Important Slope Stability Analysis using Bishops Method Formulas PDF

Formulas
Examples
with Units

List of 35
Important Slope Stability Analysis using Bishops Method Formulas

1) Change in Normal Stress given Overall Pore Pressure Coefficient Formula

Evaluate Formula

Formula

$$\Delta\sigma_1 = \frac{\Delta u}{B}$$

Example with Units

$$6\,\text{Pa} = \frac{3\,\text{Pa}}{0.50}$$

2) Change in Pore Pressure given Overall Pore Pressure Coefficient Formula

Evaluate Formula

Formula

$$\Delta u = \Delta\sigma_1 \cdot B$$

Example with Units

$$3\,\text{Pa} = 6\,\text{Pa} \cdot 0.50$$

3) Effective Angle of Internal Friction given Shear Force in Bishop's Analysis Formula

Evaluate Formula

Formula

$$\varphi' = a\tan\left(\frac{\left(S \cdot f_s\right) - \left(c' \cdot l\right)}{P - \left(u \cdot l\right)}\right)$$

Example with Units

$$9.8741^\circ = a\tan\left(\frac{\left(11.07\,\text{N} \cdot 2.8\right) - \left(4\,\text{Pa} \cdot 9.42\,\text{m}\right)}{150\,\text{N} - \left(20\,\text{Pa} \cdot 9.42\,\text{m}\right)}\right)$$

4) Effective Angle of Internal Friction given Shear Strength Formula

Evaluate Formula

Formula

$$\varphi' = a\tan\left(\frac{\zeta_{soil} - c'}{\sigma_{nm} - u}\right)$$

Example with Units

$$1.3018^\circ = a\tan\left(\frac{0.025\,\text{MPa} - 4\,\text{Pa}}{1.1\,\text{MPa} - 20\,\text{Pa}}\right)$$

5) Effective Cohesion of Soil given Normal Stress on Slice Formula

Evaluate Formula

Formula

$$c' = \tau - \left(\left(\sigma_{normal} - u \right) \cdot \tan\left(\frac{\varphi' \cdot \pi}{180} \right) \right)$$

Example with Units

$$2.0731\,\text{Pa} = 2.06\,\text{Pa} - \left(\left(15.71\,\text{Pa} - 20\,\text{Pa} \right) \cdot \tan\left(\frac{9.99^\circ \cdot 3.1416}{180} \right) \right)$$

6) Effective Cohesion of Soil given Shear Force in Bishop's Analysis Formula

Evaluate Formula

Formula

$$c' = \frac{\left(S \cdot f_s \right) - \left(\left(P - \left(u \cdot l \right) \right) \cdot \tan\left(\frac{\varphi' \cdot \pi}{180} \right) \right)}{l}$$

Example with Units

$$3.3029\,\text{Pa} = \frac{\left(11.07\,\text{N} \cdot 2.8 \right) - \left(\left(150\,\text{N} - \left(20\,\text{Pa} \cdot 9.42\,\text{m} \right) \right) \cdot \tan\left(\frac{9.99^\circ \cdot 3.1416}{180} \right) \right)}{9.42\,\text{m}}$$

7) Effective Stress on Slice Formula

Evaluate Formula

Formula

$$\sigma' = \left(\frac{P}{l} \right) - \Sigma U$$

Example with Units

$$13.9236\,\text{Pa} = \left(\frac{150\,\text{N}}{9.42\,\text{m}} \right) - 2\,\text{N}$$

8) Factor of Safety given by Bishop Formula

Evaluate Formula

Formula

$$f_s = m - \left(n \cdot r_u \right)$$

Example

$$2.71 = 2.98 - \left(0.30 \cdot 0.9 \right)$$

9) Factor of Safety given Shear Force in Bishop's Analysis Formula

Evaluate Formula

Formula

$$f_s = \frac{\left(c' \cdot l \right) + \left(P - \left(u \cdot l \right) \right) \cdot \tan\left(\frac{\varphi' \cdot \pi}{180} \right)}{S}$$

Example with Units

$$3.3932 = \frac{\left(4\,\text{Pa} \cdot 9.42\,\text{m} \right) + \left(150\,\text{N} - \left(20\,\text{Pa} \cdot 9.42\,\text{m} \right) \right) \cdot \tan\left(\frac{9.99^\circ \cdot 3.1416}{180} \right)}{11.07\,\text{N}}$$

