Questions

Module 1: **Soil Exploration**

1. Name the three laboratory tests where use of undisturbed soil sample is must.

2. What are the corrections required for SPT values obtained from the field and why?

3. Describe the minimum depth of boring determination as recommended by ASCE (1972)

4. Describe the major differences between SPT, SCPT and DCPT.

5. The P-wave velocity in a soil is 2000 m/s and unit weight of the soil is 19kN/m^3. Determine the shear modulus of the soil. [Answer: 7747.2 MPa]

6. In a two-layer soil system (as shown in Fig. 1), the velocity of the wave in layer 1 is 2 km/s. The critical distance is equal to 3 times the distance from the source where 1st refraction ray reaches the ground surface. Determine the critical distance and velocity of the wave in layer 2. Assume that $v_{p2} > v_{p1}$. [Answer: 12.12 m, 4 km/s]

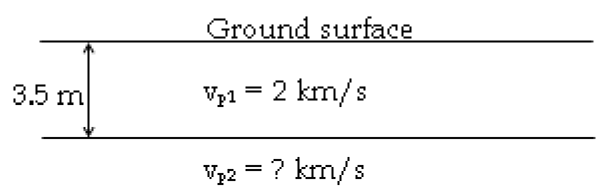

Fig.1

7. In a soil medium, the velocity of wave increases linearly with depth. The rate of change in velocity along depth is 1.05 km/s/m. Determine the velocity of the wave at a depth of 10 m. Assume the velocity of the wave at zero depth is 5 km/s. [Answer:15.5 km/s]

8. Given: N = 25, rod length= 15 m, hole diameter = 100 mm, p'_0 = 150 kPa, Er= 80; loose sand without liner. What is the standard $N'70$ value? [Answer: 20]

<u>Module 2:</u> Shallow Foundations

9. Describe the factors affecting the ultimate bearing capacity of soils.

10. What are the limitations of plate load test?

11. A strip footing 2 m wide, is supported on a soil with its base at a depth of 1 m below ground surface. The soil properties are as: c′ = 0, $\phi' = 40°$, γ_{bulk} = 18 kN/m^3, γ_{sat} = 20 kN/m^3. Determine the ultimate bearing capacity if water table is at 2 m below ground level. Use the Terzaghi equation. [Answer: 2869 kN/m^2]

12. Calculate the ultimate bearing capacity of a rectangular footing 2 m x 4 m founded at a depth of 1.5m below ground surface. The load on the footing acts at an angle of 15° to the vertical and is eccentric in the direction of width (*B*) by 15 cm. The unit weight of the soil is 18kN/m^3. c′ = 15 kN/m^2 and $\phi' = 38°$. Neglect the effect of water table location. Use Meyerhof recommendations. [Answer: 2962.5 kN/m^2]

13. Design a strip foundation of width 3m. The soil data are given in Fig. 2. The foundation is carrying 1000 kN load. The factor of safety is taken as 2.5 against shear failure. Take pore water correction factor as 0.75. Use Skempton's bearing capacity equation for clay soil. Take E = 600 c_u and μ = 0.5. The foundation is located at a depth of 1 m below ground surface.

