APPLIED GEOTECHNICAL ENGINEERING (15CV53)
SOLUTION – IAT2

1 (a) **With a neat sketch, explain active and passive pressure.**

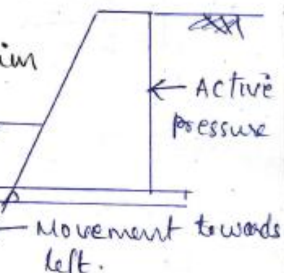
Ans:-

(2) Active Earth Pressure :

→ Soil mass yields such that it tends to stretch horizontally.

→ This is in a state of plastic equilibrium as soil is on the verge of failure.

→ Develops on the right hand side when the wall moves towards the left.



→ Caused when there is an increase in the weight of the retained soil causing a substantial increase in the horizontal reaction.

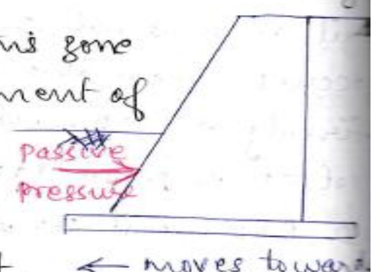
(3) Passive Pressure

→ Occurs when the wall movement tend to compress the soil horizontally.

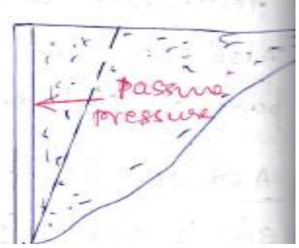
→ It is a condition of limiting equilibrium.

→ Develops on the left side of the wall below the g[round] level. because the soil in this zone is compressed when the movement of the wall is towards left.

→ Develops on the right side of the wall when the movement of the wall is towards right.



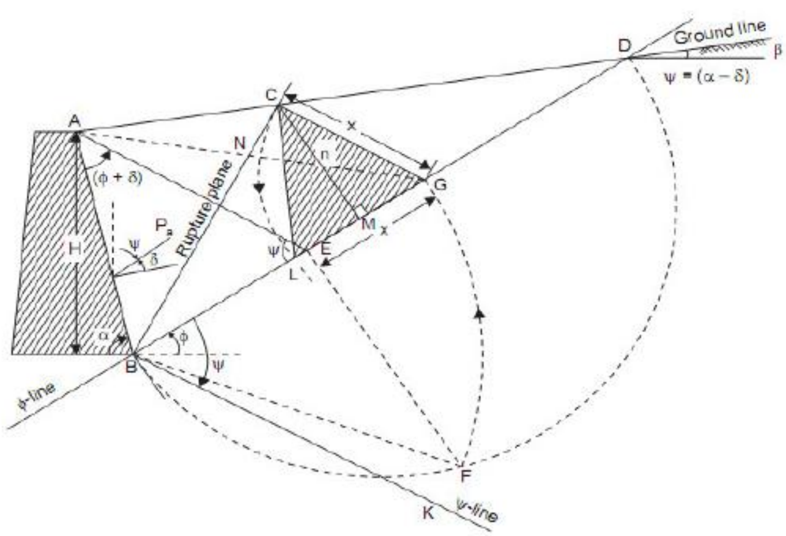
Eg. Pressure acting on anchor block.



1 (b) Explain with a nest sketch, Rebhann's construction for active pressure.

Ans:- The steps involved in the graphical method are as follows, with reference to Fig shown

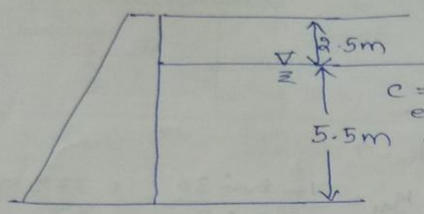
i. Let AB represent the back face of the wall and AD the backfill surface
ii. Draw BD inclined at ϕ with the horizontal from the heel B of the wall to meet the backfill surface in D.
iii. Draw BK inclined at ψ (= α – δ) with BD, which is the ψ-line.
iv. Through A, draw AE parallel to the ψ-line to meet BD in E. (Alternatively, draw AE at (ϕ + δ) with AB to meet BD in E).
v. Describe a semi-circle on BD as diameter.
vi. Erect a perpendicular to BD at E to meet the semi-circle in F.
vii. With B as centre and BF as radius draw an arc to meet BD in G
viii. Through G, draw a parallel to the ψ-line to meet AD in C.
ix. With G as centre and GC as radius draw an arc to cut BD in L; join CL and also draw a perpendicular CM from C on to LG.
x. BC is the required rupture surface.



