13 CHAPTER

Pile Foundations

Q.1 Consider the following points about group action of pile:
1. End bearing resistance decreases but skin friction resistance increases.
2. Consolidation settlement is more than in individual action.
3. Pile driving mechanism should start from centre and proceed outward.

Which of the above statement(s) is(are) wrong?
(a) 2 and 3 (b) only 1
(c) 1, 2 and 3 (d) 1 and 3

Q.2 Two piles, one bored cast in situ pile and another a precast driven pile, both of same length and diameter are constructed in a loose sand deposit. If the bearing capacity of the bored pile is Q_1, and that of the precast driven pile is Q_2, then which one of the following is correct?
(a) $Q_1 > Q_2$
(b) $Q_1 = Q_2$
(c) $Q_1 < Q_2$
(d) No specific comparison may hold good

Q.3 Consider the following conditions:
1. Two-third of the final load at which total settlement is 12 mm or the permissible total settlement other than 12 mm.
2. 50% of the final load which causes a settlement equal to 10% of the shaft diameter.
3. Two-third of the final load at which causes a net settlement of 6 mm.
4. 50% of the final load which total settlement is equal to 7.5% of bulb diameter.

If an initial pile load test is to be performed on a test under reamed pile, then the safe load on pile shall be taken as least of
(a) 1 and 2 (b) 1 and 3
(c) 1 and 4 (d) 2 and 4

Q.4 The routine test is usually performed on piles to check their capacity to take the working design load. The number of piles on which such a test should be performed is given by
(a) $1\frac{1}{2}$ to 2% of piles
(b) 2 to 10% of piles
(c) 10 to 15% of piles
(d) None of these

Q.5 If the settlement of single pile in sand is denoted by S and that of a group of N identical piles (each pile carrying the same load) by S_g, then the ratio S_g/S will (for medium dense sand)
(a) be equal to 1 irrespective of width of the group
(b) be equal to N irrespective of width of the group
(c) decrease as the width of the group increases
(d) increase as the width of the group increases

Q.6 The static cone penetration test and standard penetration test are performed on a soil at a certain depth. The value found by static cone penetration test is 8 MPa and N value found through SPT test is 20. The soil at that depth is
(a) sandy silt
(b) clay silt mixture
(c) sand and gravel mixture
(d) medium dense sand

Q.7 Consider the following statements about the under-reamed pile in swelling soils:
1. Its bulb provides anchor against movement due to volume changes of soil.
2. It is a driven pile.
3. Its bulb diameter is 2.5 times its shaft diameter.

Which of these statements are correct?
(a) 1, 2 and 3 (b) 1 and 2 only
(c) 2 and 3 only (d) 1 and 3 only

Q.8 Consider the following statements:
1. Piles are provided in groups, which are connected together by a pile cap. The structure rests on top of the pile cap. The pile cap is situated below the ground level.
2. For situations where pile is subjected to upward pull, pedestal piles or under-reamed piles are more suitable type of foundations.

Which of these statement/s is/are correct?
(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

Q.9 The initial test is performed on a test pile to determine the ultimate load capacity and safe load capacity. The maximum load on such an individual pile should not be less than
(a) $1\frac{1}{3}$ times the design load
(b) $1\frac{1}{2}$ times the design load
(c) $2\frac{1}{2}$ times the design load
(d) 4 times the design load

Q.10 The ultimate load carrying capacity of a pile to be driven through clayey soils can be determined by using
(a) dynamic formulae
(b) static formulae
(d) both (a) and (b)
(d) None of the above

Q.11 The Engineering News formula for computing the allowable load carrying capacity of a pile (Q_a), driven through the fall of hammer of weight W, and fall height H cm with steam hammer, giving S cm penetration with the last blow, is given as
(a) $Q_a = \frac{WH}{(S+0.25)}$
(b) $Q_a = \frac{WH}{6(S+0.25)}$
(c) $Q_a = \frac{WH}{(S+2.5)}$
(d) $Q_a = \frac{WH}{6(S+2.5)}$

Q.12 Consider the following statements:
1. Dynamic formulae for the determination of load carrying capacity of piles are best suited to coarse grained soils for which shear strength is independent of rate of loading.
2. The static formulae are based on the assumption that the ultimate bearing capacity of a pile is the sum of the total skin friction and bearing resistance.
3. For clays, the dynamic formulae are valueless because the skin friction developed in clay during driving is very much less than which occurs after a period of time.

