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Branch & Semester - Civil Engineering & V th Sem
Subject - Foundation Engineering (CE-313)
NIT Hamirpur (H.P.)
No. of pages - 10

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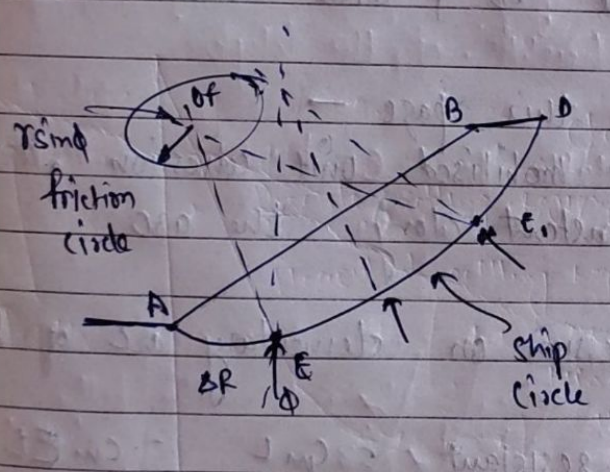
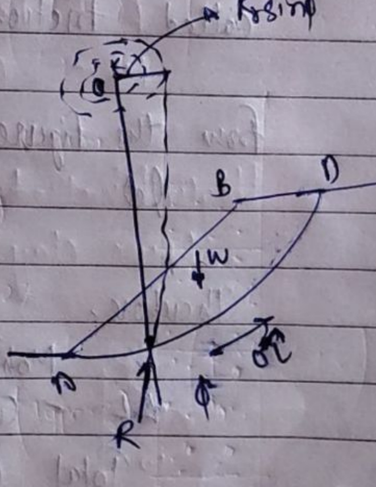
Answer - 1

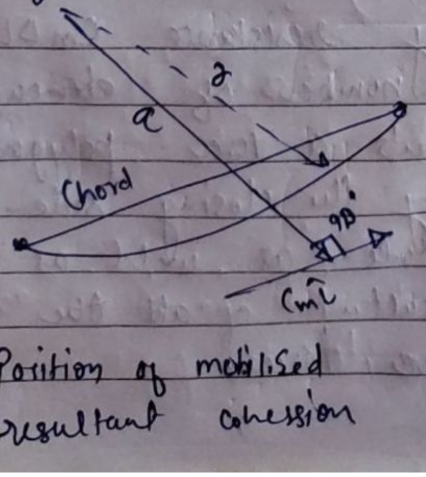
Friction Circle method :-



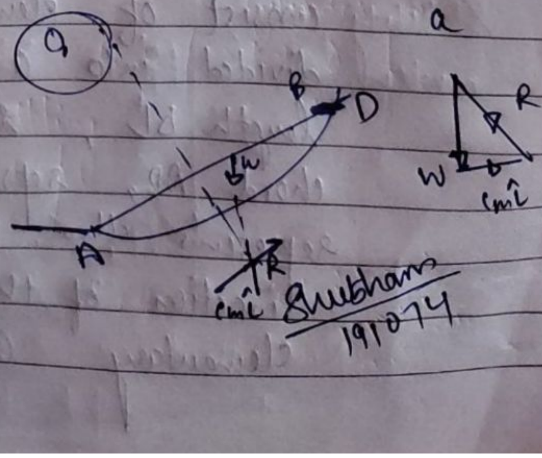
a) The friction circle



b) force acting on sliding wedge



c) Position of mobilised resultant cohesion



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→ The friction circle method can also assumes the failure surface as the arc of a circle.

From the figure, which shows a failure arc of radius r with o as the centre of rotation. If a small concentric circle is drawn with O as the centre and $r \sin\phi$ as the radius, any line EF tangential to the smaller circle will cut the failure arc AD at an obliquity ϕ. Conversely, any vector representing reaction AR at an obliquity ϕ to an element of the failure arc AD will be tangential to the small circle. This small circle of radius $r\sin\phi$ is, therefore called friction circle or ϕ circle.

