Chapter 8
Stresses in a Soil Mass

1. For the calculation of foundation settlement, which of the following is estimated?
   (a) increase of vertical stress in soil
   (b) net increase of vertical stress in soil
   (c) increase of porewater pressure
   (d) none of the above

2. The sum of the vertical components of the forces developed at the points of contact of the solid particles per unit cross-sectional area of the soil mass is called
   (a) vertical stress.
   (b) total stress.
   (c) effective stress.
   (d) neutral stress.

3. The effective stress principle for the saturated soils provides an expression involving the total stress $\sigma$, the effective stress $\sigma'$ and the porewater pressure (aka neutral stress) $u$ as
   (a) $\sigma' = \sigma + u$.
   (b) $\sigma = \sigma' + u$.
   (c) $u = \sigma + \sigma'$.
   (d) none of the above

4. The principle of effective stress was first developed by Karl Terzaghi in
   (a) 1925.
   (b) 1936.
   (c) 1943.
   (d) 1948.

5. Which of the following cannot be determined experimentally?
   (a) total stress
   (b) porewater pressure
   (c) effective stress
   (d) all of the above

6. The fluctuation of water table when it remains above the ground level causes
   (a) no changes in the total stress and porewater pressure at any point below the ground level.
   (b) no changes in the effective stress at any point below the ground level.
   (c) equal increase or decrease in total stress and porewater pressure at any point below the ground level.
   (d) both (b) and (c)
7. If the groundwater table coincides with the ground level and the saturated unit weight of soil is 19 kN/m³, the effective stress at a depth of 3 m below the ground level will be approximately
   (a) 19 kN/m².
   (b) 28 kN/m².
   (c) 57 kN/m².
   (d) none of the above

8. In Q. 7, the porewater pressure at a depth of 3 m below the ground level will be approximately
   (a) 10 kN/m².
   (b) 19 kN/m².
   (c) 29 kN/m².
   (d) 57 kN/m².

9. If the groundwater table fluctuates, but it remains below the ground level, the effective stress at any point below the groundwater table
   (a) increases with a rise of the groundwater table.
   (b) decreases with a rise of the groundwater table.
   (c) tends to become zero with a rise of the groundwater table.
   (d) remains constant with a rise or fall of the groundwater table.

10. If water is seeping through a soil layer in the vertically upward direction, the effective stress at any point within the soil
    (a) will be lower than its static case without seepage.
    (b) will be higher than its static case without seepage.
    (c) may decrease to zero for a specific hydraulic gradient.
    (d) both (a) and (c)

11. For the upward water seepage through a soil mass, boiling or quick condition occurs when the hydraulic gradient equals
    (a) \( i_{cr} = \frac{\gamma'}{\gamma_{w}} \).
    (b) \( i_{cr} = \frac{\gamma_{w}}{\gamma'} \).
    (c) \( i_{cr} = \frac{\gamma_{sat}}{\gamma_{w}} \).
    (d) \( i_{cr} = \frac{\gamma_{dry}}{\gamma_{w}} \).
    where all the symbols have their usual meaning.

12. For most soils, the critical hydraulic gradient that causes quick condition is approximately
    (a) 0.
    (b) 0.5.
    (c) 1.0.
    (d) none of the above
13. The seepage force per unit volume of soil is equal to
   (a) $i\gamma_w$.
   (b) $i\gamma$.
   (c) $i\gamma_{sat}$.
   (d) $i\gamma'$.
   where all the symbols have their usual meaning.

14. The factor of safety against heave on the downstream side of a hydraulic structure can be obtained using the concept of
   (a) structural design.
   (b) consistency limits.
   (c) seepage force.
   (d) porewater pressure.

15. The vertical normal stress at a point caused by the point load is
   (a) dependent on the Poisson’s ratio.
   (b) independent of the Poisson’s ratio.
   (c) directly proportional to the point load.
   (d) both (b) and (c)

16. The vertical normal stress caused by a point load of 10 kN acting on the ground surface at a point 1 m vertically below its point of application is
   (a) 0.
   (b) 4.775 kN.
   (c) 5 kN.
   (d) 10 kN.

17. The vertical stress increase at a depth of 1 m below the centre of the flexible circular area of 2 m diameter subjected to a pressure of 100 kN/m$^2$ is
   (a) 0.
   (b) 29.28 kN/m$^2$.
   (c) 64.65 kN/m$^2$.
   (d) 91.06 kN/m$^2$. 
Answers, Hints and Discussion

1. (b)
2. (c)
3. (b)
4. (a)
5. (c)

Discussion: Effective stress is not a physically meaningful parameter, so it cannot be determined experimentally; however, it can be calculated using the effective stress principle.

6. (d)

Hint: See Eq. (8.5), and its explanation.

7. (b)

Discussion: Eq. (8.5): \( \sigma' = (3)(19 - 9.8) = 27.6 \approx 28 \text{ kN/m}^2 \). (c) is correct for the total stress.

8. (c)

Discussion: \( u = (3)(9.8) = 29.4 \approx 29 \text{ kN/m}^2 \).

9. (b)

10. (d)

11. (a)

Hint: See Eq. (8.8).

12. (c)

13. (a)

Hint: See Eq. (8.11).

14. (c)

15. (d)

Discussion and Hint: See Eq. (8.18). (a) and (c) are correct for the horizontal normal stresses caused by the point load as observed from Eqs. (8.16) and (8.17), respectively.

16. (b)

Discussion: Eq. (8.19): \( \Delta \sigma_z = (0.4775) \frac{10}{(1)^2} = 4.775 \text{ kN} \).

17. (c)

Hint: Use Eq. (8.24).