) + \left(\frac{\tan\left(\frac{\varphi\cdot\pi}{180}\right)}{\tan\left(\frac{\theta_{cr}\cdot\pi}{180}\right)}\right)$$

ex
$$3.301915 = \left(\frac{2.05\text{Pa}\cdot 5\text{m}}{267\text{N}\cdot\sin\left(\frac{52.1°\cdot\pi}{180}\right)}\right) + \left(\frac{\tan\left(\frac{46°\cdot\pi}{180}\right)}{\tan\left(\frac{52.1°\cdot\pi}{180}\right)}\right)$$

10) Height from Toe of Wedge to Top of Wedge

Open Calculator

fx $$H = \frac{h}{\frac{\sin\left(\frac{(\theta_i - \theta)\cdot\pi}{180}\right)}{\sin\left(\frac{\theta_i\cdot\pi}{180}\right)}}$$

ex $$9.360035\text{m} = \frac{3.01\text{m}}{\frac{\sin\left(\frac{(36.85° - 25°)\cdot\pi}{180}\right)}{\sin\left(\frac{36.85°\cdot\pi}{180}\right)}}$$

11) Height from Toe of Wedge to Top of Wedge given Factor of Safety

Open Calculator

fx $$H = \left(\frac{C_{eff}}{\left(\frac{1}{2}\right)\cdot\left(F_s - \left(\frac{\tan\left(\frac{\varphi\cdot\pi}{180}\right)}{\tan\left(\frac{\theta_{cr}\cdot\pi}{180}\right)}\right)\right)\cdot\gamma\cdot\left(\frac{\sin\left(\frac{(i-\theta_{cr})\cdot\pi}{180}\right)}{\sin\left(\frac{i\cdot\pi}{180}\right)}\right)\cdot\sin\left(\frac{\theta_{cr}\cdot\pi}{180}\right)}\right)$$

ex $$6.284854\text{m} = \left(\frac{0.32\text{kPa}}{\left(\frac{1}{2}\right)\cdot\left(2.8 - \left(\frac{\tan\left(\frac{46°\cdot\pi}{180}\right)}{\tan\left(\frac{52.1°\cdot\pi}{180}\right)}\right)\right)\cdot 18\text{kN/m}^3\cdot\left(\frac{\sin\left(\frac{(64° - 52.1°)\cdot\pi}{180}\right)}{\sin\left(\frac{64°\cdot\pi}{180}\right)}\right)\cdot\sin\left(\frac{52.1°\cdot\pi}{180}\right)}\right)$$

12) Height from Toe of Wedge to Top of Wedge given Weight of Wedge

Open Calculator

fx $$H = \frac{W_{we}}{\frac{\gamma\cdot L\cdot\left(\sin\left(\frac{(\theta_i - \theta)\cdot\pi}{180}\right)\right)}{2\cdot\sin\left(\frac{\theta_i\cdot\pi}{180}\right)}}$$

ex $$9.542467\text{m} = \frac{138.09\text{kN}}{\frac{18\text{kN/m}^3\cdot 5\text{m}\cdot\left(\sin\left(\frac{(36.85° - 25°)\cdot\pi}{180}\right)\right)}{2\cdot\sin\left(\frac{36.85°\cdot\pi}{180}\right)}}$$

13) Height from Toe to Top of Wedge given Angle of Mobilized Friction

Open Calculator

fx $$H = \frac{c_m}{0.5\cdot\cos ec\left(\frac{i\cdot\pi}{180}\right)\cdot\sec\left(\frac{\varphi_{mob}\cdot\pi}{180}\right)\cdot\sin\left(\frac{(i-\theta)\cdot\pi}{180}\right)\cdot\sin\left(\frac{(\theta_{slope} - \varphi_{mob})\cdot\pi}{180}\right)\cdot\gamma}$$

ex $$7.311302\text{m} = \frac{0.30\text{kN/m}^2}{0.5\cdot\cos ec\left(\frac{64°\cdot\pi}{180}\right)\cdot\sec\left(\frac{12.33°\cdot\pi}{180}\right)\cdot\sin\left(\frac{(64° - 25°)\cdot\pi}{180}\right)\cdot\sin\left(\frac{(36.89° - 12.33°)\cdot\pi}{180}\right)\cdot 18\text{kN/m}^3}$$

