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

## Slope Stability Analysis using Culman's Method 🕑

1) Angle of Inclination given Critical Slope Angle 🕑

fx 
$$\mathrm{i} = (2 \cdot \mathrm{ heta_{cr}}) - \mathrm{\phi_m}$$

$$\mathbf{ex} \ 64.2° = (2 \cdot 52.1°) - 40°$$

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

$$\begin{split} \overleftarrow{\Phi}_{i} &= a \tan \left( \left( F_{s} - \left( \frac{C_{s}}{\left(\frac{1}{2}\right) \cdot \gamma \cdot H \cdot \left( \frac{\sin \left(\frac{\left(\theta_{i} - \theta_{slope}\right) \cdot \pi}{180}\right)}{\sin \left(\frac{\theta_{i} \cdot \pi}{180}\right)} \right) \cdot \sin \left(\frac{\theta_{slope} \cdot \pi}{180}\right)} \right) \right) \\ \end{split} \\ \end{split}$$

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

#### 3) Angle of Internal Friction given Effective Normal Stress 🕑

$$\begin{split} & \mathbf{\hat{fx}} \Phi_{\rm i} = a \tan \left( \frac{{\rm F_s} \cdot \zeta_{\rm soil}}{\sigma_{\rm effn}} \right) \\ & \mathbf{ex} \\ & \mathbf{76.87856^\circ} = a \tan \left( \frac{2.8 \cdot 250.09 {\rm MPa}}{163.23 {\rm MPa}} \right) \end{split}$$

#### 4) Angle of Mobilized Friction given Critical Slope Angle 🕑

for 
$$\phi_{\rm m}=(2\cdot\theta_{\rm cr})-{
m i}$$
 Open Calculator Contract of  $40.2^\circ=(2\cdot52.1^\circ)-64^\circ$ 



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# 5) Cohesion of Soil given Angle of Inclination and Slope angle $\mathbf{C}$ $C_{eff} = \left(F_{s} - \left(\frac{\tan\left(\frac{\varphi \cdot \pi}{180}\right)}{\tan\left(\frac{\theta \cdot \pi}{180}\right)}\right)\right) \cdot \left(\left(\frac{1}{2}\right) \cdot \gamma \cdot H \cdot \left(\frac{\sin\left(\frac{(i-\theta) \cdot \pi}{180}\right)}{\sin\left(\frac{i\pi}{180}\right)}\right) \cdot \sin\left(\frac{\theta \cdot \pi}{180}\right)\right)\right)$ ex $0.400929kPa = \left(2.8 - \left(\frac{\tan\left(\frac{4\theta \cdot \pi}{180}\right)}{\tan\left(\frac{25 \cdot \pi}{180}\right)}\right)\right) \cdot \left(\left(\frac{1}{2}\right) \cdot 18kN/m^{s} \cdot 10m \cdot \left(\frac{\sin\left(\frac{(64^{*} - 25^{*}) \cdot \pi}{180}\right)}{\sin\left(\frac{64^{*} \cdot \pi}{180}\right)}\right) \cdot \sin\left(\frac{25^{*} \cdot \pi}{180}\right)\right)$ 6) Cohesive Force along Slip Plane $\mathbf{C}$ fx $F_{c} = c_{m} \cdot L$ fx $1.5kN = 0.30kN/m^{2} \cdot 5m$ 7) Critical Slope Angle given Angle of Inclination $\mathbf{C}$ fx $\theta_{er} = \frac{i + \varphi_{m}}{2}$ fx $52^{*} = \frac{64^{*} + 40^{*}}{2}$

#### 8) Factor of Safety given Angle of Mobilized Friction

$$\mathbf{\hat{K}}\mathbf{F}_{\mathrm{s}} = rac{ an\left(rac{\Phi_{\mathrm{i}}\cdot\pi}{180}
ight)}{ an\left(rac{\phi_{\mathrm{m}}\cdot\pi}{180}
ight)}$$

$$\exp 2.072088 = \frac{\tan(\frac{82.87^{*}\cdot\pi}{180})}{\tan(\frac{40^{*}\cdot\pi}{180})}$$

