USN :

CMR Institute of Technology, Bangalore
DEPARTMENT OF CIVIL ENGINEERING
II - INTERNAL ASSESSMENT

Semester: 6-CBCS 2018
Subject: APPLIED GEOTECHNICAL ENGINEERING (18CV62)
Faculty: Ms Divya Viswanath

Date: 24 Jun 2021
Time: 09:00 AM - 10:30 AM
Max Marks: 50

Instructions to Students :

Answer all questions

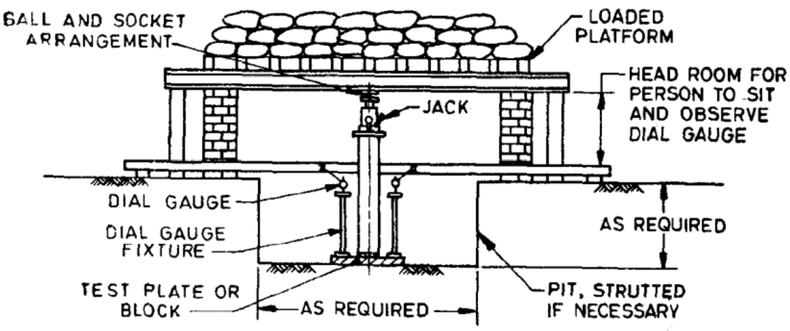
Answer All Questions

Q.No			Marks	CO	PO	BT/CL
1	a	Explain plate load test with a neat sketch.	6	CO5	PO1,PO2,PO6	L2
	b	The total time taken for 50% consolidation of clay layer is 4 years. What will be the time taken for 90% consolidation?	4	CO2	PO1,PO2	L3
2	a	Explain the different components of settlement.	6	CO2	PO1,PO2	L2
	b	What is negative skin friction? Explain its effect on the pile.	4	CO5	PO1,PO2,PO6	L2
3	a	A group of 16 piles of 600 mm diameter is arranged in a square pattern with center to center spacing of 1.2 m. The piles are 10 m long and are embedded in soft clay with cohesion of 30 kPa. Bearing resistance may be neglected for the piles. Determine the ultimate load capacity of the pile group if adhesion factor is 0.6.	5	CO5	PO1,PO2,PO6	L3
	b	What will be the gross and net safe bearing capacity of sand having Ø=36° and effective unit weight 1.8 t/m3 under a strip footing of size 1m*1m? Take Nc= 5.6, Nq= 47, Nr =43. Consider the footings are placed at a depth of 1m from ground surface and water table is at a great depth. Take FOS=3.0.	5	CO4	PO1,PO2,PO3,PO6	L4
4	a	A saturated clay with an average LL of 45% is 6m thick. Its surface is located at a depth of 8m below the ground surface. The natural water content of the clay is 40% and G=2.7. Between ground surface and clay, the subsoil consist of fine sand having unit weight of 17 kN/m3. The weight of the building increases the overburden pressure on clay by 40 kPa. Estimate the settlement of the building. Take unit weight of water=10 kN/m3.	6	CO2	PO1,PO2	L3
	b	State the characteristics of general shear failure with a neat sketch.	4	CO4	PO1,PO2,PO3,PO6	L2
5	a	A 3 m square footing is located in a dense sand at a depth of 2m. Determine the ultimate bearing capacity for the following WT positions: (a) WT at ground level (b) WT at footing base. The moist unit weight of sand above WT is 18 kN/m3 and the saturated weight is 20 kN/m3. Given ø=35°, Nc=1.2, Nq=33, Nr =34, unit weight of water=10 kN/m3.	5	CO4	PO1,PO2,PO3,PO6	L4
	b	A square group of 25 piles extends between depth of 2m and 12 m in a deposit of 20 m thick stiff clay overlying rock. The piles are 0.5 m in diameter and are spaced at 1 m center to center in the group. The average undrained strength of clay is 110 kPa and adhesion factor is 0.45. Estimate the capacity of the pile group considering an overall FOS of 3.0.	5	CO5	PO1,PO2,PO6	L3

INTERNAL ASSESSMENT TEST- 2

APPLIED GEOTECHNICAL ENGINEERNG (18CV62)

1.a.



