Chapter 10
Shear Strength of Soil

1. The internal resistance per unit area that the soil mass can offer to resist failure and sliding along any plane inside it is called __________ of the soil.
   (a) strength
   (b) shear strength
   (c) compressive strength
   (d) bearing capacity

2. The shear strength of soil is, in general, a function of
   (a) cohesion between the soil particles.
   (b) frictional resistance between the soil particles.
   (c) moisture content and porewater pressure in the soil mass.
   (d) all of the above

3. The concept of shear strength is not required directly to analyse the problems related to
   (a) bearing capacity of foundations.
   (b) stability of earth slopes.
   (c) flow through the soil mass.
   (d) lateral earth pressure from soils on retaining structures.

4. The soil mass fails because of the presence of
   (a) a critical combination of normal stress and shear stress.
   (b) the maximum normal stress.
   (c) the maximum shear stress.
   (d) either the maximum normal stress or the maximum shear stress.

5. The Mohr-Coulomb failure criterion for soils is expressed in terms of
   (a) effective stress cohesion.
   (b) effective angle of internal friction.
   (c) both (a) and (b)
   (d) none of the above

6. For sandy soils, the shear strength is
   (a) directly proportional to the effective stress.
   (b) directly proportional to the square of the effective stress.
   (c) inversely proportional to the effective stress.
   (d) inversely proportional to square of the effective stress.

7. If the effective stress within a sandy soil mass is zero, its shear strength will be equal to
   (a) zero.
   (b) half of the effective stress cohesion.
   (c) effective stress cohesion.
   (d) tangent of the effective angle of internal friction.
8. The value of effective stress cohesion $c'$ for inorganic silts is
   (a) zero.
   (b) the same as $c'$ for sands.
   (c) the same as $c'$ for clays.
   (d) both (a) and (b)

9. For normally consolidated clays, effective stress cohesion
   (a) $c' = 0$.
   (b) $c' \approx 0$.
   (c) $c' > 0$.
   (d) $c'$ cannot be approximated to zero.

10. For dense cohesionless soils, the drained friction angle
    (a) $\phi' < 35^\circ$.
    (b) $35^\circ < \phi' < 40^\circ$.
    (c) $40^\circ < \phi' < 45^\circ$.
    (d) $\phi' > 45^\circ$.

11. For normally consolidated clays, the drained friction angle
    (a) $\phi' = 0$.
    (b) $\phi' \approx 0$.
    (c) $\phi' < 20^\circ$.
    (d) $20^\circ < \phi' < 30^\circ$.

12. For cohesionless soils, the ratio of the effective major principal stress to the effective minor principal stress is
    (a) $\tan \left(45^\circ + \frac{\phi'}{2}\right)$.
    (b) $\tan \left(45^\circ - \frac{\phi'}{2}\right)$.
    (c) $\tan^2 \left(45^\circ + \frac{\phi'}{2}\right)$.
    (d) $\tan^2 \left(45^\circ + \frac{\phi'}{2}\right)$.

13. Which one of the following is the oldest and simplest form of shear test arrangement?
    (a) Direct shear test
    (b) Triaxial shear test
    (c) Vane shear test
    (d) both (b) and (c)

14. In direct shear test, the failure within the soil takes place along
    (a) the bottom of the shear box.
    (b) the plane of split of the shear box.
    (c) the weakest soil layer.
    (d) any plane depending on the soil density.
15. Select the correct statement based on the direct shear test results for sands.
   (a) Peak shear strength is equal to ultimate shear strength.
   (b) Peak shear strength is greater than ultimate shear strength.
   (c) Peak shear strength is smaller than ultimate shear strength.
   (d) none of the above

16. On shear load application, which one of the following can increase in its size?
   (a) Loose dry sand
   (b) Medium dry dense sand
   (c) Dense dry sand
   (d) none of the above

17. Which one of the following is the most reliable test method for determining shear strength parameters?
   (a) Direct shear test
   (b) Triaxial shear test
   (c) Unconfined compression test
   (d) both (b) and (c)

18. In the standard triaxial test, a cylindrical soil specimen has
   (a) length = 38 mm, diameter = 38 mm.
   (b) length = 76 mm, diameter = 76 mm.
   (c) length = 76 mm, diameter = 38 mm.
   (d) length = 38 mm, diameter = 76 mm.