Poncelet (Rebhann's) graphical construction for active thrust

1 (c) A retaining wall of 8m height retains sandy material. The properties of the sand are e=0.6, Φ=30◦ and G=2.65. The water table is at a depth of 2.5 m from the ground surface. Draw the earth pressure diagram and determine the magnitude and point of application of total active pressure.

Ans:-



Ka.

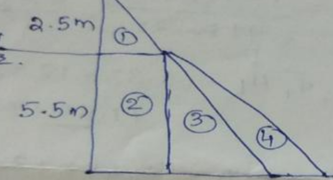
$\gamma_{sub} = \frac{(G-1)\gamma_w}{1+e}$

$= 10.116\ kN/m^3$

$\gamma_d = \frac{G\gamma_w}{1+e}$

$= 16.25\ kN/m^3$

$K_a = \frac{1-\sin 30}{1+\sin 30} = 0.33$.



$p_1 = K_{a_1} \times \gamma_d \times 2.5$

$= 13.406\ kN/m^2$

$p_2 = K_{a_1} \times \gamma_d \times H_1 = 13.406\ kN/m^2$

$p_3 = K_{a_1} \times \gamma_{sub} \times H_2 = 0.33 \times 10.116 \times 5.5$

$= 18.36\ kN/m^2$

$p_4 = \gamma_w \times H_2 = 9.81 \times 5.5 = 53.955\ kN/m^2$

$P_1 = \frac{1}{2} \times 13.406 \times 2.5 = 16.757\ kN/m^2$

$P_2 = 13.406 \times 5.5 = 73.73\ kN/m^2$

$P_3 = \frac{1}{2} \times 18.36 \times 5.5 = 50.49\ kN/m^2$

$P_4 = \frac{1}{2} \times 53.955 \times 5.5 = 148.376\ kN/m$

$P = P_1 + P_2 + P_3 + P_4 = 289.353\ kN/m$

$P \times \bar{x} = P_1 \times \left(5.5 + \frac{2.5}{3}\right) + P_2 \times \left(\frac{5.5}{2}\right) + P_3 \times \left(\frac{5.5}{3}\right) + P_4 \times \left(\frac{5.5}{3}\right)$

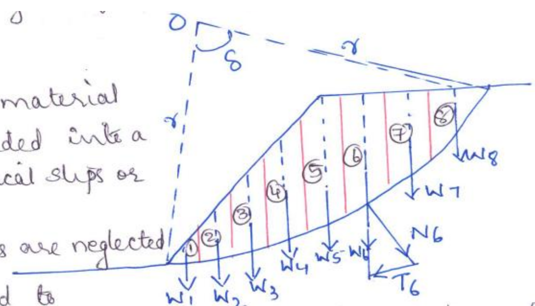
$= 106.127 + 202.76 + 92.565 + 272.02$

$\bar{x} = 2.33\text{m from base.}$

2 (a) Explain the Swedish Circle method of stability analysis for a C-Φ soil.

Ans:-

② c-φ analysis



→ Trial ○le is drawn, & material above slip circle is divided into a convinient no: of vertical slips or slices.

→ The forces b/w the slices are neglected

→ Each slice is assumed to act independently as a column of soil of unit thickness & width b.

→ Weight 'W' of each slice can be resolved into normal 'N' & tangential 'T' components.

'N' passes through centre of rotation 'O' & hence do not cause any driving moment on the slice.

$N = W\cos i$ & $T = W\sin i$.

Driving moment, $M_D = T \times r = W\sin i \times r$.

$= r \times \Sigma T$.

Resisting moment, $M_R = r\,[c\,\Sigma \Delta L + \Sigma N \tan\phi]$

where $\Sigma \Delta L = \hat{L} = \frac{2\pi r \delta}{360^\circ}$ = length AB of slip cle.

∴ FOS against sliding = $\frac{c\hat{L} + \Sigma N \tan\phi}{\Sigma T}$

A no. of trial cles are chosen & FOS in each case is computed. cle giving min FOS is the critical slip circle.

2 (b) Explain the Fellinious method of locating the center of critical slip circle.

Ans:- In case of slopes in homogeneous cohesive soil deposits, the centre of a critical circle can be directly located by using Fellenius direction angles.