From the figures before this page —

let C_m = mobilised unit cohesion, assumed constant along the arc

Therefore,

Mobilised cohesion on elementary arc of length $\Delta L = C_m \Delta L$

Total cohesion resistant $= C_m L = C_m \Sigma L$

→ If, the total cohesive resistant $C_m L$ is assumed to constant consist of elementary resistance $C_m \Delta L$, the arc AD divided into a number of elementary arc of length ΔL, represents a force polygon, and the chord AD, representing the closing side of polygon, represents the magnitude as well as direction of the resultant of all the elementary cohessive forces.

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Let $\bar{L}$ = length of the chord

Total cohessive force represents by AD $= C_m \bar{L}$

$$(C_m \hat{L})\,a = (C_m \Sigma L)\,r$$
$$= C_m \bar{L}\, r$$

$$\therefore \boxed{a = \frac{\bar{L} r}{L}}$$

Thus, the direction and location of the resultant cohessive force $C_m \bar{L}$, is known as marked in figure which is drawed along with the force W.

** → In such a way that it's line of action is tangential to the friction circle.

Based on the assumption that frictional strength has been fully mobilised is given by -

** $\left\{ F_c = {}^{C}/_{C_m} \right\}$

∴ A number of slip circles are taken and factor safety for each is found. The circle giving min. factor of safety is the critical slip factor.

** Taylor's Stability Number :-

Taylor proposed a dimensional - less parameter called taylor's stability number.

→ It is the method used to evalute slope stability for homogeneous soils having cohession.

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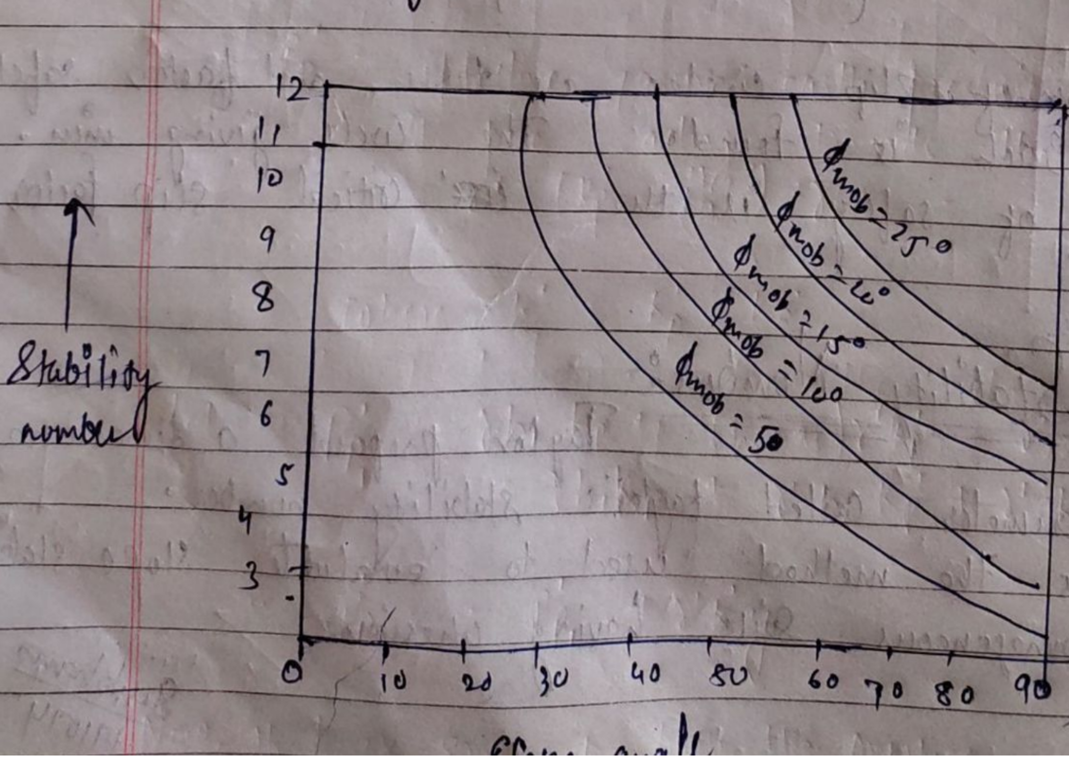
* It is based on the principle resistance of soil mass against sliding. because of cohession and internal friction acting over the failure plane.