14) Height of Wedge of Soil given Angle of Inclination and Slope angle

Open Calculator

fx $$h = \frac{H \cdot \sin\left(\frac{(\theta_i - \theta) \cdot \pi}{180}\right)}{\sin\left(\frac{\theta_i \cdot \pi}{180}\right)}$$

ex $$3.2158\text{m} = \frac{10\text{m} \cdot \sin\left(\frac{(36.85° - 25°) \cdot \pi}{180}\right)}{\sin\left(\frac{36.85° \cdot \pi}{180}\right)}$$

15) Height of Wedge of Soil given Weight of Wedge

Open Calculator

fx $$h = \frac{W_{we}}{\frac{L \cdot \gamma}{2}}$$

ex $$3.068667\text{m} = \frac{138.09\text{kN}}{\frac{5\text{m} \cdot 18\text{kN/m}^3}{2}}$$

16) Length of Slip Plane given Cohesive Force along Slip Plane

Open Calculator

fx $$L = \frac{F_c}{C_{mob}}$$

ex $$5\text{m} = \frac{1.5\text{kN}}{0.3\text{kPa}}$$

17) Length of Slip Plane given Shear Strength along Slip Plane

Open Calculator

fx $$L = \frac{T_f - \left(W \cdot \cos\left(\frac{\theta_{slope} \cdot \pi}{180}\right) \cdot \tan\left(\frac{\varphi \cdot \pi}{180}\right)\right)}{c}$$

ex $$9.687676\text{m} = \frac{20\text{Pa} - \left(10.01\text{kg} \cdot \cos\left(\frac{36.89° \cdot \pi}{180}\right) \cdot \tan\left(\frac{46° \cdot \pi}{180}\right)\right)}{2.05\text{Pa}}$$

18) Length of Slip Plane given Weight of Wedge of Soil

Open Calculator

fx $$L = \frac{W_{we}}{\frac{h \cdot \gamma}{2}}$$

ex $$5.097453\text{m} = \frac{138.09\text{kN}}{\frac{3.01\text{m} \cdot 18\text{kN/m}^3}{2}}$$

19) Mobilized Cohesion given Angle of Mobilized Friction

fx Open Calculator

$$c_m = \left(0.5 \cdot \cos ec\left(\frac{i \cdot \pi}{180}\right) \cdot \sec\left(\frac{\varphi_{mob} \cdot \pi}{180}\right) \cdot \sin\left(\frac{(i - \theta_{slope}) \cdot \pi}{180}\right) \cdot \sin\left(\frac{(\theta_{slope} - \varphi_{mob}) \cdot \pi}{180}\right.\right.$$

ex

$$0.285231\text{kN/m}^2 = \left(0.5 \cdot \cos ec\left(\frac{64° \cdot \pi}{180}\right) \cdot \sec\left(\frac{12.33° \cdot \pi}{180}\right) \cdot \sin\left(\frac{(64° - 36.89°) \cdot \pi}{180}\right) \cdot \sin\left(\frac{(36.89° - 12.}{180}\right.\right.$$

20) Mobilized Cohesion given Cohesive Force along Slip Plane

fx Open Calculator

$$c_m = \frac{F_c}{L}$$

ex

$$0.3\text{kN/m}^2 = \frac{1.5\text{kN}}{5\text{m}}$$

21) Mobilized Cohesion given Safe Height from Toe to Top of Wedge

fx Open Calculator

$$C_{mob} = \frac{H}{4 \cdot \sin\left(\frac{\theta_i \cdot \pi}{180}\right) \cdot \cos\left(\frac{\varphi_{mob} \cdot \pi}{180}\right)} \Big/ \left(\gamma_w \cdot \left(1 - \cos\left(\frac{(\theta_i - \varphi_{mob}) \cdot \pi}{180}\right)\right)\right)$$

ex

$$0.813903\text{kPa} = \frac{10\text{m}}{4 \cdot \sin\left(\frac{36.85° \cdot \pi}{180}\right) \cdot \cos\left(\frac{12.33° \cdot \pi}{180}\right)} \Big/ \left(9810\text{N/m}^3 \cdot \left(1 - \cos\left(\frac{(36.85° - 12.33°) \cdot \pi}{180}\right)\right)\right)$$