10) Height of Slice given Pore Pressure Ratio Formula

Evaluate Formula

Formula

$$z = \left(\frac{F_u}{r_u \cdot \gamma} \right)$$

Example with Units

$$3.2648\,\text{m} = \left(\frac{52.89\,\text{kN/m}^2}{0.9 \cdot 18\,\text{kN/m}^3} \right)$$

11) Horizontal Distance of Slice from Centre of Rotation Formula

Evaluate Formula

Formula

$$x = \frac{\Sigma S \cdot r}{\Sigma W}$$

Example with Units

$$1.0595\,\text{m} = \frac{32\,\text{N} \cdot 1.98\,\text{m}}{59.8\,\text{N}}$$

12) Length of Arc of Slice Formula

Evaluate Formula

Formula

$$l = \frac{P}{\sigma_{normal}}$$

Example with Units

$$9.5481\,\text{m} = \frac{150\,\text{N}}{15.71\,\text{Pa}}$$

13) Length of Arc of Slice given Effective Stress Formula

Evaluate Formula

Formula

$$l = \frac{P}{\sigma' + \Sigma U}$$

Example with Units

$$12.5\,\text{m} = \frac{150\,\text{N}}{10\,\text{Pa} + 2\,\text{N}}$$

14) Length of Arc of Slice given Shear Force in Bishop's Analysis Formula

Evaluate Formula

Formula

$$l = \frac{S}{\tau}$$

Example with Units

$$9.973\,\text{m} = \frac{11.07\,\text{N}}{1.11\,\text{Pa}}$$

15) Normal Stress on Slice Formula

Evaluate Formula

Formula

$$\sigma_{normal} = \frac{P}{l}$$

Example with Units

$$15.9236\,\text{Pa} = \frac{150\,\text{N}}{9.42\,\text{m}}$$

16) Normal Stress on Slice given Shear Strength Formula

Evaluate Formula

Formula

$$\sigma_{normal} = \left(\frac{\tau - c}{\tan\left(\frac{\varphi' \cdot \pi}{180} \right)} \right) + u$$

Example with Units

$$23.2861\,\text{Pa} = \left(\frac{2.06\,\text{Pa} - 2.05\,\text{Pa}}{\tan\left(\frac{9.99^\circ \cdot 3.1416}{180} \right)} \right) + 20\,\text{Pa}$$

17) Overall Pore Pressure Coefficient Formula

Evaluate Formula

Formula

$$B = \frac{\Delta u}{\Delta \sigma_1}$$

Example with Units

$$0.5 = \frac{3\,\text{Pa}}{6\,\text{Pa}}$$

18) Pore Pressure given Effective Stress on Slice Formula

Evaluate Formula

Formula

$$\Sigma U = \left(\frac{P}{l}\right) - \sigma'$$

Example with Units

$$5.9236\,\text{N} = \left(\frac{150\,\text{N}}{9.42\,\text{m}}\right) - 10\,\text{Pa}$$

19) Pore Pressure Ratio given Horizontal Width Formula

Evaluate Formula

Formula

$$r_u = \frac{u \cdot w}{\Sigma W}$$

Example with Units

$$0.9769 = \frac{20\,\text{Pa} \cdot 2.921\,\text{m}}{59.8\,\text{N}}$$

20) Pore Pressure Ratio given Unit Weight Formula

Evaluate Formula

Formula

$$r_u = \left(\frac{F_u}{\gamma \cdot z}\right)$$

Example with Units

$$0.9794 = \left(\frac{52.89\,\text{kN/m}^2}{18\,\text{kN/m}^3 \cdot 3.0\,\text{m}}\right)$$

21) Pore Water Pressure given Pore Pressure Ratio Formula

Evaluate Formula

Formula

$$F_u = \left(r_u \cdot \gamma \cdot z\right)$$

Example with Units

$$48.6\,\text{kN/m}^2 = \left(0.9 \cdot 18\,\text{kN/m}^3 \cdot 3.0\,\text{m}\right)$$

22) Radius of Arc when Total Shear Force on Slice is Available Formula

Evaluate Formula

Formula

$$r = \frac{\Sigma W \cdot x}{\Sigma S}$$

Example with Units

$$5.5876\,\text{m} = \frac{59.8\,\text{N} \cdot 2.99\,\text{m}}{32\,\text{N}}$$

23) Resultant Vertical Shear Force on Section N Formula

Evaluate Formula

Formula

$$X_n = \left(F_n \cdot \cos\left(\frac{\theta \cdot \pi}{180}\right)\right) + \left(S \cdot \sin\left(\frac{\theta \cdot \pi}{180}\right)\right) - W + X_{(n+1)}$$