Which of these statements are correct?
(a) both 1 and 2
(b) both 2 and 3
(c) both 1 and 3
(d) 1, 2 and 3

Q.13 Feld's rule is used to determine
(a) single pile load capacity
(b) number of piles in a group
(c) diameter of piles
(d) group efficiency of pile group

Q.14 Match List-I with List-II and select the correct answer using the codes given below the lists:
List-I
A. Friction pile
B. Batter pile
C. Tension pile
D. Compaction pile
List-II
1. Stiff clay
2. Loose granular soil
3. Lateral load
4. Uplift load

Codes:

	A	B	C	D
(a)	3	1	2	4
(b)	1	3	4	2
(c)	3	1	4	2
(d)	1	3	2	4

Q.15 Match List-I (Soil property measured) with List-II (In-situ test) and select the correct answer using the codes given below the lists:
List-I
A. Modulus of sub grade reaction
B. Relative density and strength
C. Skin friction and point bearing
D. Elastic constants
List-II
1. Cyclic pile load test
2. Pressure meter test
3. Plate load test
4. Standard penetration test

Codes:

	A	B	C	D
(a)	1	3	2	4
(b)	1	2	4	3
(c)	2	4	1	3
(d)	3	4	1	2

Q.16 Study the following statements:
1. Negative skin friction is a downward drag acting on a pile due to the downward movement of the surrounding compressible soil relative to the pile
2. Negative skin friction is also developed by lowering of ground water table
3. Negative skin friction and skin frictional resistance are caused by the relative settlement of pile

Which of these statements are correct?
(a) Both 2 and 3 (b) Only 3
(c) Both 1 and 2 (d) 1, 2 and 3

Q.17 Assertion (A): Negative skin friction will act on piles in filled up soils, which should be considered in the design of pile foundations.
Reason (R): The filled up soils start consolidating and develop a drag force on the pile.
(a) both A and R are true and R is the correct explanation of A
(b) both A and R are true but R is not a correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

Q.18 Assertion (A): The load carrying capacity of bored cast in-situ pile in a sandy soil is much less than that of a driven pile of similar dimensions.
Reason (R): A driven pile generates much more point bearing resistance than a bored pile.
(a) both A and R are true and R is the correct explanation of A
(b) both A and R are true but R is not a correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

Q.19 A square pile of section 25 cm × 25 cm and length 10 m penetrates a deposit of clay having $c = 10\ kN/m^2$ and mobilizing factor $m = 0.7$. What is the load carried by the pile by skin friction only?
(a) 35 kN (b) 55 kN
(c) 60 kN (d) 70 kN

Q.20 Assertion (A): Stresses obtained from Boussinesq's theory are considered reasonably satisfactory in foundation engineering.
Reason (R): They consider elastic soil medium and intensity of allowable stresses below foundation in most cases are quite small and justify elastic solution.
(a) both A and R are true and R is the correct explanation of A
(b) both A and R are true but R is not a correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

Q.21 A single acting steam hammer weighing 22.5 kN and falling through a height of 1.2 m drives a pile. If the final set is 12.5 mm, then according to Engineering News formula,

(a) allowable load for the pile is 300 kN
(b) ultimate bearing capacity of the pile is 300 kN
(c) allowable load for the pile is 120 kN
(d) ultimate bearing capacity of the pile is 120 kN

Q.22 A pile is drawn in uniform clay of large depth. The clay has an unconfined compression strength of 90 kN/m^2. The pile is 30 cm diameter and 6 m long. The safe frictional resistance of pile is (assuming FOS = 3, $\alpha = 0.70$).
(a) 68.4 kN (b) 98.6 kN
(c) 104.7 kN (d) 59.30 kN

