Department of Civil Engineering
Katihar Engineering College, Katihar

Subject : Soil & Rock Mechanics
Topic : Stability of Slopes (Finite Slope)
Lecture : 04
Course Instructor : Prof. Rashid Mustafa

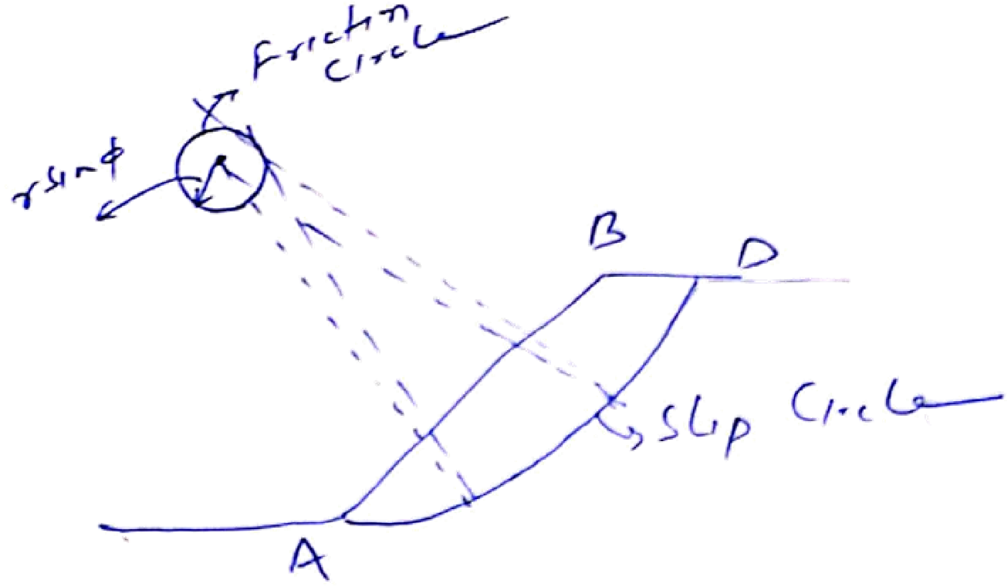
⇒ Friction Circle Method

- This method is based on total stress analysis
- The friction circle method also assumes a circular slip surface.
- The radius of the circle is taken as $r \sin\phi$ (friction circle or ϕ-circle)
- The forces acting on the sliding wedge are

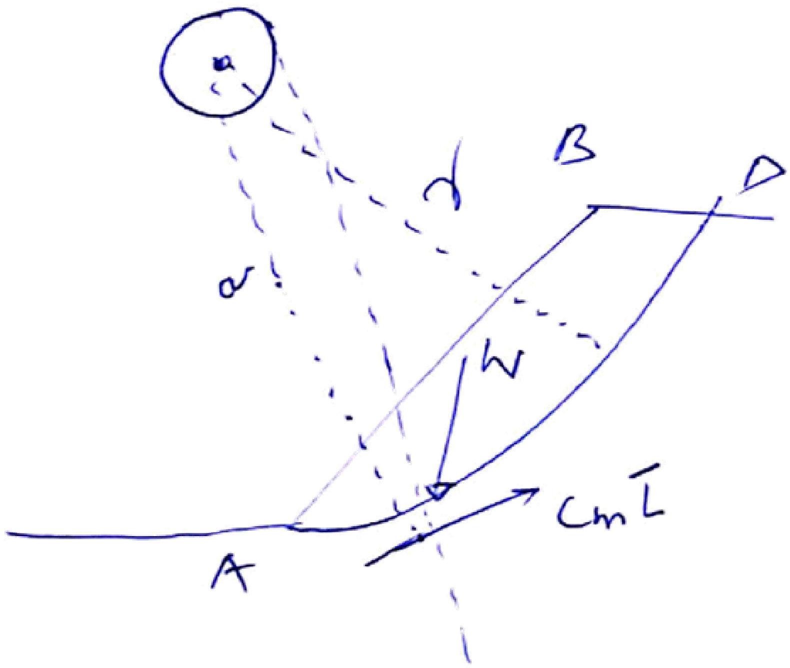
(I) Weight of the wedge (W)

