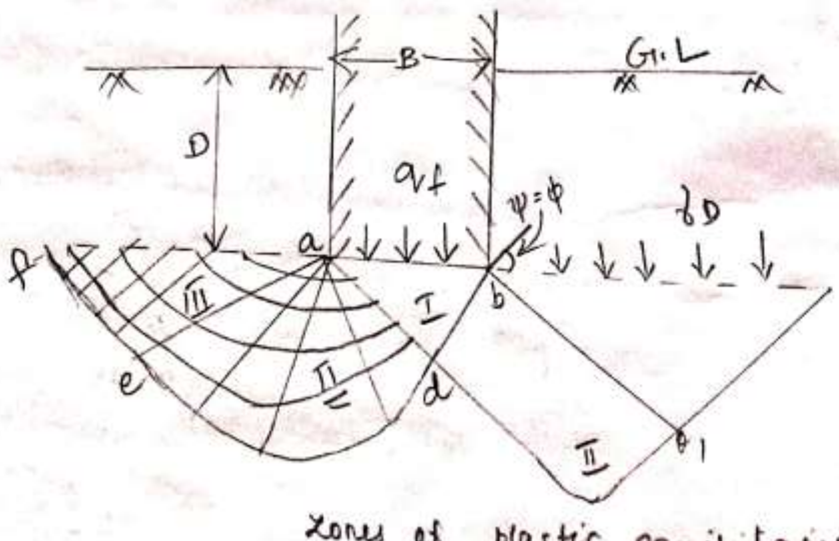
Unit-2

Terzaghi's Analysis

Terzaghi derived a general bearing capacity equation from a modification of equation proposed by prandtl.

→ The footing is shallow, [continous]
D = depth of footing ($D \leq B$)

→ Loaded soil fails along the composite surface
$fede_1f_1$



Zones of plastic equilibrium

This region can be divided into 5 zones
Zone I, two pairs of zone II, two pairs of zone III

→ When base of the footing ab sinks into the ground zone I beneath the footing prevented from lateral yield.

→ Zone I remains in elastic equilibrium state, and it acts as part of ~~equilibrium~~ footing

→ Its boundaries db and da are plane surfaces,
$\psi = \phi$ with horizontal

→ zone II = radial shear, constitutes one set shear pattern radiate from outer edge of the base of footing

→ One set radial lines are straight lines

→ Other set radial lines are logarithmic spirals (at centers & outer edges)

→ Zone III = zone of linear shear (passive Rankine's state)

→ Zone III : Boundary rise at $45° - \phi/2$

→ The failure zones not to exceed above horizontal plane.

→ Shear resistance of soil above horizontal plane through the base of footing is neglected,

Soil above plane is replaced with surcharge $q = \sigma - \gamma D$

→ The application of load intensity q_f on the footing tends to push the wedge of soil abd into ground.

Forces:-

i) The resultant of passive pressure P_p

ii) Cohesion c acting along the surface da.

iii) The passive pressure resultant makes an angle ϕ with normal to the surfaces. da and db.

iii) Downward forces:-

→ $q_f B$

→ the wt $\frac{1}{4} \gamma B^2 \tan\phi$ of the wedge.

