CBCS SCHEME

USN 18CV62

Sixth Semester B.E. Degree Examination, July/August 2022
Applied Geotechnical Engineering

Time: 3 hrs Max. Marks: 100

Note: 1. ***Answer any FIVE full questions, choosing ONE full question from each module.***
2. ***Missing data, if any may be suitably assumed.***

Module-1

1 a. What is sub-surface exploration? What are the objectives of soil exploration? **(07 Marks)**
b. With a neat sketch explain seismic refraction method. **(07 Marks)**
c. Determine the area ratios for the following soil sampler and comment the nature of samples obtained in each samplers
i) Core cutter 185mm OD 135mm ID
ii) Split Barrel 51mm OD 45mm ID
iii) Shellby tube 51mm OD 49mm ID
Which one you recommended to be used for getting good qualifier samples? **(06 Marks)**

OR

2 a. List the methods of dewatering technique used in the field and explain vacuum method. **(06 Marks)**
b. List and explain different types of samples of soil. **(06 Marks)**
c. Estimate the position of ground water table with following data by Hvorselve's method. Depth upto which water is bailed out = 10.5m.
Water rise in 1^{st} day = 0.63m
2^{nd} day = 0.57
3^{rd} day = 0.51m
(08 Marks)

Module-2

3 a. Distinguish between Boussinesq's theory with Westergaurd's theory of stress distribution. **(06 Marks)**
b. Explain contact pressure distribution of soil. **(06 Marks)**
c. A circular area 6m in diameter carries uniformly distributed load of $10 kN/m^2$. Determine the vertical stress at a depth of 2m, 4m, and 8m. Plot the variation of vertical stress with depth. **(08 Marks)**

OR

4 a. Explain :
i) Pressure bulb
ii) Pressure distribution on Horizontal plane
iii) Pressure distribution on vertical plane. **(06 Marks)**
b. What are the different types of settlements? Explain. **(06 Marks)**
c. A Normally consolidated clay layer is 18m thick. Natural water content is 45%, saturated unit weight is $18 kN/m^3$ specific gravity is 2.7 and liquid limit is 63%. The vertical stress increment at centre of clay layer due to foundation load is 9kPA. Ground water table is at the surface. Determine the settlement. **(08 Marks)**

Module-3

5 a. With a neat sketches, explain types of earth pressure. **(06 Marks)**
b. Describe Rebhann's graphical method of determining the active earth pressure on retaining wall. **(08 Marks)**

c. A Retaining wall 7.5m high retains cohesionless, horizontal backfill. The top 3m of fill has a unit weight of $18kN/m^3$ and $\phi = 30°$ and the rest has a unit weight of $24kN/m^3$ and $\phi = 20°$. Determine using Rankine's theory, the distribution of active earth pressure and total active earth thrust. **(06 Marks)**

OR

6 a. With neat sketches, explain different types of slope failures. **(06 Marks)**
b. Explain Swedish circle method of stability analysis of slopes for $C - \phi$ soils. **(06 Marks)**
c. An embankment is to be constructed with $C = 20kN/m^2$, $\phi = 20°$, $\gamma = 18kN/m^3$, F.S = 1.25 and height is 10m. Estimate side slope required. Taylor's stability numbers are as follows below table. Also find the factor of safety, if the slope is 1V: 2H given $\phi = 20°$.

Slope angle	90	75	60	45	30	20	10
Sn	0.182	0.134	0.097	0.062	0.025	0.005	0

(08 Marks)

Module-4

7 a. Explain the types of shear failures with neat sketches. **(06 Marks)**
b. With the help of neat sketches, explain the effect of water table and eccentric loading on bearing capacity of soil. **(08 Marks)**
c. A square footing is to be constructed on a deep deposit of sand at a depth of 0.9m to carry a design load of 300kN with a factor of safety of 2.5. The ground water table may rise to the ground level during rainy season. Design the plan dimension of footing given $\gamma_{sat} = 20.8\ kN/m^3$, $N_c = 25$, $N_q = 34$ and $N_\gamma = 32$. **(06 Marks)**

OR

8 a. List the assumptions and limitation made in Terzaghi's analysis. **(06 Marks)**
b. With neat sketch, explain plate load test. **(06 Marks)**
c. A square footing 2.8 × 2.8m is built on a homogeneous bed of sand of density $18kN/m^3$ and $\phi = 36°$. If depth of foundation is 1.8m. Determine the safe load on footing. Take F = 2.5, $N_c = 27$, $N_q = 36$, $N_\gamma = 35$. **(08 Marks)**

Module-5

9 a. Explain the classification of piles based on the material and function. **(08 Marks)**
b. Mention the situations where the pile foundation is necessary. **(04 Marks)**
c. In a group of 16 pile diameter is 450mm and center to center spacing of the square group is 1.5m. If $C = 50kN/m^2$, determine whether the failure would occur with the pile acting individually, or as a group? Neglect bearing at the tip of the pile. All piles are 10m long. Take adhesion factor as 2 and Factor of safety 2.5. Also find safe allowable load. **(08 Marks)**

OR

10 Write a short notes on :
i) Group capacity of piles **(05 Marks)**
ii) Negative skin friction **(05 Marks)**
iii) Under reamed piles **(05 Marks)**
iv) Settlement of piles. **(05 Marks)**

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VI SEMESTER B E DEGREE EXAMINATION, JULY/AUGUST, 2022

APPLIED GEOTECHNICAL ENGINEERING (18CV62).

QUESTION PAPER SOLUTION.

Q1.a. Sub surface exploration is an investigation of soil which is essential for judging its suitability for the proposed engineering works & preparing adequate and economic designs.

The objectives of soil exploration is to yield precise information about

1) the order of occurence & extent of soil and rock strata
2) Nature & eniginecring properties of soil & rock formation.
3) Location of groundwater and its variation.

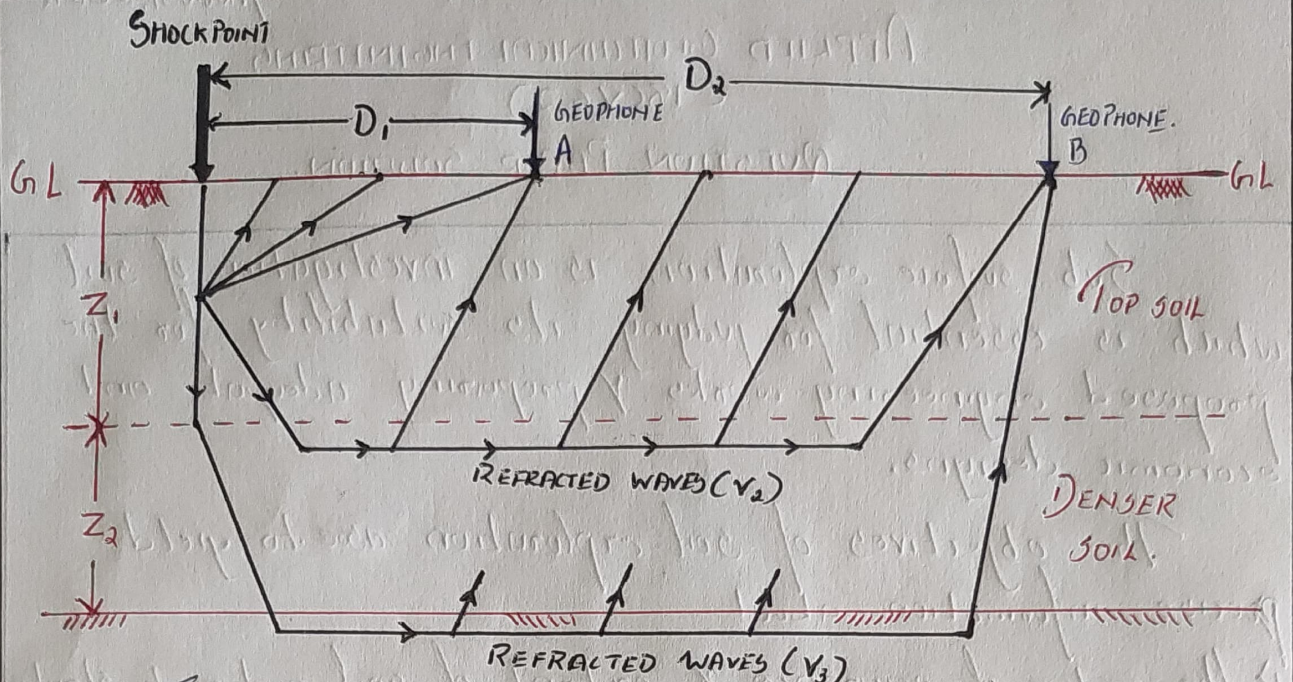
The above information may be required for a safe & economic design & execution of engineering work.