#### 9) Factor of Safety given Length of Slip Plane

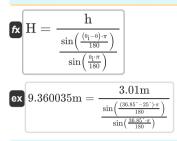
$$\begin{split} & \textbf{fx} \hline \mathbf{F}_{s} = \left(\frac{\mathbf{c} \cdot \mathbf{L}}{\mathbf{W}_{wedge} \cdot \sin\left(\frac{\theta_{cr} \cdot \pi}{180}\right)}\right) + \left(\frac{\tan\left(\frac{\theta \cdot \pi}{180}\right)}{\tan\left(\frac{\theta_{cr} \cdot \pi}{180}\right)}\right) \\ & \textbf{ex} \\ & 3.301915 = \left(\frac{2.05 \mathrm{Pa} \cdot 5\mathrm{m}}{267 \mathrm{N} \cdot \sin\left(\frac{52.1^{\circ} \cdot \pi}{180}\right)}\right) + \left(\frac{\tan\left(\frac{46^{\circ} \cdot \pi}{180}\right)}{\tan\left(\frac{52.1^{\circ} \cdot \pi}{180}\right)}\right) \end{split}$$



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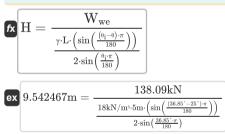


#### 11) Height from Toe of Wedge to Top of Wedge given Factor of Safety 🕑

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

$$\mathbf{ex} \mathbf{6}.284854\mathbf{m} = \left( \frac{0.32\mathbf{k}\mathbf{Pa}}{\left(\frac{1}{2}\right) \cdot \left(2.8 - \left(\frac{\tan\left(\frac{46 \cdot \pi}{180}\right)}{\tan\left(\frac{42}{180}\right)}\right)\right) \cdot 18\mathbf{k}\mathbf{N}/\mathbf{m}^{3} \cdot \left(\frac{\sin\left(\frac{(64^{\circ} - 52.1^{\circ}) \pi}{180}\right)}{\sin\left(\frac{64^{\circ} \pi}{180}\right)}\right) \cdot \sin\left(\frac{52.1^{\circ} \cdot \pi}{180}\right)} \right)$$

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



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

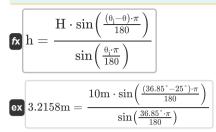
$$\begin{split} \mathbf{\hat{fx}} & \mathbf{H} = \frac{\mathbf{c_m}}{0.5 \cdot \cos ec \left(\frac{\mathbf{i} \cdot \pi}{180}\right) \cdot \sec \left(\frac{\varphi_{\mathrm{mob}} \cdot \pi}{180}\right) \cdot \sin \left(\frac{(\mathbf{i} - \theta) \cdot \pi}{180}\right) \cdot \sin \left(\frac{(\theta_{\mathrm{slope}} - \varphi_{\mathrm{mob}}) \cdot \pi}{180}\right) \cdot \gamma} \end{split} \\ \\ \mathbf{ex} \\ \hline 7.311302\mathrm{m} = \frac{0.30\mathrm{kN/m^2}}{0.5 \cdot \cos ec \left(\frac{64^* \cdot \pi}{180}\right) \cdot \sec \left(\frac{12.33^* \cdot \pi}{180}\right) \cdot \sin \left(\frac{(64^* - 25^*) \cdot \pi}{180}\right) \cdot \sin \left(\frac{(36.89^* - 12.33^*) \cdot \pi}{180}\right) \cdot 18\mathrm{kN/m^3}} \end{split}$$



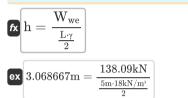
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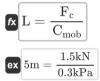
14) Height of Wedge of Soil given Angle of Inclination and Slope angle 🕑



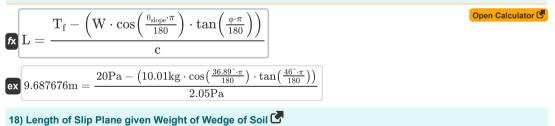
#### 15) Height of Wedge of Soil given Weight of Wedge 🕑

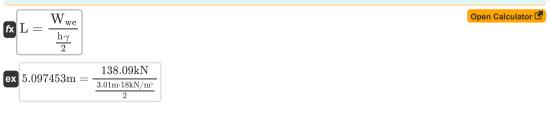


#### 16) Length of Slip Plane given Cohesive Force along Slip Plane



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







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19) Mobilized Cohesion given Angle of Mobilized Friction 🖸

$$\begin{aligned} & \text{(b)} \text{ Mobilized Cohesion given Angle of Mobilized Friction CD} \\ & \text{(cm} = \left(0.5 \cdot \cos cc \left(\frac{i \cdot \pi}{180}\right) \cdot \sec \left(\frac{\varphi_{\text{mob}} \cdot \pi}{180}\right) \cdot \sin \left(\frac{(i - \theta_{\text{slope}}) \cdot \pi}{180}\right) \cdot \sin \left(\frac{(\theta_{\text{slope}} - \varphi_{\text{mob}}) \cdot \pi}{180}\right) \\ & \text{(cm} = \left(0.5 \cdot \cos cc \left(\frac{64^{\circ} \cdot \pi}{180}\right) \cdot \sec \left(\frac{12.33^{\circ} \cdot \pi}{180}\right) \cdot \sin \left(\frac{(64^{\circ} - 36.89^{\circ}) \cdot \pi}{180}\right) \cdot \sin \left(\frac{(36.89^{\circ} - 12.38^{\circ}) \cdot \pi}{180}\right) \\ & \text{(cm} = \frac{F_c}{L} \end{aligned}$$