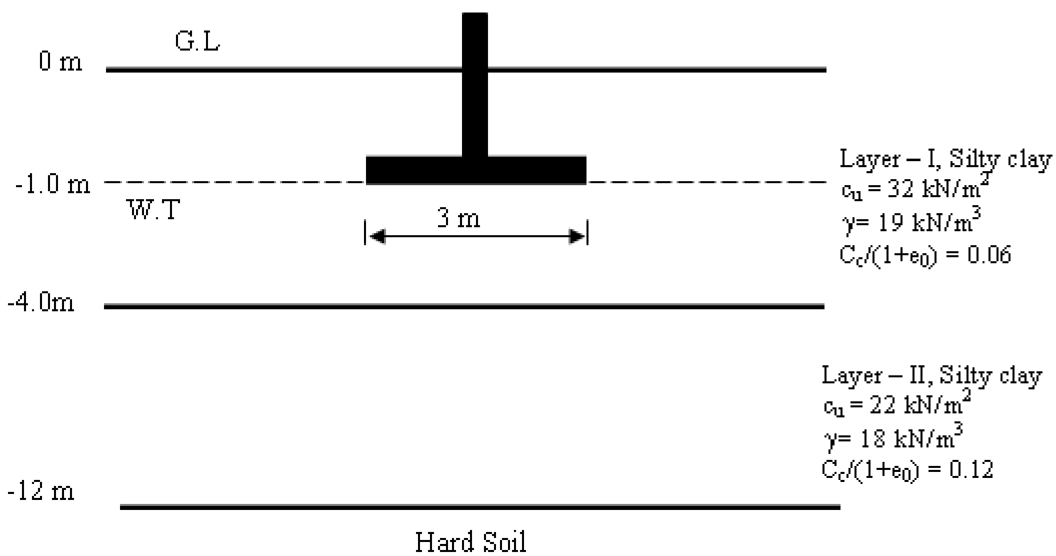

Fig. 2

14. Design a raft foundation for the building frame shown in Fig. 3(b). The soil data are given in Fig. 3(a). Each column is carrying 400 kN load. The factor of safety is taken as 2.5 against shear failure. Take pore water correction factor as 0.75. Use Skempton's bearing capacity equation for clay soil. Take E = 600 c_u and μ = 0.5. The foundation is located at a depth of 1.5 m below ground surface. Dimension of each column is 250 mm x 250 mm.

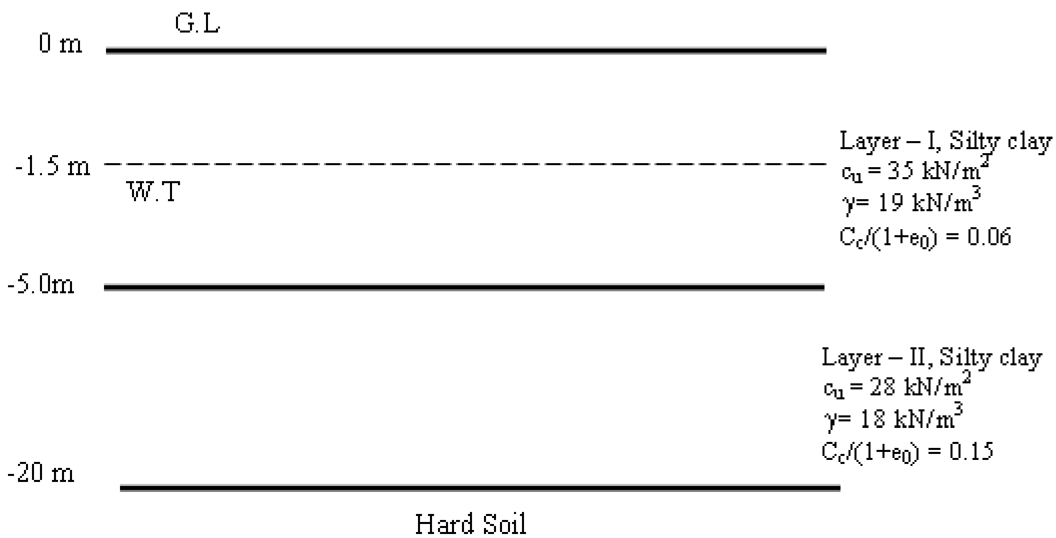

Fig. 3(a)

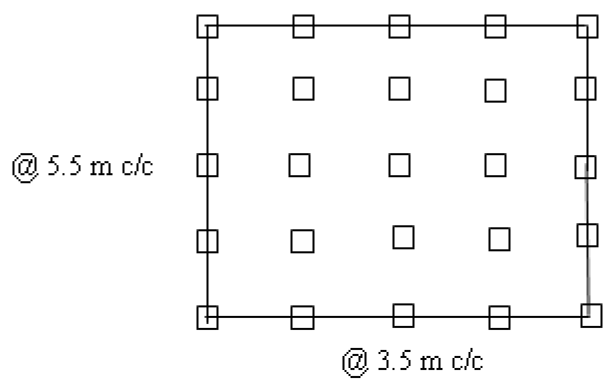

Fig. 3(b)

15. Design an isolated rectangular footing of dimension 4m x 5m. The gross pressure acting at the base of the footing is 150 kN/m^2. Choose the depth of foundation such that the factor of safety is exactly 3 against shear failure. Also check against the permissible settlement (75mm) to ensure that the design is safe from the settlement criterion too. If the design is not safe against settlement criterion, then choose the proper dimension and depth to ensure that design is safe against both the criterions. Take pore water correction factor as 0.7. Use Skempton's bearing capacity equation for clay soil. Take E = 600 c_u and μ = 0.5. The soil profile is shown in Fig.4.