The stability number (S_n) is given by -

$$S_n = \frac{C}{\gamma H_c} = \frac{C_m}{\gamma H} = \frac{C}{\gamma F}$$

Where,
C = unit cohession. C_m is unit mobilized cohession
H = vertical height of the slope
F = factor of safety with respect to cohession
H_c = critical height of the slope

Taylor method is suitable for C - ϕ soil and for ϕ = 0 (pure clay)



Where -
ϕ_m = angle of shearing resistance used in the mobilized angle.

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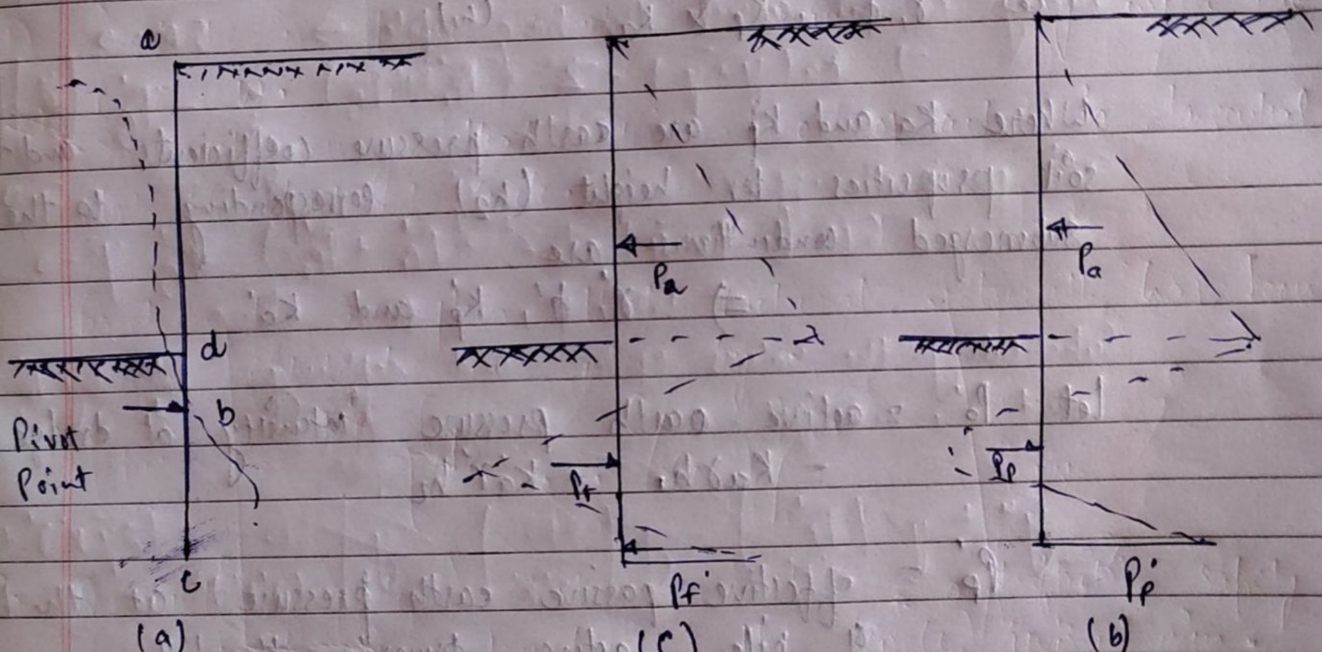
→ from the chart we can see the angle of shearing resistance used in the mobilized angle (ϕ_m)

Answer-2 To Illustrate the design of a cantiliver steel pipe wall of height —
In granular soil:-



Assume the steel pipe to be perfectly rigid under water the influence of line active pressure of the back fill the wall tends to rotate developing the active pressure behind the wall (portion cd) and passive pressure in front of the wall (pressure db).
At the pivot point (b) the soil behind the wall goes from active to passive pressure, while the soil in front of the wall goes

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(c)

Ans → from passive to active for remaining distance bc

from figure (b) show the propable quantitation pressure distribution, while (c) shows that slupified pressure diagram for computational purpose.