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.

1.b.

$$C_V = \frac{T_v \times d^2}{t}$$

$$\frac{(T_v)_{50} \times (d)^2}{t_{50}} = \frac{(T_v)_{90} \times (d)^2}{t_{90}}$$

$$t_{90} = 17.31 \text{ years}$$

2.a

Immediate Settlement:-Immediate settlement is also called elastic settlement.
- It is determined from elastic theory.
- It occurs in all types of soil due to elastic compression.
- It occurs immediately after the application of load
- It depends on the elastic properties of foundation soil, rigidity, size and shape of foundation.
- Immediate settlement is calculated by the equation.

Consolidation Settlement:-It occurs due to the process of consolidation.
- Clay and Organic soil are most prone to consolidation settlement.
- Consolidation is the process of reduction in volume due to expulsion of water under an

increased load.
• It is a time related process occurring in saturated soil by draining water from void.
• Consolidation theory is required to predict both rate and magnitude of settlement.

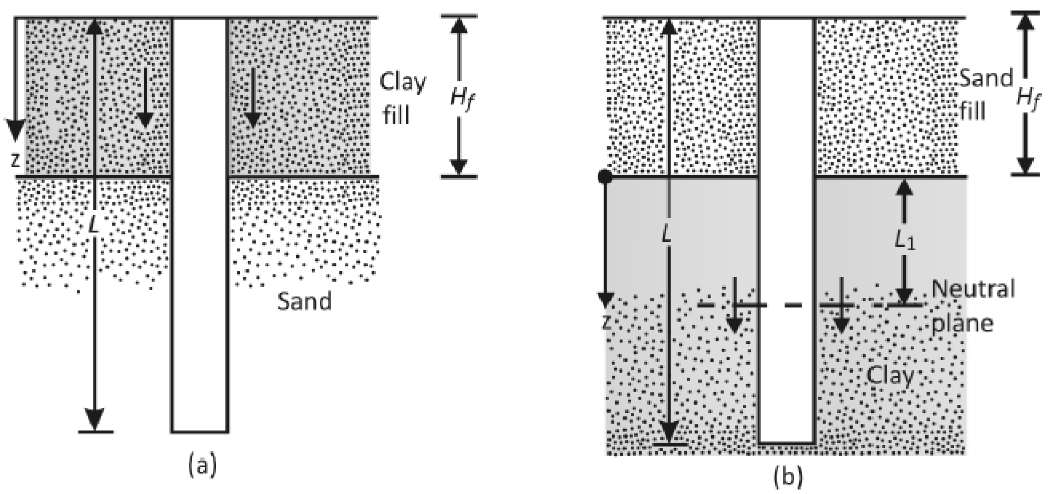
$$S_c = \left(\frac{C_c}{1+e_o}\right) H \log_{10}\left(\frac{\sigma_o + \Delta\sigma}{\sigma_o}\right)$$

Secondary Compression:-This settlement starts after the primary consolidation is completely
over.
• During this settlement, excess pore water pressure is zero.
• This is creep settlement occurring due to the readjustment of particles to a stable equilibrium under sustained loading over a long time.
• This settlement is common in very sensitive clay, organic soils and loose sand with clay binders.

$$S_S = C_\alpha H \log_{10}\left[\frac{t_{sec} - t_{prim}}{t_{prim}}\right]$$

2.b.

