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Section	A
Subject	Soil Mechanics
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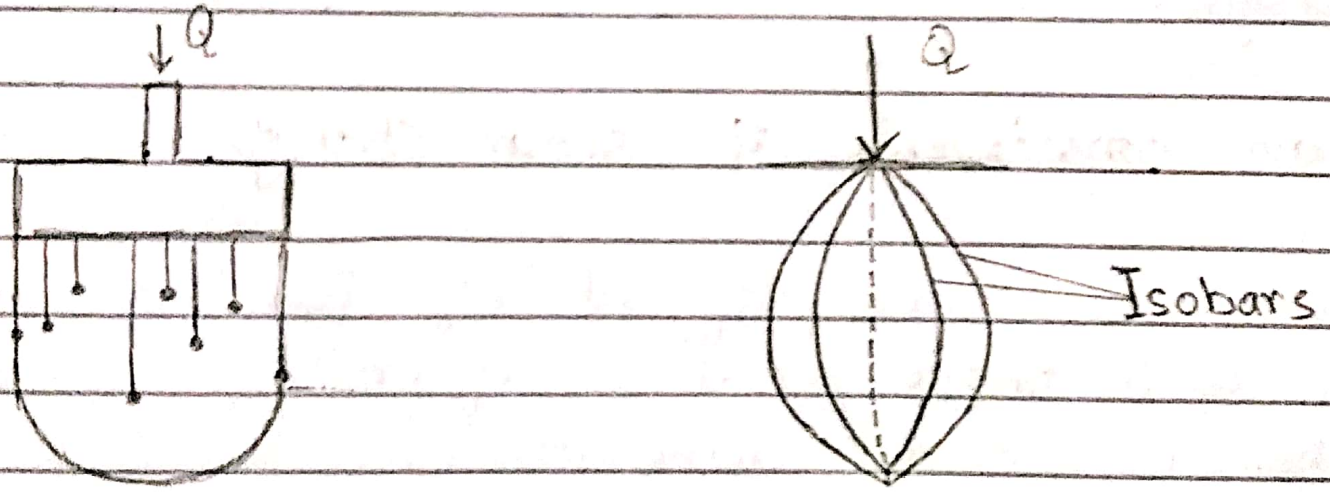
Question no. 1
Part . A

1- Isobar :—
(Pressure Bulb)
Line or curve which convert all the points below the ground surface having some vertical stresses.
In other words, Isobar is a contour of equal stress.

Isobar is useful for determining the effect of load on the vertical stresses at various points. The area bounded by isobar is known as pressure bulb.
This zone of with in which the stresses have significant effect on the settlement of structure.
Shape of isobar is similar to electrical bulb (or like an anion).



2- Shear Strength :—

The maximum resistance to shear stresses before the failure is known as shear strength. The shear stresses develop when the soil sample is subjected to direct compaison.

In the soil the failure take place due to movement of the particle not due to the breaking of particle. The shear strength is one of the principle property of soil due to a soil, is stable subjected to load. Bearing capacity of soil is also because of shearing strength. All the problems of soil is directly or indirectly related with shear strength.

Main constituents of shear strength :

I- Friction resistance offered by particle due to their shape and surface.
II- Cohesion and adhesion
III- Structual resistence offered by inter-locking of particles.

3- Compaction :-

Densification of soil by reducing air voids by application of mechanical energy. Compaction is used in

Construction of highway embankments, earth dams and many other engineering structures, whose soil must be compacted to improve their strength by increasing their unit weight.
The degree of compaction is measured in terms of its dry unit weight.

4- Effective Stresses :-
It is the combined effect of total stress and pore pressure that controls soil behavior such as shear strength, compression and distortion.
The difference between the total stress and the pore pressure is called effective stress :