19. Which of the following is not a standard type of the triaxial test?
   (a) Unconsolidated-undrained (UU) test
   (b) Unconsolidated-drained (UD) test
   (c) Consolidated-drained (CD) test
   (d) Consolidated-undrained (CU) test

20. For saturated soft soils, the Skemptions’ pore pressure parameter
   (a) $B = 1$.
   (b) $B \approx 1$.
   (c) $B > 1$.
   (d) $B < 1$.

21. In a triaxial test for the normally consolidated clay, chamber confining pressure = 100 kN/m$^2$ and deviator stress = 130 kN/m$^2$. What is the effective major principal stress?
   (a) 30 kN/m$^2$
   (b) 100 kN/m$^2$
   (c) 130 kN/m$^2$
   (d) 230 kN/m$^2$

22. For the test results given in Q. 21, what will be drained friction angle $\phi'$?
   (a) $0^\circ$
   (b) $23.2^\circ$
   (c) $45^\circ$
   (d) $90^\circ$
23. For the test results given in Q. 21, what will be the angle that the failure plane makes with the major principal plane?
   (a) 0°
   (b) 23.2°
   (c) 45°
   (d) 56.6°

24. Which of the following triaxial tests is completed quickly?
   (a) UU test
   (b) CU test
   (c) CD test
   (d) all of the above

25. \( \phi = 0 \) condition is observed in
   (a) UU test on clays.
   (b) UU test on saturated clays.
   (c) CU test on saturated clays.
   (d) CD test on saturated clays.

26. Unconfined compression test is a special type of
   (a) UU triaxial test.
   (b) CU triaxial test.
   (c) CD triaxial test.
   (d) none of the above

27. If the unconfined compression strength of a clay is 40 kN/m\(^2\), its consistency can be described as
   (a) soft.
   (b) stiff.
   (c) very stiff.
   (d) hard.

28. If the unconfined compression strength of a clay is 100 kN/m\(^2\), its undrained shear strength will be
   (a) 0.
   (b) 50 kN/m\(^2\).
   (c) 100 kN/m\(^2\).
   (d) 200 kN/m\(^2\).

29. The sensitivity ratio of most clays ranges from about
   (a) 1 to 8.
   (b) 10 to 80.
   (c) 100 to 800.
   (d) none of the above
30. Select the incorrect statement.
   (a) Most soils are partially thixotropic.
   (b) Thixotropic is a time-dependent reversible process in which materials soften when remoulded; but this loss of strength is gradually regained with time when the materials are allowed to rest.
   (c) The sensitivity ratio of quick clays is greater than 8.
   (d) none of the above
## Answers, Hints and Discussion

1. (b)
2. (d)
3. (c)
4. (d)
5. (c)
   *Hint:* See Eq. (10.3).
6. (a)
   *Hint:* See Eq. (10.3).
7. (a).
   *Discussion:* For sandy soils, \( c' = 0 \), therefore, from Eq. (10.3), \( \tau_f = 0 + (0) \tan \phi' = 0 \).
8. (d)
9. (b)
10. (c)
   *Hint:* See Table 10.1.
11. (d)
12. (c)
   *Hint:* See Eq. (10.9).
13. (a)
14. (b)
15. (b)
16. (c)
   *Hint:* See Fig. 10.5.
17. (b)
18. (c)
19. (b)
20. (b)
21. (d)
*Discussion*: Major (b) is correct for effective minor principal stress. Effective major principal stress = effective minor principal stress + deviator stress = 100 + 130 = 230 kN/m².

22. (b)
*Discussion*: For the normally consolidated clay, \( c' = 0 \); Eq. (10.8):
\[
\phi' = \sin^{-1}\left(\frac{230-100}{230+100}\right) = \sin^{-1}(0.394) = 23.2^\circ.
\]

23. (d)
*Discussion*: \( \theta = 45^\circ + \frac{23.2^\circ}{2} = 56.6^\circ \).

24. (a)
*Discussion*: CD test is carried out very slowly.

25. (a)
*Hint*: See Fig. 10.23.

26. (a)

27. (a)
*Hint*: See Table 10.3.

28. (b)
*Discussion*: Eq. (10.26): \( \tau_f = \frac{100}{2} = 50 \text{ kN/m}^2 \).

29. (a)
*Discussion*: (b) is correct for highly flocculated marine clay deposits.

30. (d)