Negative skin friction is a downward drag force exerted on the pile by the soil surrounding it. This action can occur under conditions such as the following:
1. If a fill of clay soil is placed over a granular soil layer into which a pile is driven, the fill will gradually consolidate. This consolidation process will exert a downward drag force on the pile (figure a) during the period of consolidation.
2. If a fill of granular soil is placed over a layer of soft clay, as shown in figure b, it will induce the process of consolidation in the clay layer and thus exert a downward drag on the pile.
3. Lowering of the water table will increase the vertical effective stress on the soil at any depth, which will induce consolidation settlement in clay. If a pile is located in the clay layer, it will be subjected to a downward drag force.



3.a.
For block failure,

$$Q_{u(group)} = C_{ub}N_cA_b + P_bLC_u$$

Q_p may be neglected as per question.

$$Q_{u(group)} = P_bLC_u$$

Perimeter of the block, $P_b = 4 \times 4.2 = 16.8\ m$

$$Q_{u(group)} = 16.8 \times 10 \times 30 = 5040\ kN$$

For piles acting individually,

$$Q_{u(single)} = n\left[CN_cA_p + \alpha CA_s\right]$$

$$Q_u = \alpha \times C \times A_s \times no{:}\ of\ piles$$

$$Q_u = 0.6 \times 30 \times \pi \times 0.6 \times 10 \times 16$$

$$Q_u = 5425.7\ kN$$

Hence the foundation is governed by block failure and the ultimate load capacity = **5040 kN**.

3.b.

$$q_u = 1.3CN_c + 0.5B\gamma N_\gamma + \gamma D_f N_q$$

$$q_u = (0.5 \times 1 \times 1.8 \times 43) + (1.8 \times 1 \times 47) = 123.3\ t/m2$$

$$q_s = \frac{q_u - \gamma D_f}{F} + \gamma D_f$$

$$q_s = \frac{123.3 - (1.8 \times 1)}{3} + (1.8 \times 1) = 42.3\ t/m2$$

4.a.

$C_c = 0.009 \times (45 - 10)$=0.315

$$e \times 1 = 0.40 \times 2.70$$

$$e = 1.08$$

$\Delta\sigma = 40\ kPa$

$$\gamma_{clay} = \frac{G\gamma_w}{1+e} = \frac{2.7 \times 10}{1 + 1.08} = 12.98\ kN/m3$$

$\sigma_0 = (8 \times 17) + (3 \times 12.98) = 174.942\ kPa$

$S_c = \frac{C_c}{1+e_0} \times H \times \log_{10}\left(\frac{\sigma_0 + \Delta\sigma}{\sigma_0}\right)$

$S_c = \frac{0.315}{1+1.08} \times 6 \times \log_{10}\left(\frac{174.942 + 40}{174.942}\right)$

$S_c = 0.0812\ m$

5.a.

WT is located at GL

$$q_u = 0.4B\gamma_{sub}W_\gamma N_\gamma + \gamma_{sub}D_f W_q N_q$$

$$q_u = 0.4 \times 3 \times (20 - 10) \times 0.5 \times 34 + (20 - 10) \times 2 \times 33 \times 0.5$$

$$q_u = 534 \ \ kN/m2$$

WT is located at the base of the footing

$$q_u = 0.4 \times 3 \times (20 - 10) \times 0.5 \times 34 + 18 \times 2 \times 33 \times 1$$

$$q_u = 1392 \ \ kN/m2$$

5.b.

Block Failure

$$Q_{u(group)} = C_{ub}N_c A_b + P_b L C_u$$

$$Q_{u(group)} = 110 \times 9 \times 4.5^2 + 110 \times 4 \times 4.5 \times 10$$

$$Q_{u(group)} = 39847.5 \ kPa$$

Individual pile Failure

$$Q_u = n[CN_c A_p + \alpha C A_s]$$

$$Q_u = 25\left[110 \times 9 \times \frac{\pi}{4} \times 0.5^2 + 0.45 \times 110 \times \pi \times 0.5 \times 10\right]$$

$$Q_u = 24285.937 \ kPa$$

Capacity = $\frac{\mathbf{24285.937}}{\mathbf{3}} = 8095.31 \ kN$