Slope Stability: Culmann Critical Height and Taylor's Stability Number

Critical height of a slope by Culmann's plane-failure method, and the factor of safety on cohesion using Taylor's stability number from the chart.

Method: Culmann's plane-failure method and Taylor's (1937) stability number (Das, Principles of Geotechnical Engineering, 7th ed. (Cengage, 2010), ch. 15)

Input parameters

Unit system: SI

Parameter	Value	Unit
Cohesion	25.000	kPa
Friction angle	10.000	°
Unit weight	18.000	kN/m³
Slope angle	45.000	°
Slope height	8.0000	m
Taylor stability number from the chart	0.12000	

Calculated results

Parameter	Value	Unit
Culmann critical height	21.392	m
Culmann height ratio H_c/H (on height, not on shear strength)	2.6740	
Taylor critical height	11.574	m
Taylor factor of safety on cohesion	1.4468	

Notes for this case

- Culmann assumes a plane through the toe and over-estimates critical height for flatter slopes; Taylor's circular analysis is better (read N_s for β and φ from Taylor's chart). Neither includes pore pressure or layering.

Formula and method

$$H_c = \frac{4c\sin\beta\cos\phi}{\gamma[1-\cos(\beta-\phi)]}\ \text{(Culmann)}, \quad FS_{Culmann} = \frac{H_{c,Culmann}}{H}$$

$$H_{c,Taylor} = \frac{c}{\gamma N_s}, \quad FS_c = \frac{c}{N_s \gamma H}\ \text{(Taylor)}$$

Variables

C	Cohesion	Pa
ϕ	Friction angle	rad
γ	Unit weight	N/m³
β	Slope angle	rad
H	Slope height	m
N_s	Taylor stability number from the chart	-
$H_{c,Culmann}$	Culmann critical height	m
$FS_{Culmann}$	Culmann height ratio H_c/H (on height, not on shear strength)	-
$H_{c,Taylor}$	Taylor critical height	m
FS_c	Taylor factor of safety on cohesion	-

Method and standards

Culmann and Taylor.

Assumptions and limits

- Homogeneous slope; no seepage.
- The Culmann output is a ratio of heights, not a factor of safety on shear strength; it reads much higher than a strength-based factor for the same slope.
- N_s is read by you from Taylor's chart for the slope angle and the friction angle; F_c is then a factor on cohesion with φ fully mobilised. For a factor on both c and φ, iterate with φ reduced by the same factor.

References

• Culmann's plane-failure method and Taylor's (1937) stability number (Das, Principles of Geotechnical Engineering, 7th ed. (Cengage, 2010), ch. 15)

Report details

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Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

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