$$\text{(255231kN/m^2 = \left(0.5 \cdot \cos ec \left(\frac{64^{\circ} \cdot \pi}{180}\right) \cdot \sec \left(\frac{12.33^{\circ} \cdot \pi}{180}\right) \cdot \sin \left(\frac{(64^{\circ} - 36.89^{\circ}) \cdot \pi}{180}\right) \cdot \sin \left(\frac{(36.89^{\circ} - 12.38^{\circ}) \cdot \pi}{180}\right) \\ & \text{(cm} = \frac{F_c}{L} \end{aligned}$$

$$\text{(20) Mobilized Cohesion given Cohesive Force along Slip Plane C \\ & \text{(cm} = \frac{F_c}{L} \end{aligned}$$

$$\text{(21) Mobilized Cohesion given Safe Height from Toe to Top of Wedge C \\ & \text{(21) Mobilized Cohesion given Safe Height from Toe to Top of Wedge C \\ & \text{(21) Mobilized Cohesion given Safe Height from Toe to Top of Wedge C \\ & \text{(21) Mobilized Cohesion given Safe Height from Toe to Top of Wedge C \\ & \text{(21) Mobilized Cohesion given Safe Height from Toe to Top of Wedge C \\ & \text{(21) Mobilized Cohesion given Safe Height from Toe to Top of Wedge C \\ & \text{(21) Mobilized Cohesion given Safe Height from Toe to Top of Wedge C \\ & \text{(21) Mobilized Cohesion given Safe Height from Toe to Top of Wedge C \\ & \text{(21) Mobilized Cohesion given Safe Height from Toe to Top of Wedge C \\ & \text{(21) Mobilized Cohesion given Safe Height from Toe to Top of Wedge C \\ & \text{(21) Mobilized Cohesion given Safe Height from Toe to Top of Wedge C \\ & \text{(21) Mobilized Cohesion given Safe Height from Toe to Top of Wedge C \\ & \text{(22) Safe Height from Toe to Top of Wedge C \\ & \text{(21) Mobilized Cohesion given Safe Height from Toe to Top of Wedge C \\ & \text{(21) Mobilized Cohesion given Safe Height from Toe to Top of Wedge C \\ & \text{(21) Mobilized Cohesion given Safe Height from Toe to Top of Wedge C \\ & \text{(22) Safe Height from Toe to Top of Wedge C \\ & \text{(23) Moeight from Toe to Top of Wedge C \\ & \text{(23) Moeight from Toe to Top of Wedge C \\ & \text{(23)$$



()

#### 24) Slope Angle given Shear Strength along Slip Plane 🕑

$$\begin{split} & \mathbf{\hat{\kappa}} \\ \theta_{\text{slope}} = a \cos \left( \frac{\zeta_{\text{soil}} - (\text{C}_{\text{s}} \cdot \text{L})}{\text{W}_{\text{wedge}} \cdot \tan\left(\frac{\phi \cdot \pi}{180}\right)} \right) \\ & \mathbf{\hat{ex}} \\ 90^{\circ} = a \cos\left( \frac{0.025 \text{MPa} - (5.0 \text{kPa} \cdot 5\text{m})}{267 \text{N} \cdot \tan\left(\frac{46^{\circ} \cdot \pi}{180}\right)} \right) \end{aligned}$$

