Site Investigation

1. **Q: Why is site investigation considered the initial step in addressing most geotechnical engineering issues, and what impact does it have on construction costs?**
2. **Q: How do laboratory tests and in situ tests contribute to the process of studying soil properties in geotechnical engineering, and are they mutually exclusive?**
3. **Q: What role do boring logs play in site investigation?**
4. **Q: What are the steps involved in a site investigation, and what role does the geotechnical engineer play once it's completed?**
5. **Q: Why is it crucial for soil investigation to be meticulously conducted despite its relatively small cost compared to overall project expenses?**
6. **Q: In what circumstances is it highly desirable for the geotechnical engineer to take on the role of site inspector, and why?**
7. **Q: How does the proportion of soil tested in a typical soil investigation compare to the amount of testing conducted on the structure itself, and what factors influence the precision of geotechnical parameter predictions?**
8. **Q: What are the two steps involved in the preliminary site investigation, and what tasks are associated with each step?**
9. **Q: What skills and practices are essential for a successful site visit, and why is meticulous record-keeping important?**
10. **Q: What factors influence the determination of the number, location, and depth of soundings, as well as the choice of samples and in situ tests?**
11. **Q: How many soundings (borings and in situ tests) are typically conducted for average-sized buildings and bridges, and what is the general rule for determining the number of soundings for buildings?**

12.Q: In the case of major bridges, where are soundings typically performed, and how are they distributed for extended projects like runways and highways?

13.Q: When are soundings conducted for power lines and pipelines, and under what circumstances are shallower borings acceptable?

14.Q: What is the typical depth range for soundings, and how is the depth determined in relation to the foundation width?

15.Q: What vehicles are typically present at a drilling site, and what roles do they serve?

16.Q: What are the main components of Onshore geotechnical drilling rigs?

17.Q: What are the two primary methods used for drilling soil samples, and what distinguishes each method?

18.Q: What are the two common types of drill bits used at the bottom end of drill rod?

19.Q: What are the differences between drag bits and roller bits, and how do their applications vary depending on soil type?

20.Q: How can the behavior of drilling rods indicate the type of soil being encountered during drilling?

21.Q: What is the auger method, and what are the typical diameters of solid stem and hollow stem augers used in this method?

22.Q: What advantage does the hollow stem auger offer in drilling operations, and what limitation does it face in terms of penetration depth?

23.Q: What is the primary objective in sampling , and what are the various sources of sample disturbance when sampling soil or rock deposits?

24.Q: What factors are targeted for minimization and elimination in soil or rock sample collection?

25.Q: How can factors related to sample disturbance be minimized, and what is the significance of the area ratio?

26.Q: How can changes in water content and porosity be minimized in soil or rock samples, and what measures can be taken to achieve this?

27.Q: How can the least disturbed samples of mineral soils be obtained, and why are driving and repeated pushes considered unacceptable methods?

28.Q: What are the two most common samplers used for soil sampling, and for which types of soil are they typically used?

29.Q: What is its area ratio of the Shelby tube (with this information: 76.2 mm outside diameter, 73 mm inside diameter, and 0.9 m long)? Is the sample considered undisturbed or disturbed, and why?

30.Q: Why is the length of the sample recovered often not equal to the length pushed, and what factors contribute to this discrepancy?

31.Q: How is the standard penetration test (SPT) conducted, and what is its purpose?

32.Q: What are the primary applications of the thin-wall steel tube sampler and the split spoon sampler in soil sampling, and how do they differ in terms of the types of soil samples they provide?

33.Q: How can the groundwater level at a site be determined?

34.Q: How are driven piezometers installed for Groundwater level measurement and what measurements are obtained through them?

35.Q: What is the difference between the groundwater level and the phreatic surface?

36.Q: How can sands and gravels be distinguished based on their characteristics, and what observations aid in identifying different types of sand?

37.Q: What does the term "wash hands test" indicate, and how does it differentiate between high-plasticity clays and low-plasticity clays/silts?