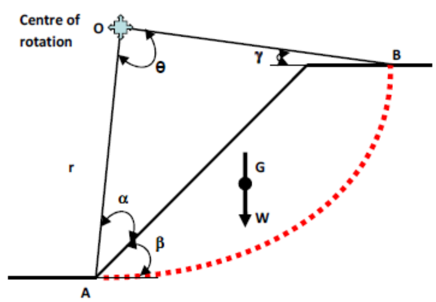
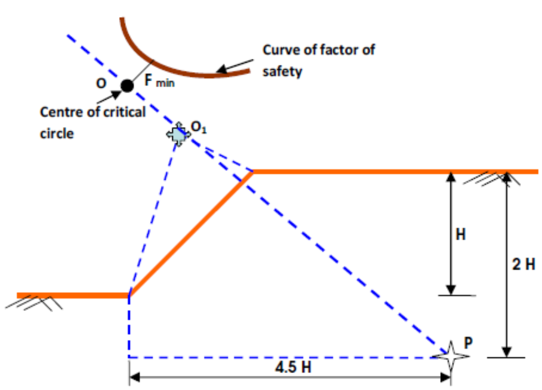


Table 2: Fellenius direction angles for locating critical slip circle

Slope	Angle α	Angle γ
1:1	28º	37º
1:1.5	26º	35º
1:2	25º	35º
1:3	25º	35º
1:5	25º	37º

For any given slope the corresponding direction angles a and g are set out from the base and the top as shown in figure. The point of intersection of these two lines is the centre of critical circle. In case of c-f soils the procedure for locating critical slip surface is slightly different and is as given below:



Locate point O1 the centre of Fellenius circle. Locate point P at 2H below the top surface of the slope and 4.5H from the toe of the slope. Extend backwards the line PO1 beyond O1. Construct trial slip circles with centres located on the extended portion of the line PO1. For each of these trial slip circles find the F.S by the method of slices. Plot the F.S for each of these trial slip circles from their respective centre and obtain a curve of factor of safety. Critical slip circle is the one that has a minimum F.S.

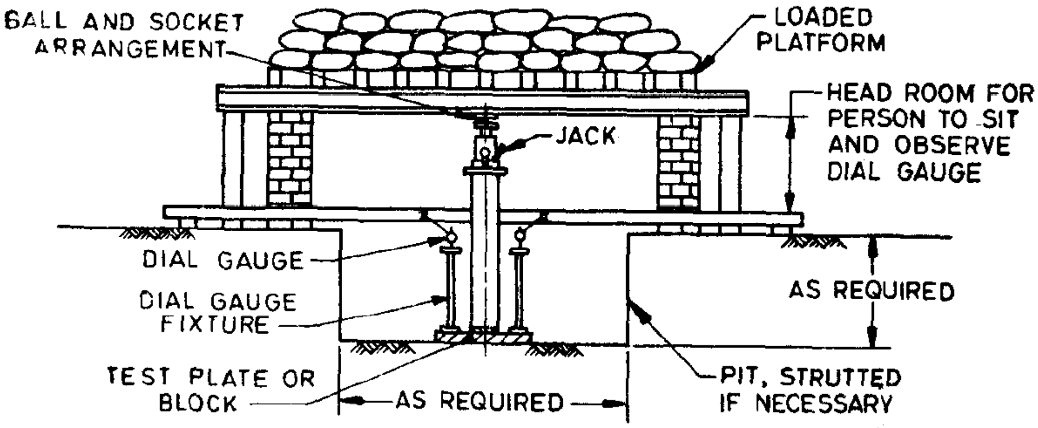
2(c) **A homogeneous slope 15 m high is made of c — ϕ soil with unit weight of l8kN/m^3, unit cohesion of 50 kPa and angle of internal friction of 25°. Compute the factor of safety with respect to cohesion and the critical height of slope. Assume S_n = 0.05.**

Ans:- $F_c = C/ S_n*ɣ*H = 50/ 0.05*18*15 = 3.704$.

$H_c = F_c * H = 3.704*15 = 55.55$ m.