b. In SEISMIC REFRACTION METHOD shock waves are created into the soil at their ground level or certain depth below it by exploding small charges in the soil or by striking a plate on soil with a hammer.

The radiating shock waves are picked up by the vibration detector, where travel time gets recorded.

Either no of geophones are arranged along a line or the shock producing device is moved away from the geophone at given interval.

Some of the waves known as direct or primary waves travel directly from shock point to geophone along ground surface.



If the sub-soil comprises 2 or more distinct layers some of the primary waves travel downwards to the lower layer & gets refracted at interface.

If the underlying layer is dense, the refracted waves travel much faster. They emerge upon & reach the geophone.

c. i) CORE CUTTER.

$d_o = 185$ mm $d_i = 135$ mm

$A_r = \frac{D_o^2 - D_i^2}{D_i^2} \times 100 = \frac{185^2 - 135^2}{135^2} \times 100 = 87.8\%$

ii) SPLIT BARREL

$d_o = 51$ mm $d_i = 45$ mm

$A_r = \frac{D_o^2 - D_i^2}{D_i^2} \times 100 = \frac{51^2 - 45^2}{45^2} \times 100 = 28.44\%$

iii) SHELBY TUBE

$d_o = 51$ mm $d_i = 49$ mm

$A_r = \frac{51^2 - 49^2}{49^2} \times 100 = 8.3\%$

SHELBY TUBE can be used $\because A_r < 10\%$.

Q2.a. The different methods of dewatering techniques are
1) Ditches & Sumps 2) Well point system
3) Shallow well system 4) Deep well system
5) Vaccum method 6) Electro osmosis method.

VACCUM METHOD.

For fine grained soil, th well point system can be extended by the vaccum method.
Both well point & deep well system can be adopted for dewatering such soils by maintaining a vaccum in the well using air tight seals.

A hole of about 25 cm diameter is created around the well point & rise pipe by jetting water.

While jetting water is still flowing, medium to coarse sand is rapidly shovelled into the hole to fill it upto 0.75 to 1m from top.

Top portion of hole is then sealed up by tamping bentonite, soil cement or clay.

Vaccum pipes ared used. to create vaccum in sand filling which results to ground surface being subjected to unbalanced atmospheric pressure which consolidates subsoil which becomes stiff.

b. The soil sample can be of 2 types
1) UNDISTURBED SAMPLE.
is sample in which the natural structure and properties remain preserved.

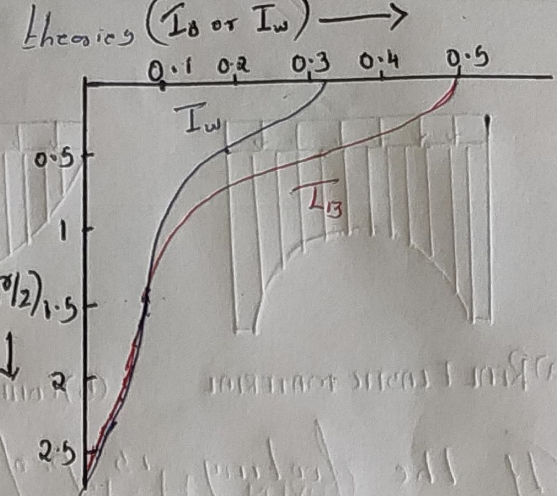
2) DISTURBED SAMPLE.

is a sample in which the natural structure of soil gets partly or fully modified and destroyed.

Although with suitable precautions if th natural water content is preserved, such a sample should however by REPRESENTATIVE of natural soil by maintaining the original proportion of various soil particles intact.

C.

Q3.a. The differences b/w 2 theories



• From the graph it is clear that Westergaard's eqn gives values consistently less than Boussineq's for th same point load upto a ratio of (r/z) equal to 1.5.

When the ratio exceeds 1.5, Westergaard's eqn gives a greater stress.

For all ratios of $r/z < 0.8$, σ_z values as per Westergaard's formula is approximately equal to $2/3^{rd}$ the values of Boussinesq's formula.

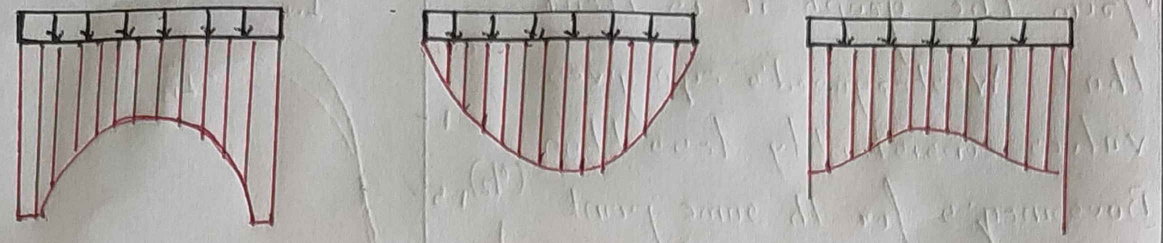
Engineer's prefer to use Boussinesq's formula as it gives conservativ values compared to Westergaard's formula.

Contact pressure is defined as the vertical pressure acting at the surface of contact between the base of footing & the underlying soil mass.

To simplify design, the distribution is assumed to be uniform.

The actual contact pressure distribution, however, depends upon the flexural rigidity of footing & elastic properties of the sub-grade.

If footing is flexible, the distribution of contact pressure is uniform irrespective of type subgrade.



(a) REAL ELASTIC MATERIAL (b) COHESIONLESS SAND (c) INTERMEDIATE SOIL

If the footing is perfectly rigid, the contact pressure distribution depends upon the type of th subgrade.