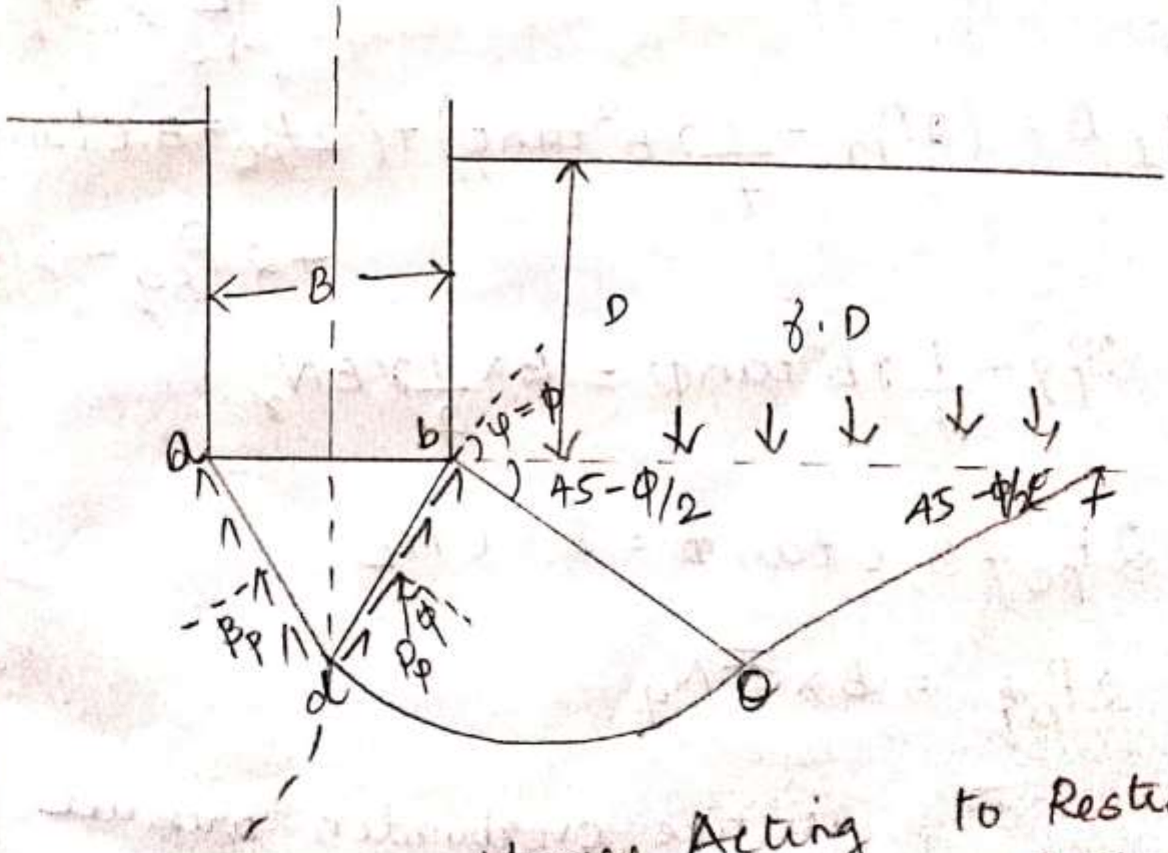
→ The upward forces

i) resultant passive pressure P_p on each of the surfaces db and da.

ii) The vertical component of cohesion acting along the length ad and bd.

The length $db = da = \frac{B/2}{\cos \phi}$ → ①

vertical component db & $da = c \frac{B/2}{\cos \phi} \sin \phi = \frac{B}{2} c \tan \phi$ → ②



Forces Acting to Restrain

$$q_f B + \frac{1}{4}\gamma B^2 \tan\phi = 2P_p + 2\cdot\frac{B}{2} c \tan\phi \quad \to (3)$$

$$q_f B = 2P_p + B.c\tan\phi - \frac{1}{4}\gamma B^2 \tan\phi \quad \to (4)$$

The resultant of passive earth pressure P_p divided by 3 components.

i) $P_{p\gamma}$ produced by wt. of shear zone dif.

ii) P_{pc} produced by soil cohesion

iii) P_{pq} produced by surcharge

Substituting the components in (4)

$$q_f B = 2(P_{p\gamma} + P_{pc} + P_{pq}) + B c\tan\phi - \frac{1}{4}\gamma B^2 \tan\phi \quad \to (5)$$

Ref:- $q_f B = 2P_{p\gamma} + 2P_{pc} + 2P_{pq} + B.c\tan\phi - \frac{1}{4}\gamma B^2 \tan\phi$

$$q_f B = (2P_{p\gamma} - \frac{1}{4}\gamma B^2 \tan\phi) + (2P_{pc} + B.c\tan\phi) + 2P_{pq} \to (6)$$

$$\Rightarrow 2P_{p\gamma} - \frac{1}{4}\gamma B^2 \tan\phi = B \times \frac{1}{2}\gamma B N_\gamma$$

$$\Rightarrow 2P_{pc} + B.c\tan\phi = B \times c N_c$$

$$\Rightarrow 2P_{pq} = B \times \bar{\sigma} N_q.$$

$\bar{\sigma}$ = effective overburden pressure above base of the footing

From eqn ⑥

$$q_f = cN_c + \bar{\sigma}.N_q + 0.5\gamma BN_\gamma$$

(Rearrange)

$$q_f = 0.5\gamma BN_\gamma + cN_c + \bar{\sigma} N_q \rightarrow ⑦$$

If W.T is below the base of the footing $\bar{\sigma} = \gamma D$

$$\gamma D N_q$$

$$q_{nf} = 0.5\gamma B N_\gamma + cN_c + \bar{\sigma}(N_q - 1) \rightarrow ⑧$$

$$q_s = \frac{1}{F}\left[0.5\gamma BN_\gamma + c N_c + \bar{\sigma}(N_q - 1)\right] + \bar{\sigma} \rightarrow ⑨$$

If the W.T is below the base of the footing, the above eqn reduces to

$$q_{nf} = 0.5\gamma BN_\gamma + cN_c + \gamma D(N_q - 1)$$

$$q_s = \frac{1}{F}\left[0.5\gamma BN_\gamma + c.N_c + \gamma D(N_q - 1)\right] + \gamma D \rightarrow ⑩$$

For purely cohesive soil, B.C

$$q_f = cN_c + \bar{\sigma} N_q = 5.7c + \bar{\sigma} \rightarrow ⑪$$

$$\bar{\sigma} = \gamma D.$$

The parameters N_c, N_q, N_γ are the dimensionless numbers. known as capacity factor.

depending only on angle of Shear resistance of the soil.

$$N_q = \frac{a^2}{2\cos^2(45^\circ + \varphi/2)} \rightarrow (12)$$

$$a = e^{(0.75\pi - \varphi/2)\tan\varphi}$$

$$N_c = (N_q - 1)\cot\varphi \rightarrow (13)$$

$$N_\gamma = \frac{\tan\varphi}{2}\left(\frac{K_{p\gamma}}{\cos^2\varphi} - 1\right) \rightarrow (14)$$

$K_{p\gamma}$ = passive earth pressure coeff

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