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NMLab 2 Pillar Design
Hand problem

Question: write an algorithm of source code:
Numerical pillar Design Approach based on
Tributary area method using Newton-Rapson method.

pillar Design(size[ ], strgth[ ], fos)

$D = 200m$, $\rho = \frac{2.6 \times 1000 \times 9.81}{10^6}$, $w_h = 3m$, $w_g = 4.5m$

if fos > 1 : S1 calculation for Bienaski formula.

calculation(size[ ], strgth[ ]):

~~X = X + log~~

For i = 1 → 4 :

~~X = X + strgth[i]~~

X = X + log(size[i])

Y = Y + log(strgth[i])

X2 = X2 + log(size[i]) * log(strgth[i])

XY = XY + log(size[i]) * log(strgth[i])

$k = \exp(y * X2 - X * XY) / (4X2 - X * X)$

$-a = (4 * XY - X * Y) / (4X2 - X * X)$

$S1 = k(1000)^{-a}$

4A calculation:

A1 = 0.36 × S1 / 3.0

A2 = 0.64 × S1 - ρ × 200.0 × fos

A3 = -2.0 × fos × ρ × 200.0 × 4.5

A4 = -fos × ρ × 200.0 × 4.5 × 4.5

var [ ] = [A1, A2, A3, A4]

wp = 100.0

Error threshhold = 0.01

for i → 1 → 100 :

$$wp_{nxt} = wp - \frac{Fwp(var[\,], wp)}{dFwp(var, wp)}$$

if (abs (wpnxt - wp) < 0.01)

break.

wp = wpnxt

Return wp

if FOS < 1 :
unstable
conditions for
mining coal.

Helper functions :

Fwp (var [ ], wp) :

For i = 1 → 4 :

fx = var [i] × pow (wp, 3-i)

return fx

dFwp (var[ ], wp) :

return 3 × var[0] * pow(wp, 2) + 2 * var[1] * wp + var[3]

Calculation of A1, A2, A3, A4 :

$G(wp) = A_1 wp^3 + A_2 wp^2 + A_3 wp + A_4 = 0$

$$FOS = \frac{Sp}{\sigma p} : \frac{\text{Rock / Coal Strength}}{\text{Applied / Insitu stress}}$$

$$FOS = \frac{S_1\left(0.64 + 0.36\frac{wp}{hp}\right)}{\gamma D} \times \frac{wp^2}{(wp+wg)^2}$$

$$\left[\frac{S_1 0.64}{\gamma D} + \frac{0.36 S_1 \frac{wp}{hp}}{\rho D}\right] \frac{wp^2}{(wp+wg)^2} - FOS = 0$$

$$wp^2\left[S_1 \times 0.64\right] + wp^3\left[0.36\frac{S_1}{hp}\right] - \rho D FOS (wp+wg)^2 = 0$$

$$wp^2\left[S_1 \times 0.64\right] + wp^3\left[\frac{0.36 S_1}{hp}\right] - \rho D FOS\left[wp^2 + wg^2 + 2wp\,wg\right] = 0$$

$$\cancel{\rho D FOS}$$

$$wp^2\left[S_1 \times 0.64 - \rho D FOS\right] + wp^3\left[\frac{0.36 S_1}{hp}\right] - \left[\rho D FOS \times 2wg\right]wp - \left[wg^2 \rho D FOS\right] = 0$$

$$\left.\begin{aligned} A_1 &= \frac{0.36 S_1}{hp} \\ A_2 &= 0.64 S_1 - \rho D FOS \\ A_3 &= -2\rho D FOS\, wg \\ A_4 &= -FOS\, \rho D\, wg^2 \end{aligned}\right\}$$

A_1, A_2, A_3, A_4 for Newton Rapson Approximation.