22) Safe Height from Toe to Top of Wedge

fx Open Calculator

$$H = \frac{4 \cdot c_m \cdot \sin\left(\frac{i \cdot \pi}{180}\right) \cdot \cos\left(\frac{\varphi_{mob} \cdot \pi}{180}\right)}{\gamma \cdot \left(1 - \cos\left(\frac{(i - \varphi_{mob}) \cdot \pi}{180}\right)\right)}$$

ex

$$10.49217\text{m} = \frac{4 \cdot 0.30\text{kN/m}^2 \cdot \sin\left(\frac{64° \cdot \pi}{180}\right) \cdot \cos\left(\frac{12.33° \cdot \pi}{180}\right)}{18\text{kN/m}^3 \cdot \left(1 - \cos\left(\frac{(64° - 12.33°) \cdot \pi}{180}\right)\right)}$$

23) Shear Strength along Slip Plane

fx Open Calculator

$$\zeta_{soil} = (C_s \cdot L) + \left(W \cdot \cos\left(\frac{\theta \cdot \pi}{180}\right) \cdot \tan\left(\frac{\varphi \cdot \pi}{180}\right)\right)$$

ex

$$0.025\text{MPa} = (5.0\text{kPa} \cdot 5\text{m}) + \left(10.01\text{kg} \cdot \cos\left(\frac{25° \cdot \pi}{180}\right) \cdot \tan\left(\frac{46° \cdot \pi}{180}\right)\right)$$

24) Slope Angle given Shear Strength along Slip Plane

Open Calculator

fx $$\theta_{slope} = a\cos\left(\frac{\zeta_{soil} - (C_s \cdot L)}{W_{wedge} \cdot \tan\left(\frac{\varphi \cdot \pi}{180}\right)}\right)$$

ex $$90° = a\cos\left(\frac{0.025\text{MPa} - (5.0\text{kPa} \cdot 5\text{m})}{267\text{N} \cdot \tan\left(\frac{46° \cdot \pi}{180}\right)}\right)$$

25) Slope Angle given Shear Stress along Slip Plane

Open Calculator

fx $$\theta_{slope} = a\sin\left(\frac{\tau_s}{W_{wedge}}\right)$$

ex $$36.81627° = a\sin\left(\frac{160\text{N/m}^2}{267\text{N}}\right)$$

26) Unit Weight of Soil given Angle of Mobilized Friction

Open Calculator

fx $$\gamma = \frac{c_m}{0.5 \cdot \cos ec\left(\frac{i \cdot \pi}{180}\right) \cdot \sec\left(\frac{\varphi_{mob} \cdot \pi}{180}\right) \cdot \sin\left(\frac{(i - \theta_{slope}) \cdot \pi}{180}\right) \cdot \sin\left(\frac{(\theta_{slope} - \varphi_{mob}) \cdot \pi}{180}\right) \cdot H}$$

ex $$18.93202\text{kN/m}^3 = \frac{0.30\text{kN/m}^2}{0.5 \cdot \cos ec\left(\frac{64° \cdot \pi}{180}\right) \cdot \sec\left(\frac{12.33° \cdot \pi}{180}\right) \cdot \sin\left(\frac{(64° - 36.89°) \cdot \pi}{180}\right) \cdot \sin\left(\frac{(36.89° - 12.33°) \cdot \pi}{180}\right) \cdot 10\text{m}}$$

27) Unit Weight of Soil given Safe Height from Toe to Top of Wedge

Open Calculator

fx $$\gamma = \frac{4 \cdot c_m \cdot \sin\left(\frac{i \cdot \pi}{180}\right) \cdot \cos\left(\frac{\varphi_{mob} \cdot \pi}{180}\right)}{H \cdot \left(1 - \cos\left(\frac{(i - \varphi_{mob}) \cdot \pi}{180}\right)\right)}$$

ex $$18.88591\text{kN/m}^3 = \frac{4 \cdot 0.30\text{kN/m}^2 \cdot \sin\left(\frac{64° \cdot \pi}{180}\right) \cdot \cos\left(\frac{12.33° \cdot \pi}{180}\right)}{10\text{m} \cdot \left(1 - \cos\left(\frac{(64° - 12.33°) \cdot \pi}{180}\right)\right)}$$

28) Unit Weight of Soil given Weight of Wedge

Open Calculator

fx $$\gamma = \frac{W_{we}}{\frac{L \cdot h}{2}}$$

ex $$18.35083\text{kN/m}^3 = \frac{138.09\text{kN}}{\frac{5\text{m} \cdot 3.01\text{m}}{2}}$$