Q3.c. GIVEN, $d = 6m$ $q = 10\ kN/m^2$

$$\sigma_z = q\left[1 - \left\{\frac{1}{1+(a/z)^2}\right\}^{3/2}\right]$$

$$a = \frac{d}{2} = \frac{6}{2} = 3m$$

At $z = 2m$, $\sigma_z = 10\left[1 - \left\{\frac{1}{1+(3/2)^2}\right\}^{3/2}\right]$

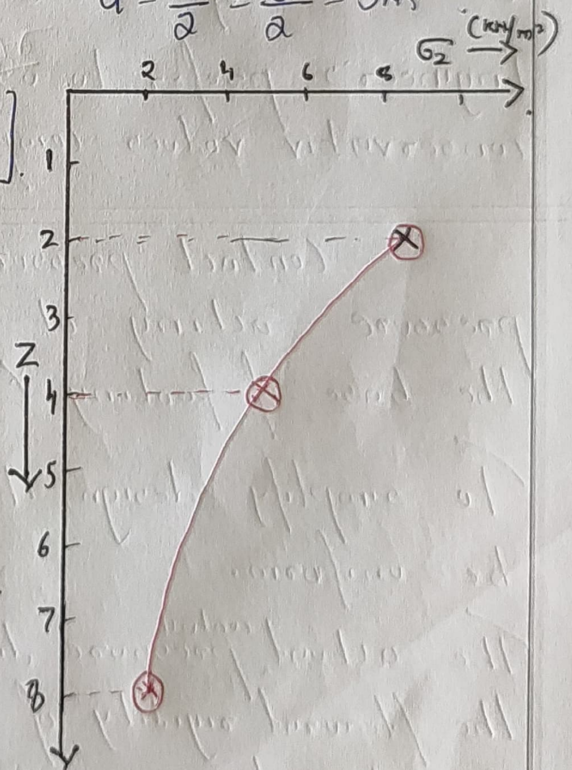
$= 8.29\ kN/m^2$

At $z = 4m$, $\sigma_z = 10\left[1 - \left\{\frac{1}{1+(3/4)^2}\right\}^{3/2}\right]$

$= 4.88\ kN/m^2$

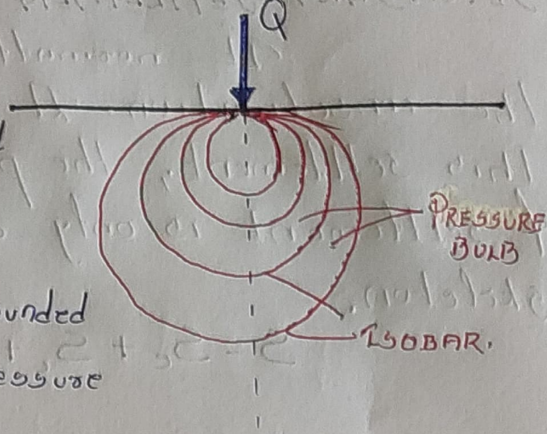
At $z = 8m$ $\sigma_z = 10\left(1 - \left\{\frac{1}{1+(3/8)^2}\right\}^{3/2}\right)$

$= 1.79\ kN/m^2$



Q4.a. **PRESSURE BULB**

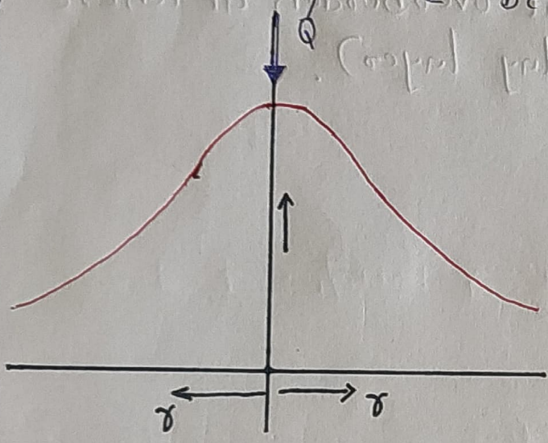
An isobar is a curve or contour connecting all points of equal vertical pressure below the ground surface.



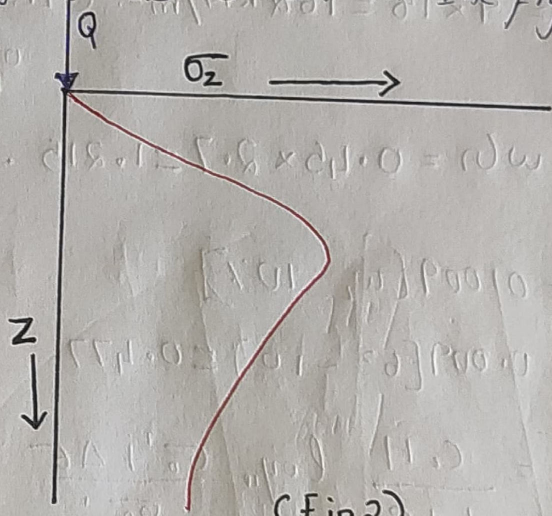
The zone in a loaded soil mass bounded by an isobar of given vertical pressure is called a pressure bulb.

PRESSURE DISTRIBUTION ON HORIZONTAL PLANE

The vertical pressure distribution on any horizontal plane at a depth 'z' below is as shown in the figure 1.



(fig 1)



(fig 2)

PRESSURE DISTRIBUTION ON VERTICAL PLANE.

The vertical pressure distribution on a vertical plane due to a point load acting on surface of the soil is as shown in the figure 2.

SECONDARY SETTLEMENT (S_s):

It normally starts with completion of the consolidation. It means, during the stage of this settlement, the pore water pressure is zero & settlement is only due to distortion of soil skeleton.

$$S = S_e + S_c + S_s$$

Q4.c. Given, $H = 18 m$, $\omega = 45\%$, $\gamma_{sat} = 18 kN/m^3$

$G = 2.7$, $\omega_L = 63\%$, $\Delta\sigma = 9 kN/m^2$

$\sigma_0 = 9 \times 18 = 162 kN/m^2$ (Initial overburden at centre of clay layer).

$e = \omega G = 0.45 \times 2.7 = 1.215$.

$C_c = 0.009[\omega_L - 10\%]$

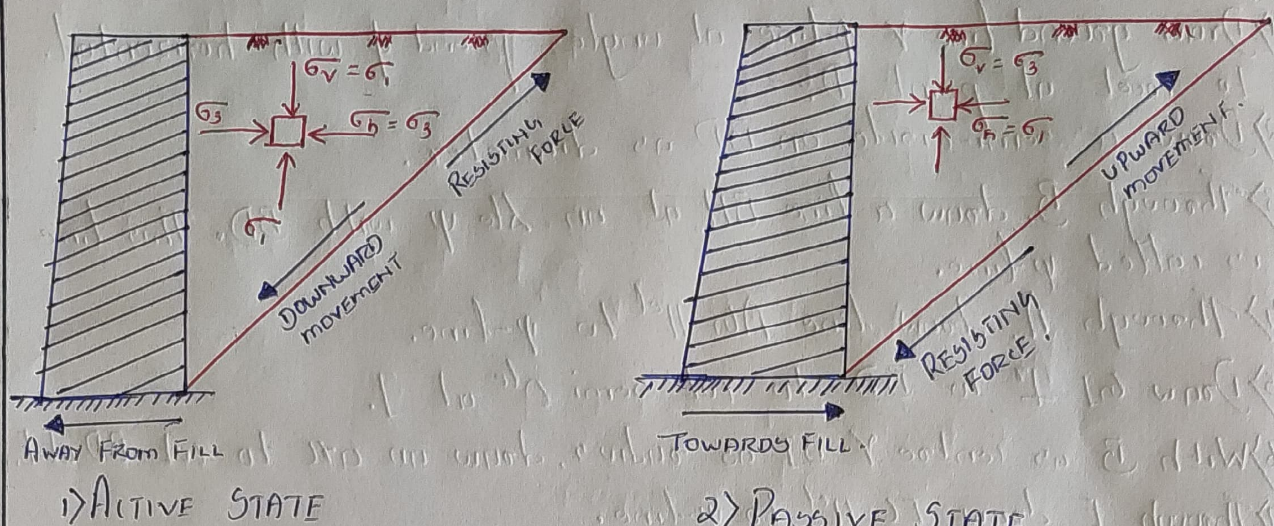
$C_c = 0.009[63 - 10] = 0.477$

$$S = \frac{C_c H}{1 + e_0} \log_{10} \frac{\sigma_0' + \Delta\sigma}{\sigma_0'}$$