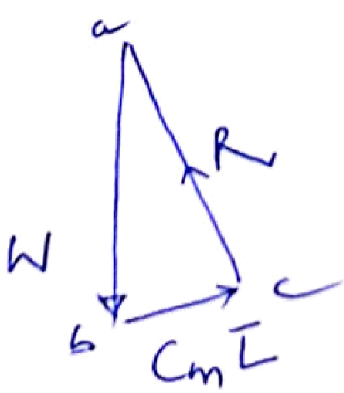
(II) Total frictional resistance or Resultant force, R

(III) Total cohesive resistance



friction Circle





Let C_m → Mobilised cohesion on elementary arch length ΔL = $C_m \cdot \Delta L$

Total cohesive resistance = $C_m \hat{L}$ = $C_m \Sigma \Delta L$

If the total cohesive resistance $C_m \hat{L}$ is assumed to consist of elementary resistance $C_m \Delta L$

Let $\bar{L}$ → length of chord AD

Total cohesive force represented by AD = $C_m \bar{L}$

$$(C_m \bar{L}) \cdot a = (C_m \Sigma \Delta L) r$$

$$C_m \cdot \bar{L} \cdot a = C_m \cdot \hat{L} \cdot r$$

$$a = r \cdot \frac{\hat{L}}{\bar{L}}$$

The direction and location of the resultant cohesive force $C_m \bar{L}$ is know.

$$\text{Factor of safety (FOS)} = \frac{c}{C_m}$$

Number of slip circles are taken and factor of safety for each is found. The circle giving minimum factor of safety is the critical

Slip Circle.

⇒ Taylor's stability Number and stability Curves.

The total cohesive force $c\hat{L}$ which resists the slipping along the slip arc at critical equilibrium.

Taylor stability Number (S_n)

$$S_n = \frac{c}{F_c \cdot \gamma \cdot H} \quad \text{—— (1)}$$

where $c \rightarrow$ Cohesion of soil

$F_c \rightarrow$ Factor of safety

$\gamma \rightarrow$ Unit wt of soil

$H \rightarrow$ Height of slope.

$S_n \rightarrow$ dimensionless quantity.