Then,

let the soil properties for height above the water table (h_1) be γ, ϕ, K_p & K_a

Where K_a and K_p are earth pressure coefficients and the soil properties for height (h_2) corresponding to the submerged condintions are
$$\Rightarrow \gamma', \phi', K_p' \text{ and } K_a'$$

let P_a' = active earth pressure intensity at dredge line
$$= K_a \gamma h_1 + K_a' \gamma' h_2$$

P_p' = effective passive earth pressure at the base of pile acting towards the fill.
$$= \gamma' (K_p' - K_a') \gamma = \gamma K' \gamma$$

where $K' = K_p' - K_a'$

let $P_{p_1}' = \gamma h_1 K_p + (h_2 + a) \gamma' K_p' - \gamma' a K_a$
$$= \gamma h_1 K_p + \gamma' h_2 K_p' + \gamma' a K_a'$$

and $P_{p_2}' = P_{p_1}' + \gamma' K' y$

Now, if ϕ is same for both the propeties Shubham 191074

then $\boxed{K = K'}$

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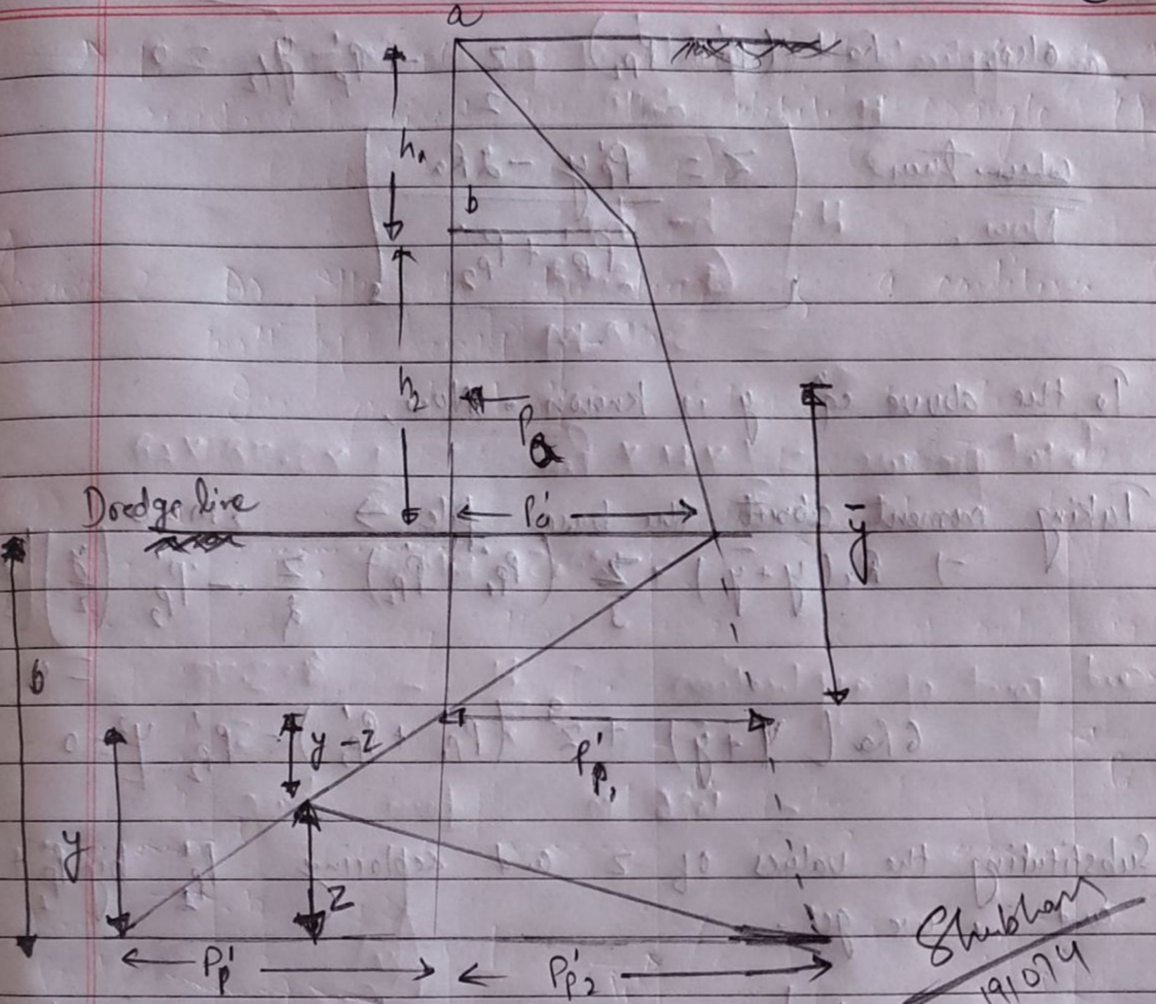