effective stress = total stress − pore pressure

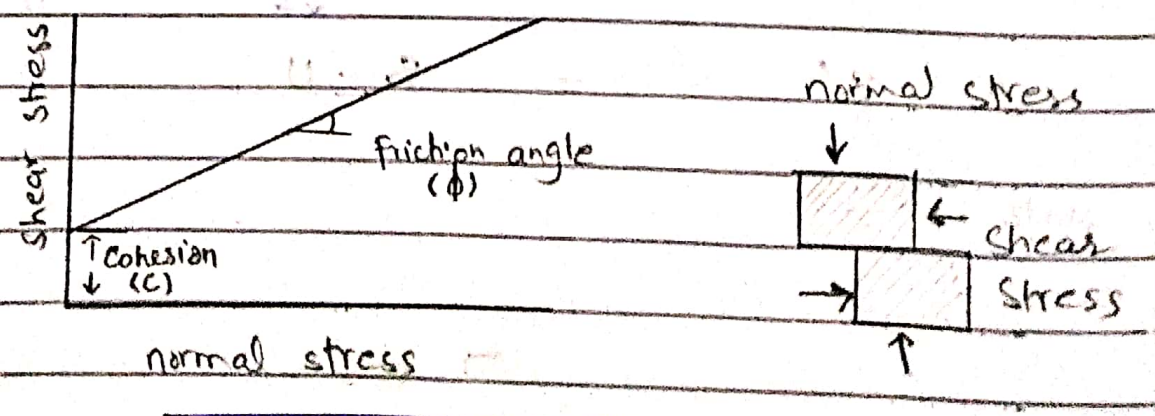
$$\sigma' = \sigma - u$$

5- Shear Parameter :-

Shear Parameter is defined as the stability analysis of a rock slope that requires assessment of shear strenght parameters, that is, Cohesion (c) and angle of internal friction (ϕ) of the rock mass. The rock mass rating (RMR) system can be used to estimate the shear strength parameters c and ϕ of the weathered and saturated rock masses.

The shear strength parameters cohesion (c) and friction angle (ϕ) can be determined by different laboratory tests for different types of soil.

(i) Direct shear Test
(ii) Triaxial shear Test



Part. B

Boussinesq's Theory of Vertical Stresses :-

His theory (1895) is based on the following assumptions :

(i) The soil medium is elastic.
(The modulus of elasticity throughout the soil sample).

(ii) The soil medium is homogenuous.
(The properties of soil are same at every point of the soil sample).

(iii) The soil is isotropic.
(The properties of soil are same in every direction of soil sample).

(iv) The soil medium is semi infinite.
(It is not total infinite).

Other assumptions are also as following :

- Soil mass is elastic, isotropic,

homogeneous and semi-infinite.

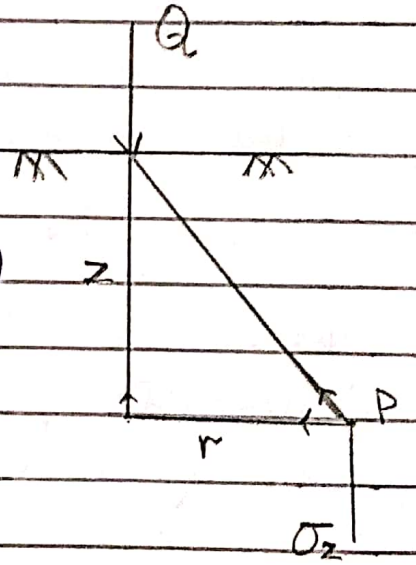
- The soil is weightless, compared to the applied loads.
- The load is a point load acting on the surface.

Vertical stress at point P due to a point load Q is:

$$\sigma_z = \frac{3Q}{2\pi z^2} \frac{1}{(1+(r/z)^2)^{5/2}}$$

(J. Boussinesq, 1895)

$$\sigma_z = \frac{Q}{z^2} I_B$$



I_B Boussinesq stress coefficient (Boussinesq influence factor)

When a point load Q acting on the surface of semi infinite solid, a vertical stress σ_z produces at any point in addition to lateral and shear stress.

Question no. 02 (8)

Part . A

Given Data :-

$\therefore 1ml = 10^{-6} m^3$

$V = 65 ml = 0.00065 m^3$

$W = 0.96 N$

$W_d = 0.785 N$

$G_s = 2.65$

Required :-

$S = ?$

Solution :-

$$\gamma_B = \frac{\gamma_w (G_s + e \times S)}{(1+e)} \longrightarrow (1)$$

$$\gamma_B = \frac{W}{V} = \frac{0.96}{0.000065}$$

$$= 14769 \ N/m^2.$$

$\gamma_w = 9800 \ N/m^2$

$e = \frac{V_v}{V_s}$ $\quad \therefore \ V_s = \frac{W_s}{V_s}$

$V_s = 0.000030\ m^3$

$e = \frac{0.000035}{0.000030}$

$e = 1.167$

Also,

$V = V_v + V_s$

$V_v = V - V_s$

$V_v = 0.000065 - 0.000030$

$V_v = 0.000035\ m^3$

But,

$G_s = \frac{\gamma_s}{\gamma_w}$

$\gamma_s = G_s \times \gamma_w$

$\gamma_s = 2.65 \times 9800$

$\gamma_s = 25970\ N/m^3$

Putting values in (1)
Same for it "S"

$S = 0.527$ or, 52.7%

Part . B

(10)

Given Data :-

Wt of wet soil (g)	1.89	2.14	2.17	2.21	2.22	2.16	2.07
Water content %	5	8	9	11	12	15	20

Volume = $950\ cm^3$

Required :-

γ_d = ?