38.Q: How does the dry strength test aid in distinguishing between high- and low-plasticity soils, and what are the observable characteristics of each type?

39.Q: What is the thread rolling test, and how is it conducted to determine soil plasticity?

40.Q: write name and descriptions of ten commonly soil names encountered in geotechnical engineering?

41. A 70-story building has an imprint of 35 m by 25 m and will be supported on a mat foundation located at a depth of 10 m. How many borings would you propose and to what depth? Where would you place the borings on the building plan view?

42. For problem 41, estimate the ratio between the volume of soil that is tested over the volume of soil involved in supporting the building. Comment on the result.

43.Which drill bit would you use for drilling in clay and which one would you use for drilling in gravel? Explain your choice.

44. Which drill bit would you use for drilling in clay and which one would you use for drilling in gravel? Explain your choice.

45. (a) Give three sources of sample disturbance; and (b) calculate the area ratio for the Shelby tube sampler and the split spoon sampler.

46.Discuss when a sampler should be pushed and when it should be driven.

47.Calculate the length of clay sample necessary to plug a Shelby tube. (Plugging means that the friction between the sample and the inner wall of the sampler becomes equal to the ultimate bearing capacity of the soil below the sampler.) Give a parametric answer and do a few sample calculations to gauge the problem.

48. Describe the simple tests that would allow you to identify a soil in the field.

49. Explain the differences between drilling onshore and drilling offshore.

50. Explain the difference between the seismic reflection and the seismic refraction methods used for offshore investigations.

51. What is a piston sampler?

52. For a rectangular vane, develop the equation that links the maximum torque Tmax to the undrained shear strength *su* of a fine-grained soil.

53. Why is the vane test not used in coarse-grained soils? Develop a way, including placing instrumentation on the vane, that would allow the vane test to give the effective stress friction angle of a sand with no effective stress cohesion intercept.

54. Why is the vane test not used in coarse-grained soils? Develop a way, including placing instrumentation on the vane, that would allow the vane test to give the effective stress friction angle of a sand with no effective stress cohesion intercept.

55. Use the elastic settlement equation for a plate test to explain why the modulus of subgrade reaction K is not a soil property while the soil modulus E is. Which one would you rather use, and why?

56. Calculate the settlement of a footing on sand after 50 years under a pressure of 100 kPa if the settlement after 1 hour under a pressure of 100 kPa during a load test is 10 mm. The soil has a viscous exponent n = 0.04.

57. Pocket erodometer tests (PETs) are performed on the end of Shelby tube samples retrieved from a levee. The average depth of the PET holes is 6 mm and the standard deviation is 2 mm. Estimate the rate of erosion if the mean velocity overflowing the levee will be 5 m/s. If the levee is subjected to overtopping for 2 hours (hurricane), how much erosion is likely to take place?

58. A sand cone apparatus is used to check the dry density of a compacted soil. The weight of dry sand used to fill the test hole and the funnel of the sand cone device is 8.7 N. The weight of dry sand used to fill the cone funnel is 3.2 N. The unit weight of the dry sand is calibrated to be 15.4 kN/m3. The weight of the wet soil taken out of the test hole is 7.5 N and the water content of the soil from the test hole is 13.2%. Calculate the dry density of the compacted soil.

59. A lightweight deflectometer is used to obtain the modulus of the compacted soil. The plate is 200 mm in diameter and the results of the tests are shown in

Figure 8.36. Calculate the modulus of deformation of the soil. What approximate stress level and strain level does it correspond to?