3 (a) **Explain with a neat sketch, plate load test.**

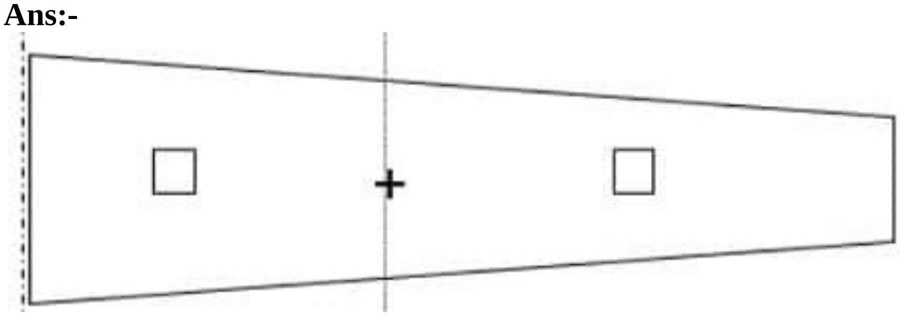
Ans:-



It is a field test for the determination of bearing capacity and settlement characteristics of ground in field at the foundation level. The test involves preparing a test pit up to the desired foundation level. A rigid steel plate, round or square in shape, 300 mm to 750 mm in size, 25 mm thick acts as model footing. Dial gauges, at least 2, of required accuracy (0.002 mm) are placed on plate on plate at corners to measure the vertical deflection. Loading is provided either as gravity loading or as reaction loading. For smaller loads gravity loading is acceptable where sand bags apply the load. In reaction loading, a reaction truss or beam is anchored to the ground. A hydraulic jack applies the reaction load. At every applied load, the plate settles gradually. The dial gauge readings are recorded after the settlement reduces to least count of gauge (0.002 mm) & average settlement of 2 or more gauges is recorded. Load Vs settlement graph is plotted as shown. Load (P) is plotted on the horizontal scale and settlement (Δ) is plotted on the vertical scale. Red curve indicates the general shear failure & the blue one indicates the local or punching shear failure. The maximum load at which the shear failure occurs gives the ultimate bearing capacity of soil.

3 (b) **Briefly explain the steps in proportioning of trapezoidal combined footing with two columns.**

Ans:-



Let B1 & B2 be the longer and smaller edge dimensions respectively of the above footing.

Let l be the c/c spacing between the columns and a1 & a2 be the projections on either sides.
Let W1 & W2 be the load acting to each column. Let W' be the weight of the footing & qs be the safe bearing capacity.

Area of the footing = (B1 + B2)* L /2 ⟹ 1

Area required = (W1 + W2 +W')/ qs ⟹ 2

Equating 1 & 2 we get, B1 + B2 = 2(W1 + W2 + W')/ (qs * L) ⟹ 3

X = (W2 * l)/ (W1 + W2) ⟹ 4

Distance of CG of trapezium from long edge = L (B1 + 2*B2)/ 3*(B1 + B2) ⟹ 5

A1 + W2*l / (W1 + W2) = L (B1 + 2*B2)/ 3*(B1 + B2) ⟹ 6

From 3 & 6, B1 & B2 can be determined.
Net upward pressure = W1 + W2 / 0.5*L*(B1 + B2).

(c) A 3m square footing is located in dense sand at a depth of 2m. Determine the safe bearing capacity using Terzhaghi's theory, for the following WT positions: (a) at GL (b) at footing level (c) at 1m below the footing. The moist unit weight of sand above the WT is l8kN/m^3, and γ_{sat} = l8kN/m^3. Φ=26°, γ_w = l0kN/m^3, FOS = 3.

Φ	**N_c**	**N_q**	**N_γ**
15	**12.9**	**4.4**	**2.5**
20	**17.7**	**7**	**5**
25	**25.1**	**12.7**	**9.7**

Ans:- Since this is a case of LSF, tan Φ= (2/3) * tan 26
Hence we get Φm = 18. ɣsub = 8 Kn/m3
For Φ = 18, Nq = 5.96, Nɣ = 4.
Ultimate bearing capacity qu = 0.4Bɣ NɣWɣ + ɣDfNqWq
Safe bearing capacity qs = (qu - ɣDf) / FOS + ɣDf
<u>Case 1:-</u> Wq = 0.5, Wɣ = 0.5, qu = 66.88 Kn/m^2 & qs = 32.96 Kn/m^2

<u>Case 2:-</u> Wq = 1.0, Wɣ = 0.5, qu = 233.76 Kn/m^2 & qs = 101.92 Kn/m^2
<u>Case 3:-</u> Wq = 1.0, Wɣ = 0.66, ɣavg = 11.33 Kn/m^3, qu = 250.45 Kn/m^2 & qs = 107.48 Kn/m^2