→ Let C_m be the mobilised cohesion

$$F_c = \frac{c}{C_m}$$

$$C_m = \frac{c}{F_c}$$

$$S_n = \frac{c}{F_c \cdot \gamma \cdot H} = \frac{C_m}{\gamma \cdot H}$$

$$S_n = \frac{c}{F_c \gamma \cdot H} = \frac{C_m}{\gamma \cdot H}$$

Let H_c be the critical height

$$F_c = \frac{H_c}{H}$$

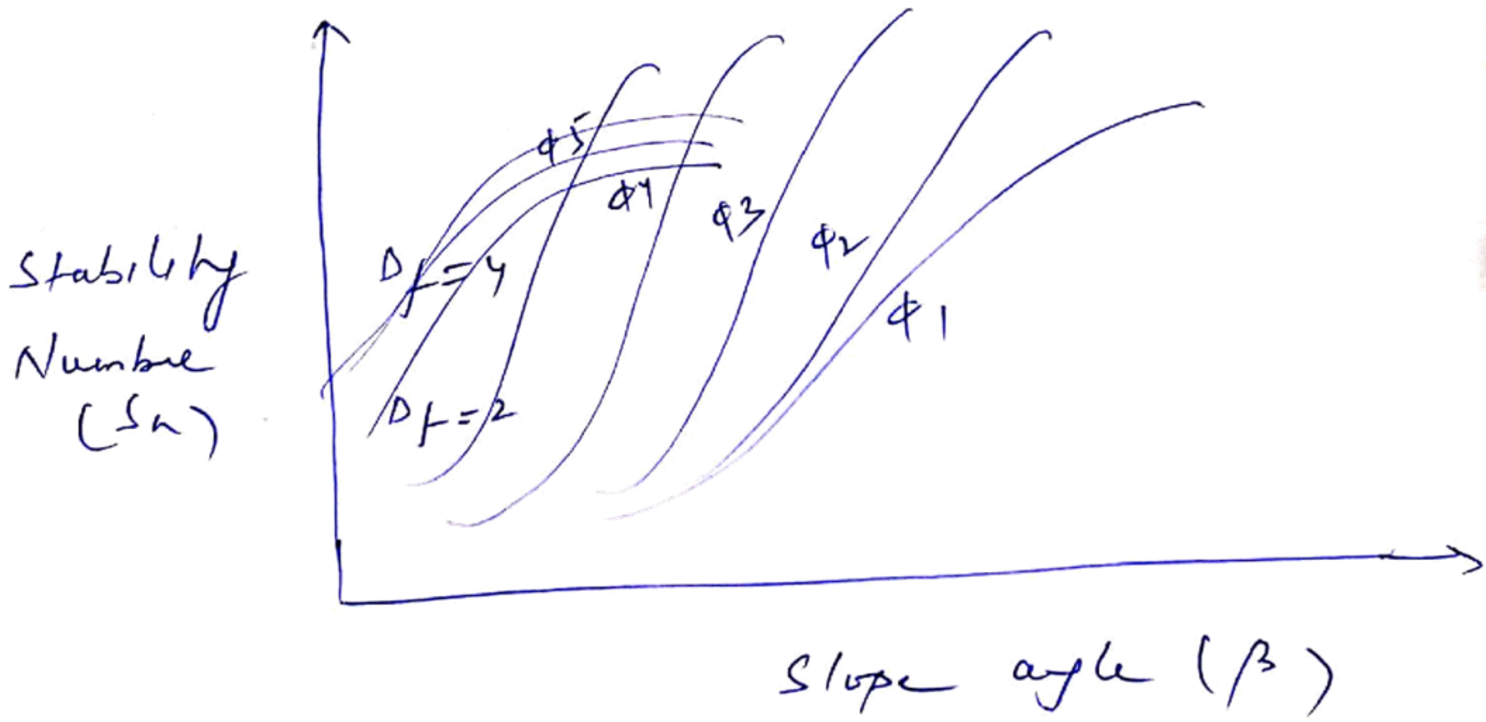
$$S_n = \frac{c}{F_c \cdot \gamma \cdot H} = \frac{c}{\gamma \cdot H_c} = \frac{C_m}{\gamma \cdot H}$$

→ This Taylor stability Number depends on the slope angle (β), Angle of internal friction (ϕ) & depth factor (D_f)

$$S_n = fn(\beta, \phi, D_f)$$

→ Using Taylor stability curve.

$$\phi_m = \tan^{-1}\left(\frac{\tan\phi}{FOS}\right)$$



Taylor stability chart can be utilised for following purpose:

(i) For a slope of height H at angle β in a soil for which γ, c and φ are known, then FoS is required.

(ii) For a required factor of safety of a slope in a soil whose characteristics are known, then what is the steepest ~~slope~~ angle at which slope of a certain height can be allowed?

⇒ Sudden Drawdown

In case of sudden drawdown the angle φ is empirically reduced to angle ϕ_w, called weighted friction angle.

$$\phi_w = \frac{\gamma_{sub}}{\gamma_{sat}} \cdot \phi_u$$

ϕ_w is used ~~to~~ in the stability chart to obtain Taylor stability Number, S_n

$$\Rightarrow \quad \phi_m = \tan^{-1}\left(\frac{\tan\phi}{FoS}\right)$$

Approximately it can be written as

$$\phi_m = \frac{\phi}{FoS}$$