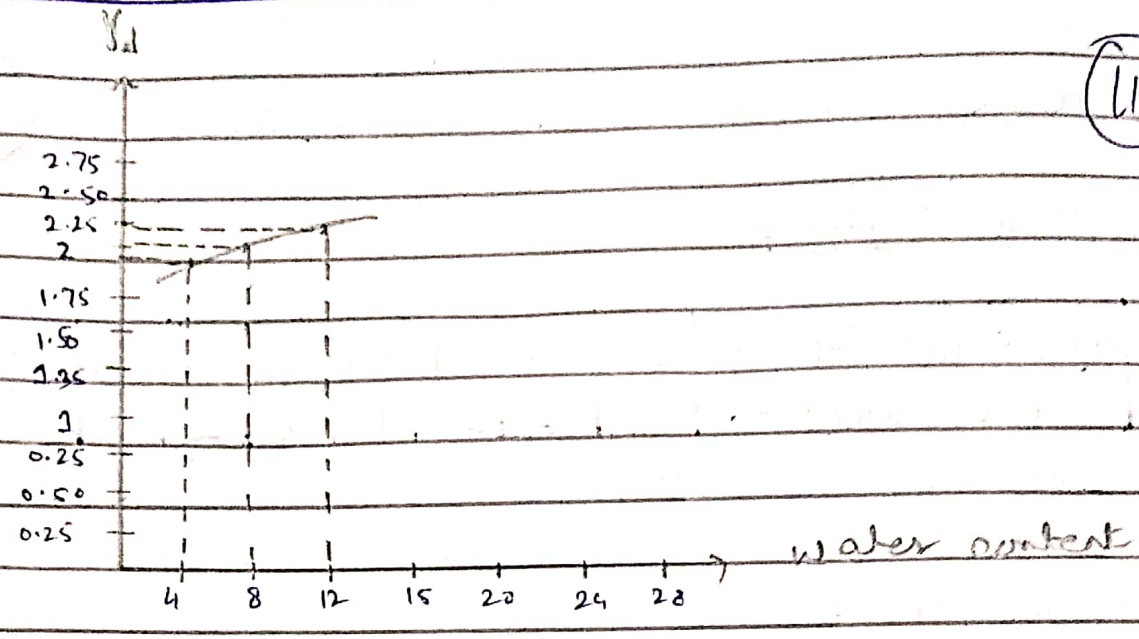
OMC = ?

Compaction curve = ?

Solution :-

As we know that

Wt of wet soil (g)	1890	2140	2170	2210	2220	2160	2070
Water content %	5	8	9	11	12	15	20
Bulk unit wt (γ_B) = 1890/950	1.98	2.75	2.28	2.33	2.34	2.27	2.18
γ_d $\gamma_d = \gamma_B/1+W_c$ = 1.98/1+0.05	1.89	2.08	2.09	2.10	2.09	1.97	1.82
			$\gamma_{d\,max}$ = 2.10				



Question no. 03
Part . A

California Bearing Ratio Test (CBR) :-

The method is used to find out the strength of subgrade used for the design of roads. Developed by California state of highway department.

- In this method of 5kg of soil specimen is taken. water is added to it, unit reaches to O.M.C.

- Then the CBR mould is cleaned
- Then mould is filled with prepared soil sample. 1/3 part of the mould is filled. The layer is compacted by giving 56 blows distributed.
- In this way the mould is filled in five layers after the fifth layer the excess of soil is struck off. Then the mould which containing the soil specimen is placed in CBR machine, load is applied in such a way that the penetration load rate is 1.25 mm/min or 0.05" /min

CBR value =

$$\frac{\text{Load required for 0.1 Penetration of the plunger in the soil sample}}{\text{Standard load required for 0.1 Penetration of the plunger in the standard material (crushed stones)}} \times 100$$

Standard load :-

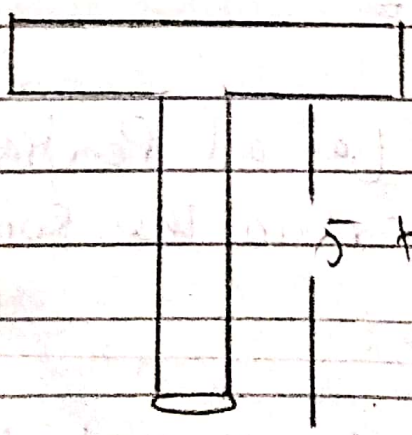
0.1 penetration = 3000 lbs
0.2 penetration = 4500 lbs.

Part. B

i) **Probing :-**

(Probing or Sounding)

It consist of a rod, diameter of rod is 1/4 inch to 1 inch. Length of rod will be 5 to 13 feet, it consist of handle.



2- Anger Borings:-

→ Hand operated Angee
→ Power operated Anges

Thus method is used for soil exploration, it is a simple method. Maximum depth for This exploration is 10 m or 32 feet.

3- Test Pits :-

Maximum depth of pit is 5m to 6m. This Test is perform where boring is different Especially for gravity soil.

Types of Deep Exploration :-

4- Wash Boring :-

Consist of steel pipe which diameter is 2 to 8 inch and length is 5 to 10 feet.

Pump

In this method I is used to pump out soil and water, then the soil particles are allowed to settle and water is removed then the soil is tested in lab.

5- Percussion Boring:-

This percussion drilling is done upto a depth of 25 m.
It is also called cable tool drilling.
This is a method of heavy equipment.
This expensive method is time consuming process.