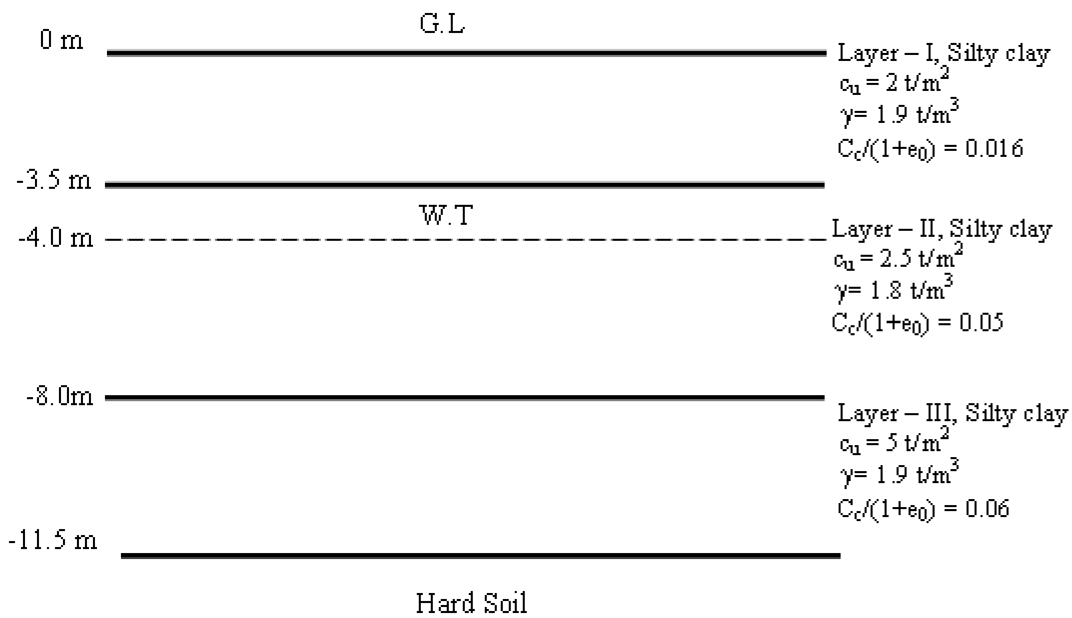

Fig.4

16. Two plate load tests were conducted for two square plates of size 30 cm x 30 cm and 60cm x 60 cm. The load corresponding to the 25 mm settlement is 40 kN and 85 kN for 30 cm and 60 cm plate, respectively. Determine the dimension of a square footing to carry 1000 kN load with a permissible settlement of 25mm. [Answer: 4.2m x 4.2 m]

Module 3: Deep Foundations

17. Describe how tip resistance and friction resistance of pile can be separately determined by pile load test.

18. Describe the various components of a well foundation. Describe the various types of caissons.

19. Describe how the load carrying capacity of under reamed pile with single and double bulbs is determined.

20. What is negative skin friction? Why negative skin friction is developed in the pile?

21. When tension and laterally loaded piles are used? Mention the type of structures where these piles are used.

22. Design a friction pile group to carry a total load of 3500 kN including the weight of pile cap at a site where the soil is uniform clay to a depth of 20m, underlain by rock. Average unconfined compressive strength of clay is 70 kN/m^2, γ = 19 kN/m^3, $C_c/(1+e_0)$ = 0.08. A factor of safety of 3 is required against shear failure. Neglect the bearing and assume adhesion factor of 0.8. Restrict the length of the piles upto 15m. Also check the settlement of the pile group. The permissible settlement of the pile group is 40mm. The location of ground water table is 2.5 m below ground level. Take pore water correction or consolidation correction factor as 0.75. Take E = 600 c_u and μ = 0.5.

23. A 20m long R.C.C pile is installed in uniform sand. The horizontal force subjected to the pile is 35 kN. The coefficient of subgrade modulus of 9MN/m^3, EI of piles 3.7 x 10^7 N-m^2. Calculate the deflection of pile head for both free-head and fixed-head condition. Take the nondimensional coefficient for laterally loaded long pile for deflection calculation: A_y = 2.435 and B_y = 1.023 at Z =0. [Answer: 5.42 mm, 3 mm]

24. A group of 16 piles arranged in a square and installed in a deposit of soft clay. The diameter and length of each pile is 250 mm and 10 m, respectively. Determine the required spacing so that 100% group efficiency can be achieved. Neglect the bearing of the piles and take adhesion factor of 0.8. [Answer: 0.91m]

Module 4: Retaining Structures and Reinforced Earth

25. Describe why the bearing capacity of foundation increases due to the application of geosynthetic reinforcements below the foundation.