25) Slope Angle given Shear Stress along Slip Plane 🕑

fx 
$$\theta_{
m slope} = a \sin\left(rac{ au_{
m s}}{W_{
m wedge}}
ight)$$
  
ex  $36.81627^\circ = a \sin\left(rac{160 {
m N/m^2}}{267 {
m N}}
ight)$ 

26) Unit Weight of Soil given Angle of Mobilized Friction 🕑

$$\begin{split} \mathbf{\widehat{K}} & \gamma = \frac{\mathbf{C}_{\mathrm{m}}}{0.5 \cdot \cos ec \left(\frac{\mathbf{i} \cdot \pi}{180}\right) \cdot \sec \left(\frac{\varphi_{\mathrm{mob}} \cdot \pi}{180}\right) \cdot \sin \left(\frac{(\mathbf{i} - \theta_{\mathrm{slope}}) \cdot \pi}{180}\right) \cdot \sin \left(\frac{(\theta_{\mathrm{slope}} - \varphi_{\mathrm{mob}}) \cdot \pi}{180}\right) \cdot \mathbf{H}} \end{split} \\ \mathbf{ex} \\ \mathbf{18.93202kN/m^{3}} = \frac{0.30 \mathrm{kN/m^{2}}}{0.5 \cdot \cos ec \left(\frac{64^{*} \cdot \pi}{180}\right) \cdot \sec \left(\frac{12.33^{*} \cdot \pi}{180}\right) \cdot \sin \left(\frac{(64^{*} - 36.89^{*}) \cdot \pi}{180}\right) \cdot \sin \left(\frac{(36.89^{*} - 12.33^{*}) \cdot \pi}{180}\right) \cdot 10 \mathrm{m}} \end{split}$$

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

$$\begin{split} & \textbf{fx} \\ \gamma = \frac{4 \cdot c_m \cdot \sin\left(\frac{i \cdot \pi}{180}\right) \cdot \cos\left(\frac{\phi_{mob} \cdot \pi}{180}\right)}{H \cdot \left(1 - \cos\left(\frac{(i - \phi_{mob}) \cdot \pi}{180}\right)\right)} \\ & \textbf{ex} \\ 18.88591 \text{kN/m}^3 = \frac{4 \cdot 0.30 \text{kN/m}^2 \cdot \sin\left(\frac{64^* \cdot \pi}{180}\right) \cdot \cos\left(\frac{12.33^* \cdot \pi}{180}\right)}{10 \text{m} \cdot \left(1 - \cos\left(\frac{(64^* - 12.33^*) \cdot \pi}{180}\right)\right)} \end{split}$$

#### 28) Unit Weight of Soil given Weight of Wedge 🚰



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29)	Weight of Wedge of Soil 🗗	
fx	$\mathrm{W}_{\mathrm{we}} = rac{\mathrm{L} \cdot \mathrm{h} \cdot \mathrm{\gamma}}{2}$	Open Calculator 🕑
ex	$135.45 \mathrm{kN} = rac{5 \mathrm{m} \cdot 3.01 \mathrm{m} \cdot 18 \mathrm{kN} / \mathrm{m}^3}{2}$	





## Variables Used

- C Cohesion in Soil (Pascal)
- Ceff Effective Cohesion in Geotech as Kilopascal (Kilopascal)
- Cm Mobilized Cohesion in Soil Mechanics (Kilonewton per Square Meter)
- Cmob Mobilized Cohesion in Kilopascal (Kilopascal)
- C<sub>s</sub> Cohesion of Soil (Kilopascal)
- F<sub>c</sub> Cohesive Force in KN (Kilonewton)
- Fs 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<sub>f</sub> Shear Strength of Soil (Pascal)
- W Weight of Wedge (Kilogram)
- Wwe Weight of Wedge in Kilonewton (Kilonewton)
- Wwedge Weight of Wedge in Newton (Newton)
- **Y** Unit Weight of Soil (Kilonewton per Cubic Meter)
- γw Unit Weight of Water in Soil Mechanics (Newton per Cubic Meter)
- ζ soil Shear Strength (Megapascal)
- ζ<sub>soil</sub> Shear Stress of Soil in Megapascal (Megapascal)
- **θ** Slope Angle (Degree)
- θ<sub>cr</sub> Critical Slope Angle in Soil Mechanics (Degree)
- **θ**<sub>i</sub> Angle of Inclination in Soil Mechanics (Degree)
- θ<sub>slope</sub> Slope Angle in Soil Mechanics (Degree)
- σ<sub>effn</sub> Effective Normal Stress of Soil in Megapascal (Megapascal)
- T S Average Shear Stress on Shear Plane in Soil Mech (Newton per Square Meter)
- **φ** Angle of Internal Friction (Degree)
- Φ<sub>i</sub> Angle of Internal Friction of Soil (Degree)
- φ<sub>m</sub> Angle of Mobilized Friction (Degree)
- φ<sub>mob</sub> 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/m<sup>2</sup>), Pascal (Pa), Newton per Square Meter (N/m<sup>2</sup>)
   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/m<sup>3</sup>), Newton per Cubic Meter (N/m<sup>3</sup>) 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 C
- Bearing Capacity of Soils Formulas G
- Bearing Capacity of Soils: Meyerhof's Analysis
   Formulas
- Foundation Stability Analysis Formulas
- Atterberg Limits Formulas G
- Bearing Capacity of Soil: Terzaghi's Analysis
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- Lateral Pressure for Cohesive and Non Cohesive Soil Formulas

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- Void Ratio of Soil Sample Formulas
- Water Content of Soil and Related Formulas G

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