$$= \frac{0.477 \times 18}{1 + 1.215} \log \frac{162 + 9}{162}$$

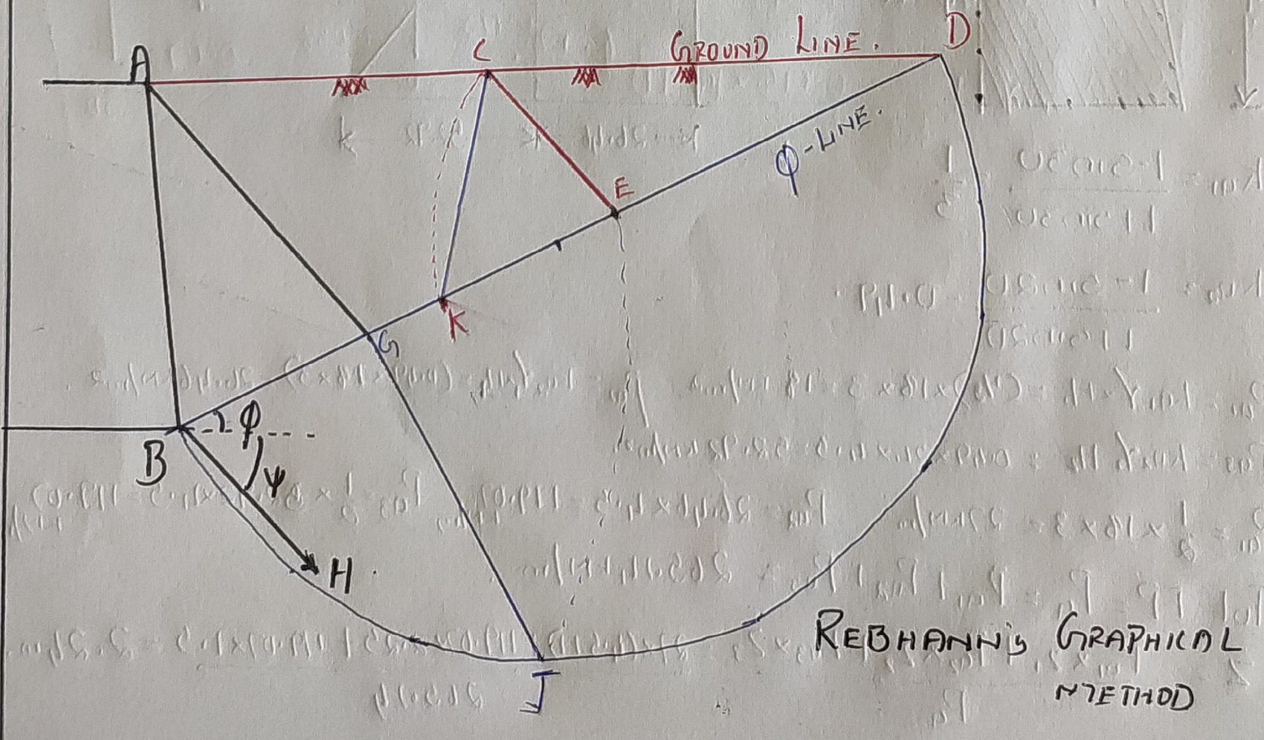
$= 0.091 m = 91 mm$.

Q5.a.



* During the active state, the wall moves away from the backfill.
* The resisting force due to shear strength of soil is developed in an upward direction along failure plane.
- In passive state the wall moves towards the fill due to some thrust etc.
- The soil behind the wall moves in the upward direction. & hence the resisting force is in downward direction.

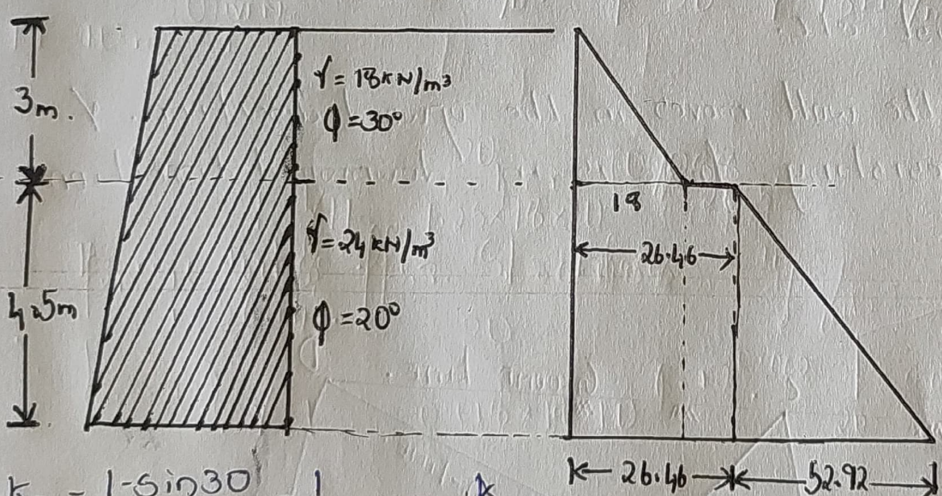
b.



PROCEDURE.

1) Draw ground line & φ-line at angles β and φ with horizontal to meet at point D.
2) Draw a semi-circle on BD as diameter.
3) Through B, draw a line BH at an ∠le ψ with BD. This line is called ψ line.
4) Through A, draw line AG ‖el to ψ-line.
5) Draw GJ ⊥r to BD to cut semi ○le at J.
6) With B as centre & BJ as radius, draw an arc to cut BD at E.
7) Through E draw EC ‖el to ψ-line.
8) With 'E' as centre & EC as radius draw an arc to cut BD at 'K'. Join CK.
9) Total active earth pressure, $P_a = \gamma(\triangle KCE) = \gamma \times (\frac{1}{2} \times KE \times x)$.

Q5.c.



$K_{a_1} = \frac{1 - \sin 30}{1 + \sin 30} = \frac{1}{3}$

$K_{a_2} = \frac{1 - \sin 20}{1 + \sin 20} = 0.49$

$P_{a1} = K_{a1} \gamma \times H_1 = (1/3) \times 18 \times 3 = 18 \text{ kN/m}^2$ $P_{a2} = K_{a2} \gamma_1 H_1 = (0.49 \times 18 \times 3) = 26.46 \text{ kN/m}^2$.

