Chapter 18
Pile Foundations

1. Piles are structural members made of
   (a) steel.
   (b) concrete.
   (c) timber.
   (d) all of the above

2. Which of the following foundations will have the highest cost?
   (a) Pile foundation
   (b) Strip footing
   (c) Square footing
   (d) Mat foundation

3. Pile foundations may not be considered when
   (a) the upper soils layer(s) is (are) highly compressible and too weak to support the load transmitted by the superstructure.
   (b) subjected to horizontal and uplifting forces.
   (c) the bedrock is present near the ground surface.
   (d) the soil is expansive and collapsible to a great depth below the ground surface.

4. The usual length of timber piles is
   (a) 5 m to 15 m.
   (b) 10 m to 45 m.
   (c) 15 m to 60 m.
   (d) none of the above

5. The usual load carried by timber piles is
   (a) 300 kN to 500 kN.
   (b) 300 kN to 1200 kN.
   (c) 300 kN to 3000 kN.
   (d) none of the above

6. In general, the ultimate pile load is equal to
   (a) the load carried at the pile point.
   (b) the load carried by skin friction developed at the side of the pile.
   (c) the sum of the load carried at the pile point and the load carried by skin friction developed at the side of the pile.
   (d) none of the above

7. The length of friction piles depend on
   (a) the shear strength of soil.
   (b) the applied load.
   (c) the pile size.
   (d) all of the above
8. Which of the following piles is a non-displacement pile?
   (a) driven piles
   (b) concrete piles
   (c) closed-ended piles
   (d) bored piles

9. The frictional resistance along the pile shaft is generally fully mobilised when the relative displacement between the soil and the pile is about
   (a) 1 to 2 mm.
   (b) 5 to 10 mm.
   (c) 5 to 10 cm.
   (d) 10 to 50 cm.

10. For the maximum point resistance, the pile tip should move about
    (a) 5 to 10% of the pile width (or diameter).
    (b) 10 to 25% of the pile width (or diameter).
    (c) 25 to 50% of the pile width (or diameter).
    (d) 50 to 100% of the pile width (or diameter).

11. When the pile is loaded,
    (a) the frictional resistance is fully mobilised first.
    (b) the point resistance is fully mobilised first.
    (c) both frictional resistance and point resistance are fully mobilised simultaneously.
    (e) the frictional resistance is fully mobilised when the pile tip moves about 10 to 25% of the pile width (or diameter).

12. When the ultimate load is applied to the pile, the soil at the pile tip fails mostly in a
    (a) general shear failure.
    (b) local shear failure.
    (c) punching shear failure.
    (d) none of the above

13. If the angle of internal friction of sandy soil deposit is 30°, the limiting pile point resistance will be approximately
    (a) 1500 kN/m².
    (b) 1732 kN/m².
    (c) 3000 kN/m².
    (d) none of the above

14. For piles in saturated clays in undrained condition, the load-carrying capacity of the pile tip is
    (a) \( Q_p = c_u A_p \).
    (b) \( Q_p = 3c_u A_p \).
    (c) \( Q_p = 9c_u A_p \).
    (d) \( Q_p = 27c_u A_p \).
    where all the symbols have their usual meanings.
15. If the average value of the standard penetration resistance of the soil is 10, the average unit frictional resistance for high-displacement driven piles may be equal to
(a) 10 kN/m².
(b) 20 kN/m².
(c) 30 kN/m².
(d) 40 kN/m².

16. The effective vertical stress increases with pile depth to a maximum limit at a depth of
(a) 15 to 20 pile diameters.
(b) 15 to 20 pile diameters and remains constant thereafter.
(c) 20 to 30 pile diameters.
(d) 15 to 20 pile diameters and remains constant thereafter.

17. The earth pressure coefficient at the top of the pile is approximately
(a) equal to \( K_0 \).
(b) equal to \( K_a \).
(c) equal to \( K_p \).
(d) less than \( K_0 \).

18. When the displacement of clayey soil caused by pile driving results in a passive lateral pressure at any depth, the frictional resistance of the pile is determined by using
(a) \( \alpha \) method.
(b) \( \beta \) method.
(c) \( \gamma \) method.
(d) all of the above

19. If the undrained cohesion of a clayey soil deposit is 100 kN/m², the unit skin resistance of the pile in the clayey soil deposit will be approximately equal to
(a) 25 kN/m².
(b) 50 kN/m².
(c) 75 kN/m².
(d) 100 kN/m².

20. The factor of safety generally used to determine the allowable load-carrying capacity of a pile form its ultimate load-carrying capacity ranges from
(a) 1 to 2.5.
(b) 2.5 to 4.
(c) 4 to 6.
(d) none of the above

21. The ultimate point resistance of a pile in rock is approximately
(a) \( q_p = q_{u-R}(N_\phi + 1) \).
(b) \( q_p = q_{u-R}(2N_\phi + 1) \).
(c) \( q_p = 2q_{u-R}(N_\phi + 1) \).
(d) \( q_p = q_{u-R}(N_\phi + 2) \).
where all the symbols have their usual meanings.
22. The elastic settlement of a pile under a vertical working load is the sum of 
   (a) settlement of the pile shaft and the settlement of the pile caused by the load carried at the pile point. 
   (b) settlement of the pile shaft and the settlement of the pile caused by the load transmitted along the pile shaft. 
   (c) settlement of the pile caused by the load carried at the pile point and the settlement of the pile caused by the load transmitted along the pile shaft. 
   (d) settlement of the pile shaft, settlement of the pile caused by the load carried at the pile point and the settlement of the pile caused by the load transmitted along the pile shaft.