26. Why sufficient length of the reinforcement is required beyond the loaded region of the footing or beyond the failure surface?

27. What is hydro-dynamic effect of pore water? How the hydro-dynamic force is determined?

28. Describe the steps to design reinforced retaining wall (both external and internal) under seismic condition.

29. What are the different type of failures of reinforced earth foundation and reinforced retaining walls?

30. Determine the factor of safety of the following slope under seismic condition (as shown in Fig.5). The cohesion of the soil is 10 kN/m^2 and ϕ = 25°. Take, k_h = 0.2 and k_v = 0.0. Unit weight of the soil is 20kN/m^3. In the figure, slope angle is 30° and the failure surface is making an angle 26° with horizontal [Answer: 2.55]

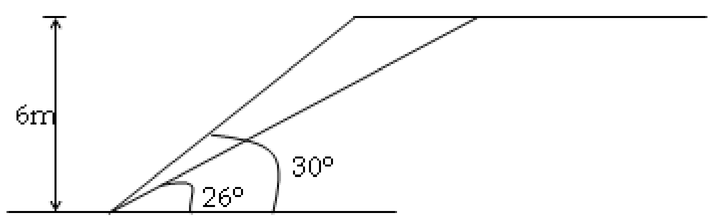

Fig. 5

31. Design a 6 m high geotextile retaining wall is to backfill with granular soil having properties of $\gamma_{backfill}$ = 19 kN/m^3, $\phi_{backfill}$ = 32°, $\delta_{backfill\text{-}wall}$ = 0.9$\phi_{backfill}$, K_a = 0.28, and $c_{backfill}$ = 0. A geotextile with allowable tensile strength of 20 kN/m is intended to be used in its construction. Use equal spacing and equal length in case of geotextile reinforcements. The foundation soil properties are given as: $\gamma_{foundation}$ = 20 kN/m^3, $\phi_{foundation}$ = 15°, $\delta_{foundation\ soil}$ = 0.95$\phi_{foundation}$, c = 20 kN/m^2, c_a = 0.8c. Check the stability only for overturning and sliding. The factor of safety against overturning and sliding is taken as 3. The frictional angle between the soil and geotextiles is taken as 28°.

32. Consider a 4 m high vertical retaining wall (β = 0) with horizontal backfill (i = 0). Given for the soil, ϕ_b = ϕ = 32°, c = 0, γ = 18 Kn/m^3, and δ = 0. Calculate P_{AE} and the location of the resultant force with k_v = 0.0 and k_h = 0.2. [Answer: 63 kN, 1.65m from the base]

33. Provide the suitable depth of penetration of the cantilever sheet pile (as shown in Fig6) such that a minimum factor of safety 1.3 can be achieved. Consider the effect of water in both the sides.

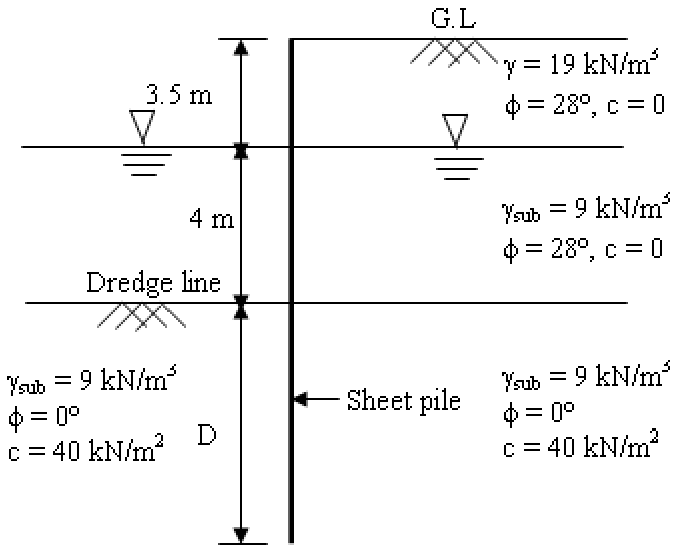

Fig 6.

34. Check the stability of the gravity retaining wall as shown in Fig. 7. Take the net ultimate soil pressure equal to 500 kN/m². Use Coulomb's theory. Neglect the effect of passive lateral earth pressure effect. $K_a = 0.417$.