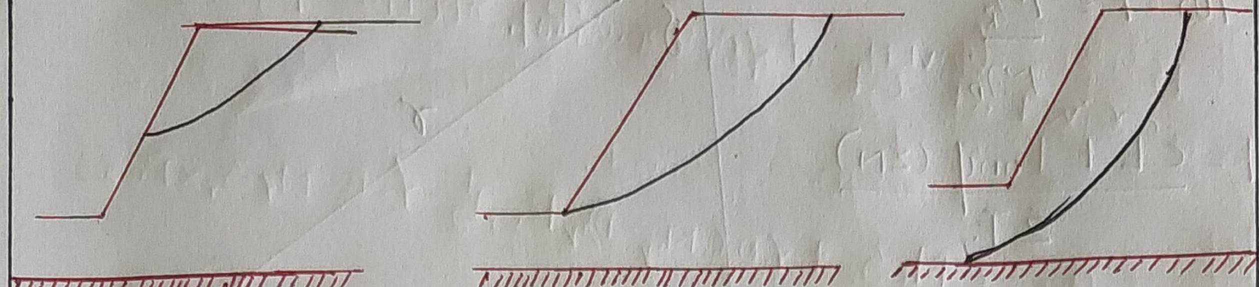
$P_{a3} = K_{a2} \gamma_2 H_2 = 0.49 \times 24 \times 4.5 = 52.92 \text{ kN/m}^2$.

$P_{a_1} = \frac{1}{2} \times 18 \times 3 = 27 \text{ kN/m}$ $P_{a2} = 26.46 \times 4.5 = 119.07 \text{ kN/m}$ $P_{a3} = \frac{1}{2} \times 52.92 \times 4.5 = 119.07 \text{ kN/m}$

Tot EP $= P_a = P_{a_1} + P_{a_2} + P_{a_3} = 265.14 \text{ kN/m}$

$\bar{z} = \frac{P_{a_1} \times z_1 + P_{a_2} \times z_2 + P_{a_3} \times z_3}{P_a} = \frac{27 \times (4.5 + 1) + 119.07 \times 2.25 + 119.07 \times 1.5}{265.14} = 2.24 \text{ m}$.

Q6.a.



FACE FAILURE (a) TOE FAILURE (b) BASE FAILURE (c)

Two types of failure may occur in finite slopes.

1) **SLOPE FAILURE**: occurs along a surface of sliding that intersects the slope at or above its toe.

a) Slope failure is called FACE FAILURE if arc passes above toe.

b) Slope failure is called TOE FAILURE if arc passes through toe.

2) **BASE FAILURE**: When soil beneath the toe is weak th failure occurs along a surface that passes at some distance below the toe. Such a failure is called BASE FAILURE.

b. SWEDISH SLIP CIRCLE METHOD.

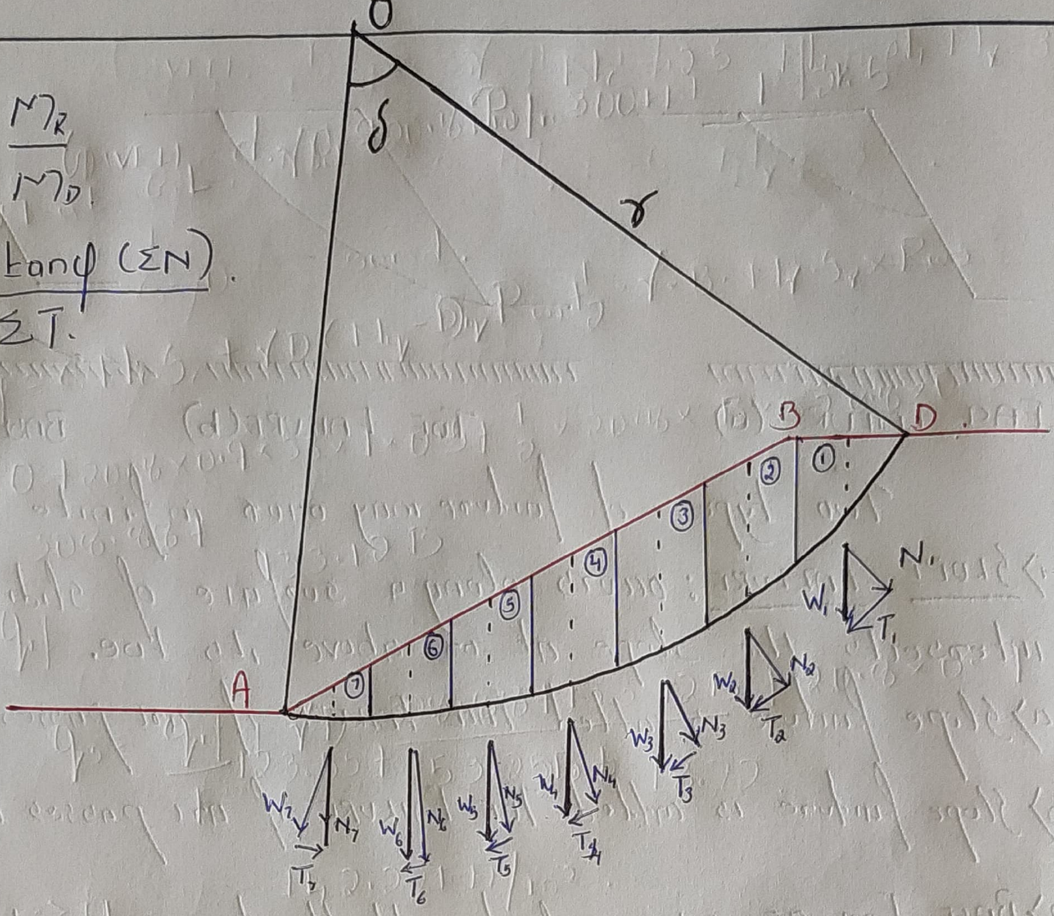
- Let AB be the slope. A trial slip circle is drawn & material above slip surface is divided into convinient no. of vertical strips or slices.
- Forces b/w slices are neglected, each slice is assumed to act independently of width 'b'.
- Weight, W of each slice is assumed to act at its centre. This weight W of each slice is resolved into normal (N) and tangential (T) components.
- Normal component (N) will pass through centre of rotation (O) & hence donot cause driving moment.
- Tangential component (T) causes a driving moment. However component of few slices at base may cause resisting moment.

Driving moment, $M_D = T \cdot r$ (for 1 slice) $= r(\Sigma T)$ for entire surface

Resisting moment, $M_r = r[c\,\Sigma(\Delta L) + \tan\phi\,(\Sigma N)]$.

$$FOS = F = \frac{M_R}{M_D}$$

$$F = \frac{c\hat{L} + \tan\phi\,(\Sigma N)}{\Sigma T}$$



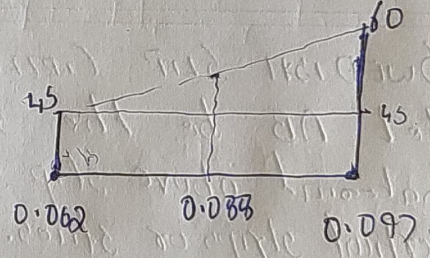
Q6.c. Given, (1) $C = 20\ kN/m^2$ $\phi = 20^\circ$ $\gamma = 18\ kN/m^3$ $F = 1.25$

$H = 10m$ $i = ?$

$$S_n = \frac{c}{F_c \gamma H} = \frac{20}{1.25 \times 18 \times 10} = 0.088$$

From Table for $S_n = 0.088$,

$i = 56.14^\circ$.