23. The settlement of a pile caused by the load carried at the pile point is 
   (a) directly proportional to the width or diameter of the pile. 
   (b) inversely proportional to the Young’s modulus of elasticity of the soil at or below the pile point. 
   (c) directly proportional to the point load per unit area at the pile point. 
   (d) all of the above

24. The pile load test should be carried out to at least a total load of 
   (a) the proposed working load. 
   (b) two times the proposed working load. 
   (c) three times the proposed working load. 
   (d) four times the proposed working load.

25. The pile settlement increases with load to a certain point, beyond which the load-settlement curve becomes vertical. The load corresponding to the point where the load-settlement curve becomes vertical is 
   (a) the load-carrying capacity of the pile. 
   (b) the allowable load-carrying capacity of the pile. 
   (c) the ultimate load-carrying capacity of the pile. 
   (d) none of the above

26. With time, the loss of undrained shear strength occurred during driving of piles into soft clays is partially or fully regained within 
   (a) 1 to 2 days. 
   (b) 5 to 10 days. 
   (c) 10 to 30 days. 
   (d) 30 to 60 days.

27. The Engineering News Record (ENR) formula is used to determine 
   (a) the pile settlement. 
   (b) the allowable load-carrying capacity of the pile. 
   (c) the ultimate load-carrying capacity of the pile. 
   (d) none of the above

28. The downward drag force exerted on the pile by the soil surrounding it is called 
   (a) drag force. 
   (b) skin friction. 
   (c) negative skin friction. 
   (d) positive skin friction.
29. The negative skin friction on the pile can occur when
   (a) a fill of clay soil is placed over a granular soil layer into which the pile is driven.
   (b) a fill of granular soil is placed over a layer of soft clay into which the pile is driven.
   (c) lowering of the water table that causes increase in the vertical effective stress on the
       clay soil into which the pile is driven.
   (d) all of the above

30. Negative skin friction
   (a) can cause the failure of piles.
   (b) decreases the load-carrying capacity of piles.
   (c) both (a) and (b)
   (d) can never cause the failure of piles.

31. Select the correct statement.
   (a) Piles are never used in groups to transmit the structural load to the soil.
   (b) In most cases, piles are used in groups to transmit the structural load to the soil.
   (c) In most cases, piles are used in a group of two to transmit the structural load to the
       soil.
   (d) In most cases, piles are used in a group of three to transmit the structural load to the
       soil.

32. In practice, the minimum center-to-center pile spacing is
   (a) 0.5D.
   (b) D.
   (c) 1.5D.
   (d) 2.5D.
   where D is the pile diameter or width.

33. In ordinary situations, the center-to-center pile spacing is about
   (a) D to 1.5D.
   (b) 2D to 2.5D.
   (c) 3D to 3.5D.
   (d) 4D to 4.5D.
   where D is the pile diameter or width.

34. For driven piles in sand with pile spacing equal to or greater than three times the pile
diameter or width, the efficiency of the load-carrying capacity of a group of pile is
   generally
   (a) equal to 1.
   (b) equal to or less than 1.
   (c) greater than 1.
   (d) equal to or greater than 1.

35. The elastic settlement of a group of piles is
   (a) directly proportional to the square root of the width of pile group section.
   (b) inversely proportional to the square root of the diameter or width of a pile in the
       group.
   (c) directly proportional to the elastic settlement of each pile at the comparable working
       load.
   (d) all of the above
Answers, Hints and Discussion

1. (d)
2. (a)
3. (c)
4. (a)
   Discussion: (c) is correct for steel piles, (c) for precast prestressed concrete piles.
5. (a)
   Discussion: (b) is correct for steel piles, (c) for precast concrete piles.
6. (c)
7. (d)
8. (d)
9. (b)
10. (b)
11. (a)
12. (c)
13. (b)
   Discussion: Eq. (18.14) and Fig. 18.11: \[ q_t \approx (50)(60)(\tan 30^0) = 1732 \text{ kN/m}^2. \]
14. (c)
   Hint: See Eq. (18.16).
15. (b)
   Discussion: Eq. (18.20): \[ f_{av} = (2)(10) = 20 \text{ kN/m}^2. \] (a) is correct for low-displacement piles, see Eq. (18.21).
16. (b)
17. (c)
   Discussion: (d) is correct for the earth pressure coefficient at the pile tip.
18. (c)
19. (b)
   Discussion: Eq. (18.27) and Fig. 18.17: \[ f = (0.5)(100) = 50 \text{ kN/m}^2. \]
20. (b)
21. (a)  
*Hint:* See Eq. (18.38).

22. (d)

23. (d)  
*Hint:* See Eq. (18.43).

24. (b)

25. (c)

26. (d)

27. (c)

28. (c)

29. (d)

30. (c)

31. (b)

32. (d)

33. (c)

34. (a)

35. (d)