Example with Units

$$2.1106\,\text{N} = \left(12.09\,\text{N} \cdot \cos\left(\frac{45^\circ \cdot 3.1416}{180}\right)\right) + \left(11.07\,\text{N} \cdot \sin\left(\frac{45^\circ \cdot 3.1416}{180}\right)\right) - 20.0\,\text{N} + 9.87\,\text{N}$$

24) Resultant Vertical Shear Force on Section N+1 Formula

Evaluate Formula

Formula

$$X_{(n+1)} = W + X_n - \left(F_n \cdot \cos\left(\frac{\theta \cdot \pi}{180} \right) \right) + \left(S \cdot \sin\left(\frac{\theta \cdot \pi}{180} \right) \right)$$

Example with Units

$$10.9529\,\text{N} = 20.0\,\text{N} + 2.89\,\text{N} - \left(12.09\,\text{N} \cdot \cos\left(\frac{45° \cdot 3.1416}{180} \right) \right) + \left(11.07\,\text{N} \cdot \sin\left(\frac{45° \cdot 3.1416}{180} \right) \right)$$

25) Shear Force in Bishop's Analysis Formula

Evaluate Formula

Formula

$$S = \tau \cdot l$$

Example with Units

$$10.4562\,\text{N} = 1.11\,\text{Pa} \cdot 9.42\,\text{m}$$

26) Shear Force in Bishop's Analysis given Factor of Safety Formula

Evaluate Formula

Formula

$$S = \frac{\left(c' \cdot l \right) + \left(P - \left(u \cdot l \right) \right) \cdot \tan\left(\frac{\varphi' \cdot \pi}{180} \right)}{f_s}$$

Example with Units

$$13.4154\,\text{N} = \frac{\left(4\,\text{Pa} \cdot 9.42\,\text{m} \right) + \left(150\,\text{N} - \left(20\,\text{Pa} \cdot 9.42\,\text{m} \right) \right) \cdot \tan\left(\frac{9.99° \cdot 3.1416}{180} \right)}{2.8}$$

27) Shear Strength given Normal Stress on Slice Formula

Evaluate Formula

Formula

$$\tau = \left(c' + \left(\sigma_{normal} - u \right) \cdot \tan\left(\frac{\varphi' \cdot \pi}{180} \right) \right)$$

Example with Units

$$3.9869\,\text{Pa} = \left(4\,\text{Pa} + \left(15.71\,\text{Pa} - 20\,\text{Pa} \right) \cdot \tan\left(\frac{9.99° \cdot 3.1416}{180} \right) \right)$$

28) Shear Stress given Shear Force in Bishop's Analysis Formula

Evaluate Formula

Formula

$$\tau = \frac{S}{l}$$

Example with Units

$$1.1752\,\text{Pa} = \frac{11.07\,\text{N}}{9.42\,\text{m}}$$

29) Total Normal Force Acting at Base of Slice Formula

Evaluate Formula

Formula

$$P = \sigma_{normal} \cdot l$$

Example with Units

$$147.9882\,\text{N} = 15.71\,\text{Pa} \cdot 9.42\,\text{m}$$

30) Total Normal Force Acting at Base of Slice given Effective Stress Formula

Evaluate Formula

Formula

$$P = \left(\sigma' + \Sigma U\right) \cdot l$$

Example with Units

$$113.04\,\text{N} = \left(10\,\text{Pa} + 2\,\text{N}\right) \cdot 9.42\,\text{m}$$

31) Total Normal Force Acting on Slice given Weight of Slice Formula

Evaluate Formula

Formula

$$F_n = \frac{W + X_n - X_{(n+1)} - \left(S \cdot \sin\left(\frac{\theta \cdot \pi}{180}\right)\right)}{\cos\left(\frac{\theta \cdot \pi}{180}\right)}$$

Example with Units

$$12.8695\,\text{N} = \frac{20.0\,\text{N} + 2.89\,\text{N} - 9.87\,\text{N} - \left(11.07\,\text{N} \cdot \sin\left(\frac{45° \cdot 3.1416}{180}\right)\right)}{\cos\left(\frac{45° \cdot 3.1416}{180}\right)}$$