60. **A borehole is drilled into a deep and uniform clay layer to a depth of 1.5 m. A 75 mm inside diameter casing is lowered to the bottom of the 100 mm diameter borehole and sealed to the borehole walls. The water is bailed out so that the water level starts 1 m below the groundwater level outside of the casing at time equal 0. Three days later the water level has risen 0.3 m in the casing. Calculate the hydraulic conductivity k of the clay layer.**
61. **A 10 m-thick layer of silty sand is underlain by a deep layer of high-plasticity clay. The groundwater level is 2 m below the ground surface. A 100 mm diameter boring is drilled to a depth of 10 m and cased with a screen that allows the water to enter the borehole freely along the borehole walls. A pump is set up to pump the water out of the hole and reaches a steady state condition after 2 days; at that time, it is able to maintain the water level in the hole at a depth of 6 m when the flow rate is 0.2 cubic meters per minute. Additional boreholes indicate that the radius of influence of the depressed water level is 9 m. Calculate the hydraulic conductivity of the silty sand layer.**
62. **A cone penetrometer dissipation test is performed at a depth of 15.2 m below the groundwater level in a silt deposit. The results of the test are given in Figure 8.43a. Calculate the hydraulic conductivity of the silt layer.**
63. **A sealed double-ring infiltrometer is used to evaluate the field-scale hydraulic conductivity of a 1 m-thick clay liner underlain by a free-draining layer of sandy gravel. The SDRI has a square outside ring that is 4 m by 4 m and an inside ring that is 1 m by 1 m. The wall of the outer ring is embedded and sealed 0.45 m below the ground surface and the wall of the inner ring is embedded and sealed 0.15 m below the ground surface. Water is poured into the infiltrometer to a height of 0.5 m above the ground surface and the inner ring is capped. After a period of one week, during which the liner below the infiltrometer becomes saturated and a steady-state flow develops, the daily volume of water flowing into the liner is 0.01 m3 as measured by a plastic bag**

connected to the sealed inside ring. The soil swells, and vertical movement measurements of the inside ring indicate that this swelling amounts to 0.004 m3 per day. Calculate the hydraulic conductivity of the liner.

64. **Discuss the advantages and drawbacks of in situ tests versus laboratory tests.**
65. **What are the four main categories of laboratory tests? Give three examples for each category.**
66. **What device would you use to measure the following quantities? In each case explain the basic principle of the device.**
    a. **Force**
    b. **Pressure**
    c. **Shear stress**
    d. **Water compression stress**
67. **What devices and techniques would you use to measure the water tension stress (suction)? In each case explain the basic principle of the device.**
68. **What devices would you use to measure the following quantities? In each case explain the basic principle of the device.**
    a. **Displacement**
    b. **Normal strain**
    c. **Shear strain**
69. **f A Modified Proctor Compaction Test is performed on a sample of silty sand in a 152 mm diameter mold. The maximum dry unit weight is 19.6 kN/m3 and the optimum water content is 11%. If the specific gravity of solids is 2.65, draw the three-phase diagram of the sample in the mold and calculate all volumes and weight for that sample. What is the degree of saturation?**
70. **For the consolidation test, what is the difference between the incremental loading procedure and the constant rate of strain procedure?**
71. **Regarding deformation laboratory tests, discuss the differences between tests on saturated soils and tests on unsaturated soils (or, more precisely, tests on soils where the water is in compression and tests on soils where the water is in tension).**

72. A direct shear test is performed on a sample of saturated clay. The sample is 25 mm high and 75 mm in diameter. The test cell is inundated such that the water stress is hydrostatic at the beginning of the test.

   a. How would you run the test so as to measure the undrained shear strength of the clay?

   b. How would you run the test so as to obtain the drained shear strength parameters for the clay?

73. A direct shear test is performed on a sample of dry sand. The sample is 50 mm in diameter and 25 mm high and is subjected to a vertical force of 100 N. At failure, the shear force applied is 60 N, the horizontal movement is 3 mm, and the vertical movement is 0.5 mm. Calculate the shear strength of the sand and the friction angle, and estimate the dilation angle.

74. A direct shear test is performed on a sample of saturated clay. The test is a quick test such that water does not have time to

75.drain during the test. The vertical load on the sample induces a total normal stress of 50 kPa and at failure the shear force induces a shear stress of 100 kPa.

   a. Calculate the undrained shear strength of the clay.

   b. How is it possible for this clay to have such high shear strength, considering the low normal stress?