29) Weight of Wedge of Soil

Open Calculator

$$W_{we} = \frac{L \cdot h \cdot \gamma}{2}$$

ex $$135.45\text{kN} = \frac{5\text{m} \cdot 3.01\text{m} \cdot 18\text{kN/m}^3}{2}$$

Variables Used

- **c** Cohesion in Soil *(Pascal)*
- **C_{eff}** Effective Cohesion in Geotech as Kilopascal *(Kilopascal)*
- **c_m** Mobilized Cohesion in Soil Mechanics *(Kilonewton per Square Meter)*
- **C_{mob}** Mobilized Cohesion in Kilopascal *(Kilopascal)*
- **C_s** Cohesion of Soil *(Kilopascal)*
- **F_c** Cohesive Force in KN *(Kilonewton)*
- **F_s** Factor of Safety in Soil Mechanics
- **h** Height of Wedge *(Meter)*
- **H** Height from Toe of Wedge to Top of Wedge *(Meter)*
- **i** Angle of Inclination to Horizontal in Soil *(Degree)*
- **L** Length of Slip Plane *(Meter)*
- **T_f** Shear Strength of Soil *(Pascal)*
- **W** Weight of Wedge *(Kilogram)*
- **W_{we}** Weight of Wedge in Kilonewton *(Kilonewton)*
- **W_{wedge}** Weight of Wedge in Newton *(Newton)*
- **γ** Unit Weight of Soil *(Kilonewton per Cubic Meter)*
- **γ_w** Unit Weight of Water in Soil Mechanics *(Newton per Cubic Meter)*
- **ζ_{soil}** Shear Strength *(Megapascal)*
- **ζ_{soil}** Shear Stress of Soil in Megapascal *(Megapascal)*
- **θ** Slope Angle *(Degree)*
- **θ_{cr}** Critical Slope Angle in Soil Mechanics *(Degree)*
- **θ_i** Angle of Inclination in Soil Mechanics *(Degree)*
- **θ_{slope}** Slope Angle in Soil Mechanics *(Degree)*
- **σ_{effn}** Effective Normal Stress of Soil in Megapascal *(Megapascal)*
- **τ_s** Average Shear Stress on Shear Plane in Soil Mech *(Newton per Square Meter)*
- **φ** Angle of Internal Friction *(Degree)*
- **Φ_i** Angle of Internal Friction of Soil *(Degree)*
- **φ_m** Angle of Mobilized Friction *(Degree)*
- **φ_{mob}** Angle of Mobilized Friction in Soil Mechanics *(Degree)*

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Function: **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.
- Function: **asin**, asin(Number)
  The inverse sine function, is a trigonometric function that takes a ratio of two sides of a right triangle and outputs the angle opposite the side with the given ratio.
- Function: **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.
- Function: **cos**, cos(Angle)
  Cosine of an angle is the ratio of the side adjacent to the angle to the hypotenuse of the triangle.
- Function: **cosec**, cosec(Angle)
  The cosecant function is a trigonometric function that is the reciprocal of the sine function.
- Function: **sec**, sec(Angle)
  Secant is a trigonometric function that is defined ratio of the hypotenuse to the shorter side adjacent to an acute angle (in a right-angled triangle); the reciprocal of a cosine.
- Function: **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.
- Function: **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: **Weight** in Kilogram (kg)
  Weight Unit Conversion
- Measurement: **Pressure** in Kilopascal (kPa), Megapascal (MPa), Kilonewton per Square Meter (kN/m²), Pascal (Pa), Newton per Square Meter (N/m²)
  Pressure Unit Conversion
- Measurement: **Force** in Kilonewton (kN), Newton (N)
  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 Megapascal (MPa), Kilopascal (kPa)
  Stress Unit Conversion

Check other formula lists

- Bearing Capacity for Strip Footing for C-Φ Soils Formulas
- Bearing Capacity of Cohesive Soil Formulas
- Bearing Capacity of Non-cohesive Soil Formulas
- Bearing Capacity of Soils Formulas
- Bearing Capacity of Soils: Meyerhof's Analysis Formulas
- Foundation Stability Analysis Formulas
- Atterberg Limits Formulas
- Bearing Capacity of Soil: Terzaghi's Analysis Formulas
- Compaction of Soil Formulas
- Earth Moving Formulas
- Lateral Pressure for Cohesive and Non Cohesive Soil Formulas
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