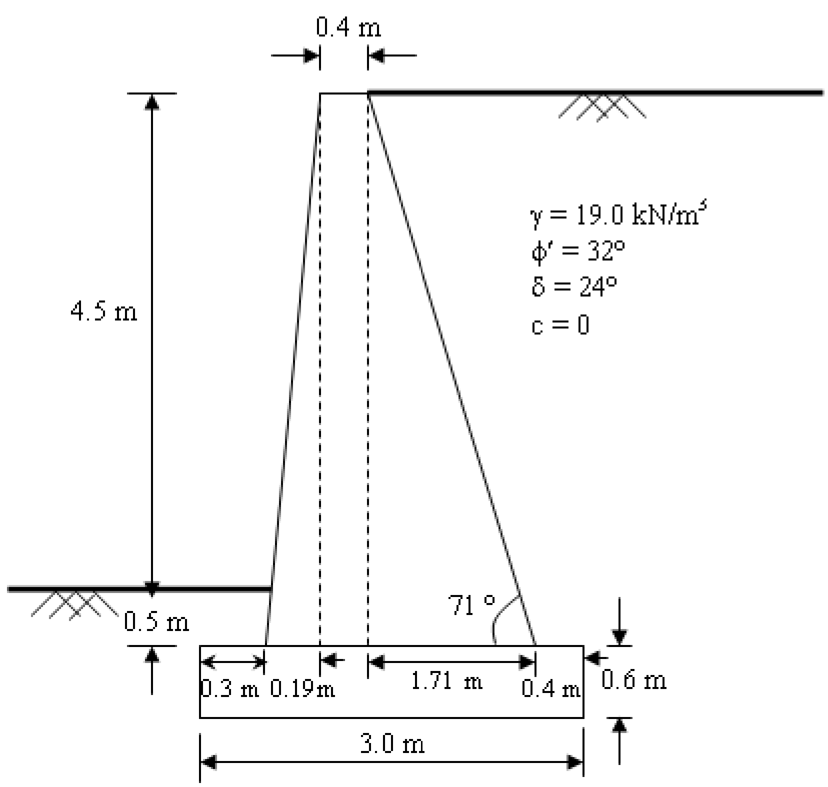

Fig. 7

35. Determine the forces in the struts for the bracing system as shown on Fig. 8. Take γ = 19 kN/m^3, c = 32 kN/m^2, ϕ = 0 and spacing in the perpendicular direction is 2.0 m. Assume that the struts are connected at A, B, C and D levels. [Answer: F_A = 89.8 kN, F_B=132.1 kN, F_C = 78.3 kN, F_D = 7.6 kN]

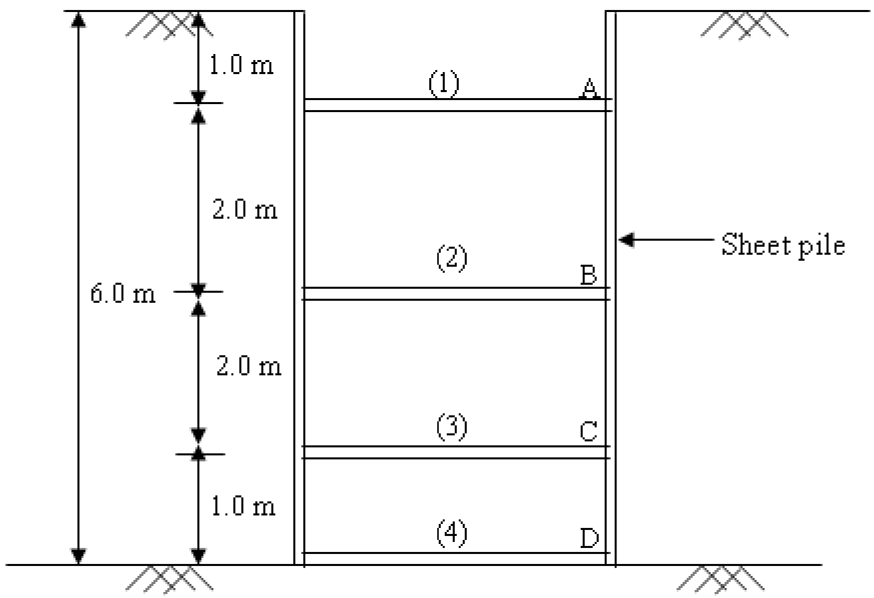

Fig.8

Module 5: Soil-Foundation Interaction

36. Describe the limitations of Winkler Model. How these limitations are removed? How non-linearity can be incorporated in the model?

37. Describe how the modulus of sub-grade reaction can be determined.

38. What are the advantages of Pasternak Model?

39. Derive the basic equation of a beam resting on elastic foundation.

40. Mention the application area of infinite beam.