76. Two direct shear tests are performed on a sample of saturated clay. The tests are slow tests such that the water stress (pore pressure) remains equal to zero. The following conditions exist at failure:

   a. Test 1: N = 300N, T = 250N, A = 0.01m2, S = 100%, uw = 0kPa

   b. Test 2: N = 600N, T = 400N, A = 0.01m2, S = 100%, uw = 0kPa

where N is the normal force, T is the shear force, A is the sample cross-sectional area, S is the degree of saturation, and uw is the water stress. Calculate the effective stress cohesion and effective stress friction angle of the clay.

77. For strength laboratory tests, discuss the differences between tests on saturated soils and tests on unsaturated soils (or, more precisely, tests on soils

where the water is in compression and tests on soils where the water is in tension).

78. **Assume the same conditions as in problem 10.16 but this time the soil is unsaturated and the readings at failure are as follows:**

    Test 1: N = 600 N, T = 1900 N, A = 0.01 m2, S = 60%, uw = −400 kPa

    Test 2: N = 200 N, T = 900 N, A = 0.01 m2, S = 40%, uw = −300 kPa

    where N is the normal force, T is the shear force, A is the sample cross-sectional area, S is the degree of saturation, and uw is

    the water tension stress. Calculate the effective stress cohesion and effective stress friction angle of the clay.

79. **What are the differences between the direct shear test and the simple shear test? Explain your answers.**
80. **What are the two main phases in running a triaxial test? With respect to drainage during each one of these two phases, what are the different types of tests that can be run? For each type of test, what parameters can you obtain from the data?**
81. **What is the stress path and what shape does it typically have for the triaxial test?**
82. **A lab vane test is performed on a silty clay. At failure, the maximum torque is 5.7 N.m. The vane is 50 mm high and 25 mm in diameter. Calculate the undrained shear strength of the silty clay. The vane is rotated 10 times rapidly and the torque on the tenth revolution is measured to be 3.5 N.m. Calculate the residual undrained shear strength of the silty clay.**
83. **A silty sand is subjected to a constant head permeameter test. The flow collected at the downstream end is 221 mm3/s; the sample is 75 mm in diameter and 100 mm high. The difference between the water level in the upstream overflow and the downstream overflow is 0.5 m. Calculate the hydraulic conductivity k of the silty sand.**
84. **A clay sample is tested in a falling head permeameter. The sample is 75 mm in diameter and 100 mm high. The small tube is 3 mm in diameter. The difference**

in height between the water level in the small tube above the sample and the downstream overflow is measured as a function of time. At time t = 0, the difference is 1.1 m and at time t = 1 hr, the difference is 1.05 m. Calculate the hydraulic conductivity k of the clay.

85. A 1.8 m-tall human being drinks one liter of water. Two hours later, this person goes to the bathroom and eliminates the liter of water. Is this case a constant head permeameter or a falling head permeameter? Calculate the hydraulic conductivity of the human body. Make reasonable assumptions when necessary.

86. A sample of fine sand is tested in the EFA. The mean diameter of the grains is D50 = 1 mm. When the velocity is set at 1 m/s, the piston below the sample of sand has to be raised at a rate of 16.7 mm/minute. The cross-section of the conduit where the water is flowing is rectangular, with a width of 100 mm and a height of 50 mm. Calculate the shear stress at the interface between the water and the sand for the 1 m/s velocity.

87.c A sample of low-plasticity clay is tested in the EFA. The surface of the clay sample is considered smooth. When the velocity is set at 3 m/s, the piston below the sample of sand has to be raised at a rate of 1 mm every 3 minutes. The cross-section of the conduit where the water is flowing is rectangular, with a width of 100 mm and a height of 50 mm. Calculate the shear stress at the interface between the water and the sand for the 3 m/s velocity.