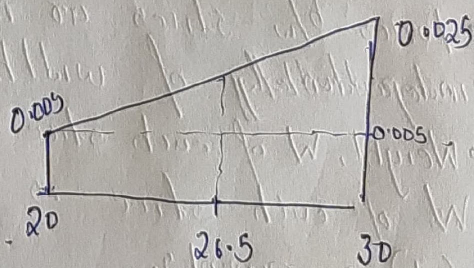


case (2) $F = ?$ $i = \tan^{-1}(1/2) = 26.5^\circ$

for $i = 26.5$ from table

$S_n = 0.018$.

$$\therefore F = \frac{c}{S_n \gamma H} = \frac{20}{0.018 \times 18 \times 10} = 6.17.$$



Q7.a. GENERAL SHEAR FAILURE (Fig ①)

1) It has well defined failure surface reaching upto ground surface.
2) Considerable bulging of soil.
3) Failure is accompanied by tilting.
4) Failure is sudden ~~with~~

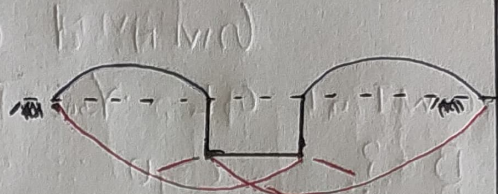


Fig ①

LOCAL SHEAR FAILURE (Fig ②).

1) Failure patter is well defined only below the footing.
2) There is only slight bulging.
3) There is no tilting of footing.
4) Failure is not sudden & is defined by large settlements.

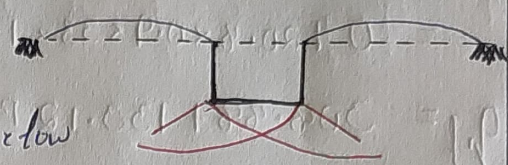


Fig ②

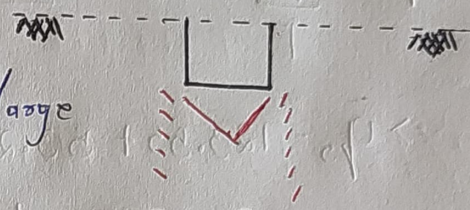


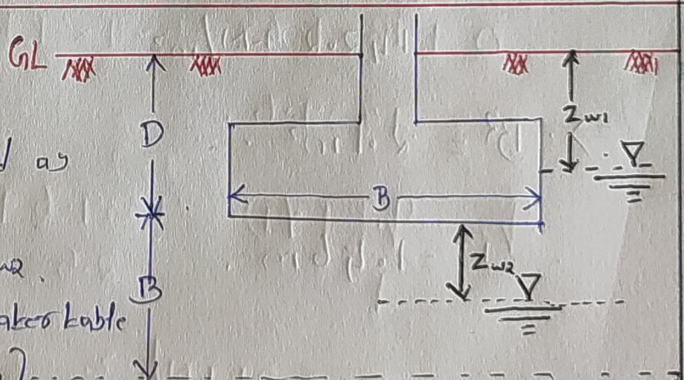
Fig ③

PUNCHING SHEAR FAILURE (Fig ③)

1) Failure pattern is not observed.
2) There is no bulging of soil.
3) There is no tilting of footing.
4) Failure is characterized by very large settlement.

b. EFFECT OF WATER TABLE.

For any position of water table Terzaghi's eqn. can be modified as



$q_f = cN_cS_c + \gamma_1 DN_qR_{w1} + \frac{1}{2}\gamma BN_\gamma S_\gamma R_{w2}$.

R_{w1}, R_{w2} —> Reduction factor for water table

$R_{w1} = 0.5\left[1 + \frac{Z_{w1}}{D}\right]$ $R_{w2} = 0.5\left[1 + \frac{Z_{w2}}{B}\right]$

when WT is at GL, $Z_{w1} = 0$ $Z_{w2} = 0$ ∴ $R_{w1} = 0.5$ & $R_{w2} = 0.5$.

when WT is at BASE, $Z_{w1} = D$ $Z_{w2} = 0$ ∴ $R_{w1} = 1$ & $R_{w2} = 0.5$.

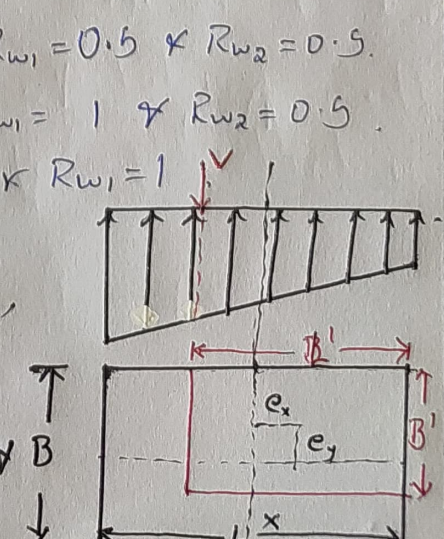
when WT is at $Z_{w2} = B$, ~~[illegible]~~ $R_{w2} = 1$ & $R_{w1} = 1$

EFFECT OF ECCENTRICITY.

If the total load 'V' acts eccentrically, the width B & length 'L' should be reduced as

$B' = B - 2e_y$ $L' = L - 2e_x$

$A' = L' \times B'$



4 GIVEN, $d = 0.9m$ $P_u = 300kN$ $F = 2.5$

GWT at GL, $\gamma_{sat} = 20.8 kN/m^3$ $N_c = 25$ $N_q = 34$ $N_\gamma = 32$

$B = ?$ $c = 0$ ∵ sand.

$q_{nf} = cN_cS_c + \gamma D(N_q - 1)S_q R_{w1} + \frac{1}{2} \times \gamma \times B \times N_\gamma \times S_\gamma \times R_{w2}$.

$= 0 + 20.8 \times 0.9 \times 33 \times 1 \times 0.5 + \frac{1}{2} \times 20.8 \times B \times 32 \times 0.8 \times 0.5$.

$q_{nf} = 308.88 + 133.12B$

$q_s = \frac{q_{nf}}{F} + \gamma D = \frac{308.88 + 133.12B}{2.5} + 20.8 \times 0.9$

$\Rightarrow q_s = 123.55 + 53.25B + 18.72$.

$= 142.27 kN/m^2$.

$A_{req} = \frac{P_u}{q_s}$

$\Rightarrow B^2 = \frac{300kN}{142.27 kN/m^2}$

$\Rightarrow B^2 = 2.1 m^2$.

$\therefore B = 1.46m$.

