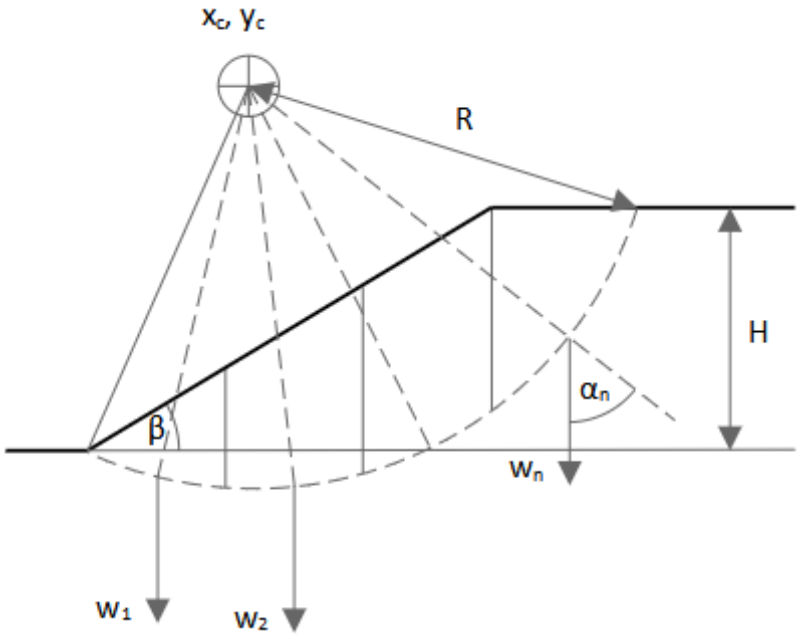
Slope Failure by the Ordinary Method of Slices

This application finds the factor of safety against toe circle slope failure. Toe circle failure occurs if the failure circle cuts through the bottom of the slope (or toe) of the slope.

The factor of safety is the ratio of the maximum stress a soil can sustain to the actual applied stress.



The applciation employs the Ordinary Method of Slices. Other methods of slope failure analysis, such as Bishop's Simplified Method, can be easily implemented.

Parameters

Soil density	$\rho := 20 \times 10^3\ \mathrm{N \cdot m^{-3}}$
Cohesion	$c := 30\ \mathrm{kN \cdot m^{-2}}$
Friction angle	$\phi := 45\ \mathrm{deg}$
Slope angle	$\beta := 26.6\ \mathrm{deg}$
Height	$H := 17\ \mathrm{m}$
Circle radius	$R := 49\ \mathrm{m}$

Centre of trial circle (should be varied so that factor of safety is a minimum)

$x_c := 0\ m \qquad y_c := 50\ m$

Number of slices

$n := 6$

Solution

Coordinates of slope

$$slope := \begin{bmatrix} 0 \cdot H & 0 \cdot H \\ \frac{H}{\tan(\beta)} & H \\ \frac{3}{2} \cdot \frac{H}{\tan(\beta)} & H \end{bmatrix}$$

Interpolating function for slope

$y_{slope} := \text{CurveFitting:-Spline}(slope[\,..,1], slope[\,..,2], x, \text{degree} = 1)$

Failure circle

$$y_{fail} := y_c - \sqrt{R^2 - (x_c - x)^2}$$

Distance

$$X := \text{Vector}\left(n, i \ \ \frac{i \cdot x_{max}}{n}\right)$$

Intersection point of failure circle and top of slope

$$x_{max} := x_c + \sqrt{R^2 - (y_c - H)^2} = 36.222\ m$$

Slice weight

$$w := \text{Vector}\left(n, i \ \ \frac{x_{max}}{n} \cdot \text{eval}\left(y_{slope} - y_{fail}, x = X[i]\right) \cdot \rho\right)$$

Slice bottom angle of inclination

$$\alpha := \text{Vector}\left(n, i \ \ \text{eval}\left(\arctan\left(\frac{x - x_c}{y_c - y_{fail}}\right), x = X[i]\right)\right)$$

Slice friction length

$$\Delta L := \text{Vector}\left(n, i \ \ \frac{x_{max}}{n \cdot \cos(\alpha[i])}\right)$$

Factor of safety

$$FS := \frac{\text{add}\left(c \cdot \Delta L[i] + w[i] \cdot \cos(\alpha[i]) \cdot \tan(\phi), i = 1..n\right)}{\text{add}\left(w[i] \cdot \sin(\alpha[i]), i = 1..n\right)} = 3.640$$

Plot the failure circle and slope

```
p1 := plots:-pointplot([[x_c, y_c]], symbol = solidcircle,
 symbolsize = 20, legend = "Circle Center")

p2 := plot(y_slope, x = 0 m..x_max + 10 m, legend = "Slope",
color = brown, thickness = 6)

p3 := plot(y_fail, x = 0 m..x_max, color = black, linestyle = dash)
```

```
plots:-display(p1, p2, p3, labels = ["Distance", "Height"], labelfont = [Arial],
labeldirections = [horizontal, vertical], axesfont = [Arial], legendstyle = [location = top]) =
```