Diagram

→ The point of rotation o located at distance a below dredge line has zero earth pressure.
The magnitude of earth pressure at the location e, o, and f are calculated as, —

$$a\gamma'(K_p' - K_a') = P_a' \Rightarrow a = \frac{P_a'}{\gamma'(K_p' - K_a')}$$

$$\boxed{a = \frac{P_R'}{\gamma' K'}}$$

Thus, a known

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also, $R_a + (P_p' + P_{p_2}')\frac{z}{2} - P_p'\, y/2 = 0$

~~when~~, then $$\boxed{z = \frac{P_p' y - 2R_a}{P_p' + P_{p_2}'}}$$

To the above eqⁿ y is known. Now,

Taking moment about the base pile → $\Sigma M = 0$

$$\Rightarrow R_a(y+\bar{y}) + \frac{z}{3}(P_{p_1}' + P_{p_2}')\frac{z}{2} - P_{p_2}'\left(\frac{y}{2}\right)\left(\frac{y}{3}\right) = 0$$

$$6R_a(y+\bar{y}) + z^2(P_{p_1}' + P_{p_2}') - P_{p_2}' y^2 = 0$$

Substituting the values of z and replacing P_{p_2}' by $P_{p_2}' + P_{p_1}'$ and , we get -

$$y^4 + y^3\left(\frac{P_p'}{\gamma' K'}\right) - y^2\left(\frac{8R_a}{\gamma' K'}\right) - y\left[\frac{6R_a}{(\gamma' K')^2}(2\bar{y}K'\gamma' + P_{p_1}')\right]$$

$$\frac{-6R_a\, y P_p' + 4R_a^2}{(\gamma' K')^2} = 0$$

y can be found / obtained from the above equation and D can be computed as $\boxed{D = a + y}$

Ans

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Ans-3 Given us that

Retainting wall = h meter

ϕ = zero, $\gamma = 18 \, kN/m^3$

cohession $c = 20 \, kN/m^2$

Value of height 'h' = 6 m (my roll no fall in 61-80 series) 191074 Shubham

find out Total pressure = ?

and point of application = ?

So. we know that

$$h_{tc} = \frac{2c}{\gamma} \tan\alpha = \frac{2 \times 20}{18} \tan 45^\circ$$

$$= \frac{\cancel{40}^{20}}{\cancel{18}_{9}} \times 1 = \frac{20}{9}$$

$$= 2.22 \text{ meter}$$

and,

$$P_{aH} = K_a \gamma H - 2c\sqrt{K_a}$$

and $K_a = \dfrac{1 - \sin\phi}{1 + \sin\phi}$

$$K_a = \frac{1 - \sin 0}{1 + \sin 0} = \frac{1}{1} = 1$$

and, $P_{aH} = 1 \times 18 \times 6 - 2 \times 20 \sqrt{1}$

$= 108 - 40$

$= 68 \, kN/m^2$

then, ~~total pressure~~ $= \cancel{\frac{1}{2} \times 2.22 \times 68}$

$= \cancel{94.52 \, kN/m^2}$

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~~and application of point of pressure is~~

$\frac{H}{3} = \frac{3.78}{3}$

Now, $H = h - h_{fc}$

$= 6 - 2.22$

$= 3.78$ m

Total pressure $= \frac{1}{2} \times H \times P_{aH} = \frac{1}{2} \times 3.78 \times 68$

$= 128.52$ KN/m^2

and point of application $= \frac{H}{3} = \frac{3.78}{3}$

$= 1.26$ m from base

Ans

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