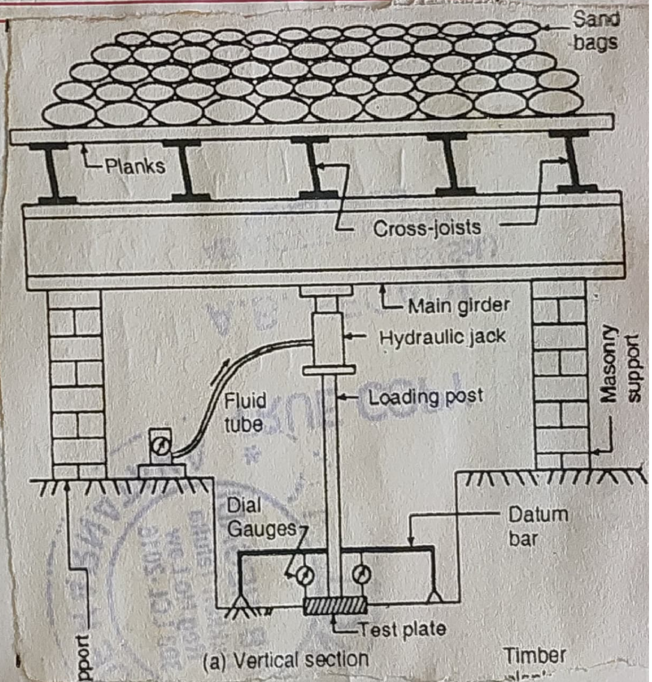
Q8.a. ASSUMPTIONS OF TERZAGHI'S ANALYSIS.

1) The soil is homogeneous & isotropic.
2) The footing has a rough base & the problem is essentially 2 dimensional.
3) Failure zones do not extend above the horizontal plane through the base of footing.
4) The elastic zone has straight boundaries inclined at $\psi = \phi$ to the horizontal & plastic zones fully develop.

LIMITATIONS

1) As the soil compresses ϕ changes; slight downward movement of footing may not fully develop plastic state.
2) Error due to assumption no (4) increases with foundation depth & hence theory is only suitable for shallow foundation.

b. PLATE LOAD TEST.



(a) Vertical section

It is a field test to determine the UBC of soil & probable settlement under given loading.

The test essentially consists in loading a rigid plate at the foundation level & determn the settlement corresponding to each load increment.

The UBC is then taken as the load at which the plate starts sinking at a rapid rate.

The method assumes that down to th depth of influence of stresses, the soil strata is reasonably uniform.

The Bearing plate used is either circular or square, made of mild steel of thickness not less than 25mm & size varying from 300 to 750mm.

There are 2 types of loading arrangements 1) GRAVITY LOADING platform 2) REACTION TRUSS method.

Q8.6. GIVEN, $B = 2.8m$ $\gamma = 18 kN/m^3$ $\phi = 36°$

$D_f = 1.8m$ $F = 2.5$ $N_c = 27$ $N_q = 36$ $N_\gamma = 35$.

$c = 0$ ∴ sand.

$q_{nf} = cN_c S_c + \gamma D (N_q - 1) S_q R_{w1} + \frac{1}{2} \times \gamma B \times N_\gamma \times S_\gamma \times R_{w2}$

$= 0 + 18 \times 1.8 \times 35 \times 1 \times 1 + \frac{1}{2} \times 18 \times 2.8 \times 35 \times 0.8 \times 1$

$= 1839.6$

$q_o = \frac{q_{nf}}{F} + \gamma D = \frac{1839.6}{2.5} + 18 \times 1.8$

$= 768.24 kN/m^2$

$A_{req} = \frac{P_u}{q_o}$

$\Rightarrow P_u = A_{req} \times q_o$

$= (2.8 \times 2.8) \times 768.24$

$= 6023 kN$

Q9.a. The classification of pile foundation based on the material & function is

BASED ON MATERIAL

1) CONCRETE PILES. are further classified as

a) PRECAST PILES: which are generally used for max design load of 80T. They are reinforced to withstand handling stresses also. Heavy equipment is required for handling & driving. They incur large cost in cutting off extra length or adding more length.

b) CAST IN-SITU PILES: which are further classified as i) Driven piles ii) Bored piles are generally used for a max design load of 75T except for compacted, pedestral piles.

2) TIMBER PILES: have small bearing capacity & are not permanent unless treated.

3) COMPOSITE PILES: are suitable where the upper part of a pile is to project above the water table.

BASED ON FUNCTION

1) END BEARING PILE: are used to transfer load through water or soft soil to a suitable bearing stratum.

2) FRICTION PILES: are used to transfer loads to a depth of a friction load carrying material by means of skin friction.

3) COMPACTION PILES: are used to compact loose granular soil, thus increasing their bearing capacity.

4) TENSION or UPLIFT PILES: anchor down the structure subjected to uplift due to hydrostatic pressure or overturning moment.

b. Pile foundation is necessary when

1) when heavy loads are to transfered to a hard strata which is available at great depth.

2) a highly compressible strata is present

3) if the structure is subjected to high horizontal loads.

Q9c. GIVEN, $n = 16$ $d = 45cm$ $L = 10m$.

width of group = ~~150~~ $1.5m \times 3 + 0.45m = 4.95m$

i) for the group.

$Q_{ug} = c \times perimeter \times Length$

$= c \times 4B \times L$

$= 50 \times (4 \times 4.95) \times 10$

$= 9900 kN$

ii) For Piles acting individually.

$Q_{ug} = n Q_{up} =$

$= n\{m c A_p\}$.

where, $A_p = \pi \times d \times L$

$= \pi \times 0.45m \times 10$

$= 14.137 m^2$

$Q_{ug} = 16 \times 2 \times 50 \times 14.137$

$= 16 \times 1413.7 kN$.

$= 22619.5 kN$

which is more than load carried by group action
Hence foundation will fail by the piles acting ~~individually~~ as group.

Q10. **GROUP CAPACITY OF PILES.**

When several closely spaced piles are grouped together, the bearing capacity of a pile group may or may not be equal to sum of bearing capacity of individual piles constituting a group.

In clay, total bearing value Q_{ug} of a group of friction piles < product of friction bearing value of individual pile multiplied by no of piles.

There is no reduction due to grouping occurring in end bearing piles.

For combined end bearing & friction piles only the load carrying capacity of friction portion is reduced.

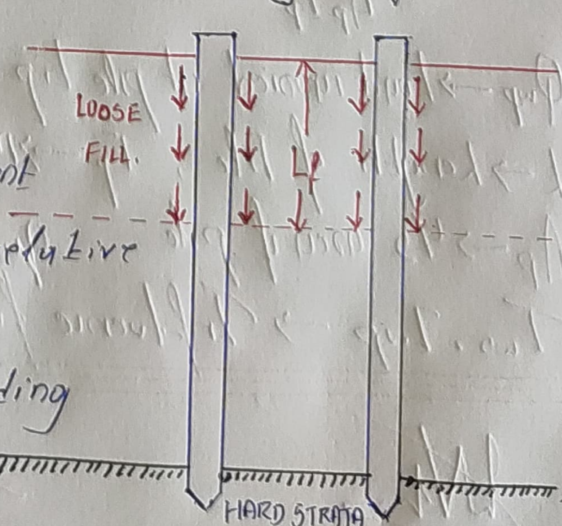
The ultimate load will then be given by

$Q_{ug} = PL\tau_f + A\tau_p$.

A → c/s of the pile group at base

P → Perimeter group τ_f → shear strength of soil.