32) Total Shear Force on Slice given Radius of Arc Formula

Evaluate Formula

Formula

$$\Sigma S = \frac{\Sigma W \cdot x}{r}$$

Example with Units

$$90.304\,\text{N} = \frac{59.8\,\text{N} \cdot 2.99\,\text{m}}{1.98\,\text{m}}$$

33) Total Weight of Slice given Total Shear Force on Slice Formula

Evaluate Formula

Formula

$$\Sigma W = \frac{\Sigma S \cdot r}{x}$$

Example with Units

$$21.1906\,\text{N} = \frac{32\,\text{N} \cdot 1.98\,\text{m}}{2.99\,\text{m}}$$

34) Unit weight of Soil given Pore Pressure Ratio Formula

Evaluate Formula

Formula

$$\gamma = \left(\frac{F_u}{r_u \cdot z}\right)$$

Example with Units

$$19.5889\,\text{kN/m}^3 = \left(\frac{52.89\,\text{kN/m}^2}{0.9 \cdot 3.0\,\text{m}}\right)$$

35) Weight of Slice given Total Normal Force Acting on Slice Formula

Evaluate Formula

Formula

$$W = \left(F_n \cdot \cos\left(\frac{\theta \cdot \pi}{180}\right)\right) + \left(S \cdot \sin\left(\frac{\theta \cdot \pi}{180}\right)\right) - X_n + X_{(n+1)}$$

Example with Units

$$19.2206\,\text{N} = \left(12.09\,\text{N} \cdot \cos\left(\frac{45° \cdot 3.1416}{180}\right)\right) + \left(11.07\,\text{N} \cdot \sin\left(\frac{45° \cdot 3.1416}{180}\right)\right) - 2.89\,\text{N} + 9.87\,\text{N}$$

Variables used in list of Slope Stability Analysis using Bishops Method Formulas above

- **B** Pore Pressure Coefficient Overall
- **c** Cohesion in Soil *(Pascal)*
- **c'** Effective Cohesion *(Pascal)*
- F_n Total Normal Force in Soil Mechanics *(Newton)*
- f_s Factor of Safety
- F_u Upward Force in Seepage Analysis *(Kilonewton per Square Meter)*
- **l** Length of Arc *(Meter)*
- **m** Stability Coefficient m in Soil Mechanics
- **n** Stability Coefficient n
- **P** Total Normal Force *(Newton)*
- **r** Radius of Soil Section *(Meter)*
- r_u Pore Pressure Ratio
- **S** Shear Force on Slice in Soil Mechanics *(Newton)*
- **u** Upward Force *(Pascal)*
- **w** Width of Soil Section *(Meter)*
- **W** Weight of Slice *(Newton)*
- **x** Horizontal Distance *(Meter)*
- $X_{(n+1)}$ Vertical Shear Force at other Section *(Newton)*
- X_n Vertical Shear Force *(Newton)*
- **z** Height of Slice *(Meter)*
- **γ** Unit Weight of Soil *(Kilonewton per Cubic Meter)*
- **Δu** Change in Pore Pressure *(Pascal)*
- $\Delta\sigma_1$ Change in Normal Stress *(Pascal)*
- ζ_{soil} Shear Strength *(Megapascal)*
- **θ** Angle of Base *(Degree)*
- σ_{nm} Normal Stress in Mega Pascal *(Megapascal)*
- σ_{normal} Normal Stress in Pascal *(Pascal)*
- σ' Effective Normal Stress *(Pascal)*

Constants, Functions, Measurements used in list of Slope Stability Analysis using Bishops Method Formulas above

- constant(s): **pi**, 3.14159265358979323846264338327950288 *Archimedes' constant*
- 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), Megapascal (MPa), Kilonewton per Square Meter (kN/m²) *Pressure Unit Conversion*
- Measurement: **Force** in Newton (N) *Force Unit Conversion*
- Measurement: **Angle** in Degree (°) *Angle Unit Conversion*
- Measurement: **Specific Weight** in Kilonewton per Cubic Meter (kN/m³) *Specific Weight Unit Conversion*
- Measurement: **Stress** in Pascal (Pa) *Stress Unit Conversion*

- **ΣS** Total Shear Force in Soil Mechanics *(Newton)*
- **ΣU** Total Pore Pressure *(Newton)*
- **ΣW** Total Weight of Slice in Soil Mechanics *(Newton)*
- **τ** Shear Strength of Soil in Pascal *(Pascal)*
- **φ'** Effective Angle of Internal Friction *(Degree)*
- τ Shear Stress of Soil in Pascal *(Pascal)*

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