NEGATIVE SKIN FRICTION:

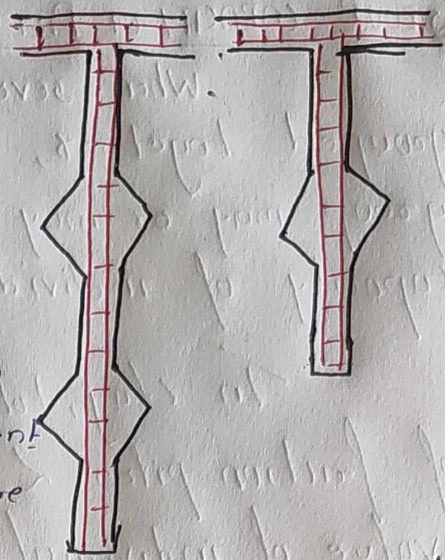


is a downward drag acting on a pile due to downward movement of surrounding compressible soil relative to the pile.

This happens when the surrounding compressible soil has been recently filled or formed.

As the soil consolidates, the soil moves downwards developing friction which tend to carry the pile farther into the ground.

UNDER REAMED PILES.



are bored cast in-situ concrete piles having one or more bulbs formed by enlarging the bore hole for the pile stem by an under reaming tool.

These piles find application in widely varying situations in different types of soil where foundations are required to be taken down to a certain depth to avoid the undesirable effect of seasonal moisture changes as in expansive soils or to reach strata or to obtain adequate capacity for downward, upward & lateral loads or to take foundation below scour level & for moments.

SETTLEMENT OF PILES.

The total settlement of piles has following components

1) Elastic settlement of pile 2) Settlement caused by load at Pile tip.
3) Settlement caused by load transfer along pile shaft.

$S_{e1} = \frac{(Q_{wp} + \xi Q_{ws}) L}{A_p E_p}$, $S_{e2} = \frac{q_{wp} D(1-\mu^2) I_{wp}}{E_s}$, $S_{e3} = \frac{Q_{ws} D(1-\mu_s^2) I_{ws}}{pLE_s}$.

Q_{wp} → Load carried at pile tip Q_{ws} → Load carrid by skin friction

L → Length of Pile, E_p → Modulus of Elasticity of Pile.

A_p → c/s area of pile q_{wp} → Load at pile tip μ_s → poisson's ratio

I_{ws}, I_{wp} → Influence factor.

(HARSHAVARDHAN V.S)
STAFF - INCHARGE

24-09-2022

26/9/22
Dean, Academics
KLS VDIT, HALIYAL

CBCS SCHEME

USN 2 V D 1 9 C V 0 3 6 — 18CV62

Sixth Semester B.E. Degree Examination, July/August 2022
Applied Geotechnical Engineering

Time: 3 hrs — Max. Marks: 100

Note: 1. *Answer any FIVE full questions, choosing ONE full question from each module.*
2. *Missing data, if any may be suitably assumed.*

Module-1

1 a. What is sub-surface exploration? What are the objectives of soil exploration? (07 Marks)

b. With a neat sketch explain seismic refraction method (07 Marks)

c. Determine the area ratios for the following soil sampler and comment the nature of samples obtained in each samplers

i) Core cutter 185mm OD 135mm ID

ii) Split Barrel 51mm OD 45mm ID

iii) Shellby tube 51mm OD 49mm ID

Which one you recommended to be used for getting good qualifier samples? (06 Marks)

OR

2 a. List the methods of dewatering technique used in the field and explain vacuum method. (06 Marks)

b. List and explain different types of samples of soil. (06 Marks)

c. Estimate the position of ground water table with following data by Hvorselve's method.

Depth upto which water is bailed out = 10.5m.

Water rise in 1^{st} day = 0.63m

2^{nd} day = 0.57

3^{rd} day = 0.51m (08 Marks)

Module-2

3 a. Distinguish between Boussinesq's theory with Westergaurd's theory of stress distribution. (06 Marks)

b. Explain contact pressure distribution of soil. (06 Marks)

c. A circular area 6m in diameter carries uniformly distributed load of $10kN/m^2$. Determine the vertical stress at a depth of 2m, 4m, and 8m. Plot the variation of vertical stress with depth. (08 Marks)

OR

4 a. Explain :

i) Pressure bulb

ii) Pressure distribution on Horizontal plane

iii) Pressure distribution on vertical plane. (06 Marks)

b. What are the different types of settlements? Explain. (06 Marks)

c. A Normally consolidated clay layer is 18m thick. Natural water content is 45%, saturated unit weight is $18kN/m^3$ specific gravity is 2.7 and liquid limit is 63%. The vertical stress increment at centre of clay layer due to foundation load is 9kPA. Ground water table is at the surface. Determine the settlement. (08 Marks)

Module-3

5 a. With a neat sketches, explain types of earth pressure. (06 Marks)

b. Describe Rebhann's graphical method of determining the active earth pressure on retaining wall. (08 Marks)

c. A Retaining wall 7.5m high retains cohesionless, horizontal backfill. The top 3m of fill has a unit weight of 18kN/m³ and $\phi = 30°$ and the rest has a unit weight of 24kN/m³ and $\phi = 20°$. Determine using Rankine's theory, the distribution of active earth pressure and total active earth thrust (06 Marks)

OR

6 a. With neat sketches, explain different types of slope failures (06 Marks)
b. Explain Swedish circle method of stability analysis of slopes for C – ϕ soils (06 Marks)
c. An embankment is to be constructed with C = 20kN/m², $\phi = 20°$, γ = 18kN/m³, F.S = 1.25 and height is 10m. Estimate side slope required. Taylor's stability numbers are as follows below table. Also find the factor of safety if the slope is 1V : 2H given $\phi = 20°$.

Slope angle	90	75	60	45	30	20	10
Sn	0.182	0.134	0.097	0.062	0.025	0.005	0

(08 Marks)

Module-4

7 a. Explain the types of shear failures with neat sketches. (06 Marks)
b. With the help of neat sketches, explain the effect of water table and eccentric loading on bearing capacity of soil. (08 Marks)
c. A square footing is to be constructed on a deep deposit of sand at a depth of 0.9m to carry a design load of 300kN with a factor of safety of 2.5. The ground water table may rise to the ground level during rainy season. Design the plan dimension of footing given γ_{sat} = 20.8 kN/m³, N_c = 25, N_q = 34 and N_γ = 32 (06 Marks)

OR

8 a. List the assumptions and limitation made in Terzaghi's analysis (06 Marks)
b. With neat sketch, explain plate load test (06 Marks)
c. A square footing 2.8 × 2.8m is built on a homogeneous bed of sand of density 18kN/m³ and $\phi = 36°$. If depth of foundation is 1.8m. Determine the safe load on footing. Take F = 2.5, N_c = 27, N_q = 36, N_γ = 35. (08 Marks)

Module-5

9 a. Explain the classification of piles based on the material and function. (08 Marks)
b. Mention the situations where the pile foundation is necessary. (04 Marks)
c. In a group of 16 pile diameter is 450mm and center to center spacing of the square group is 1.5m. If C = 50kN/m², determine whether the failure would occur with the pile acting individually, or as a group? Neglect bearing at the tip of the pile. All piles are 10m long. Take adhesion factor as 2 and Factor of safety 2.5. Also find safe allowable load. (08 Marks)

OR

10 Write a short notes on :
i) Group capacity of piles (05 Marks)
ii) Negative skin friction (05 Marks)
iii) Under reamed piles (05 Marks)
iv) Settlement of piles (05 Marks)

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