Q.23 A pile is driven with a single acting steam hammer of weight 15 kN with free fall of 900 mm. The final set, the average of the last three blows, is 27.5 mm. The safe load using engineering news formula is
(a) 150 kN (b) 125 kN
(c) 75 kN (d) 95 kN

Q.24 A group of 16 piles of 600 mm diameter are arranged in a square pattern with centre to centre spacing of 1.2 m. The piles are 10 m long and are embedded in soft clay with cohesion 30 kN/m^2. Bearing resistance may be neglected. ($\alpha = 0.6$). The ultimate load capacity of the pile group is
(a) 4080 kN (b) 5040 kN
(c) 8230 kN (d) 9160 kN

Linked data question:
A square pile group of 9 piles passes through a recently filled up material of 4.5 m depth. The diameter of the pile is 30 cm and pile spacing is 90 cm centre to centre If the unconfined compressive strength of cohesive material is 60 kN/m^2 and unit weight is 15 kN/m^3.

Q.25 The negative skin friction of pile group based on individual pile failure is
(a) 1245 kN (b) 1145 kN
(c) 1425 kN (d) 1325 kN

Q.26 The negative skin friction of pile group considering block failure
(a) 1245 kN (b) 1324 kN
(c) 1432 kN (d) 1314 kN

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Answers Pile Foundations

1. (b)	2. (c)	3. (c)	4. (a)	5. (d)	6. (a)	7. (d)	8. (c)	9. (c)	10. (b)
11. (b)	12. (d)	13. (d)	14. (b)	15. (d)	16. (c)	17. (a)	18. (a)	19. (d)	20. (c)
21. (a)	22. (d)	23. (c)	24. (b)	25. (b)	26. (c)				

Explanations Pile Foundations

2. (c)
In bored cast in situ, only end bearing resistance occur, but in driven both skin friction and end bearing occur.

7. (d)
Under-reamed pile is a special type of bored pile which is provided with a bulb/pedestal at the end. The usual size of such piles are 150 to 200 mm shaft diameter, 3 to 4 m long. The diameter of under-reamed portion is usually 2 to 3 times the shaft diameter.

10. (b)
The dynamic formulas used are suitable for dense sands as the clays may get remoulded on dynamic action.

11. (b)
According to Engineering News Formula, allowable load, Q_a, is given as

$$Q_a = \frac{WH}{F(S+C)}$$

Where Q_a and W are in kg, H is in cm, S is the final set in cm/blow for drop hammers, $C = 2.5$ and for single acting $C = 0.25$ steam hammers and
F = Factor of safety = 6

$$\therefore \quad Q_a = \frac{WH}{6(S+0.25)}$$

19. (d)
The load carried by skin-friction only
$= m \times c \times p \times L$
$= 0.7 \times 10 \times 4 \times 0.25 \times 10 = 70$ kN

21. (a)
Allowable load as per Engineering news formula with a factor of safety of 6.

$$Q_a = \frac{1}{6}\left(\frac{Wm_h}{S+c}\right) = \frac{1}{6}\left(\frac{22.5\times(1.2\times100)\times1}{1.25+0.254}\right)$$

$= 299.2$ kN $\approx$ 300 kN
C for steam hammer = 0.254 cm
W = weight of hammer (kN)
h = height of fall (cm)
S = Penetration of pile per hammer flow (cm)

22. (d)
Cohesion of clay

$$= \frac{1}{2}\times 90 = 45 \text{ kN/m}^2$$

Frictional resistance,
$= \alpha C A_s$
$= 0.7 \times 45 \times \pi \times 0.3 \times 6 = 178.13$ kN
$\therefore$ Safe frictional resistance

$$= \frac{178.13}{3} = 59.3 \text{ kN}$$

23. (c)
Allowable load on pile,

$$Q_{ap} = \frac{500 W_h \times H}{3(s+25)}$$

$$= \frac{500\times15\times0.90}{3(27.5+25)} \text{kN} = 75 \text{ kN}$$

(For single acting steam hammer)

24. (b)
Arrangement:
$= 4 \times 4 = 16$ piles
$d = 0.6$ m, $s = 1.2$ m, $L = 10$ m,
$c = 30$ kN/m^2, $\alpha = 0.60$
Neglecting bearing resistance
$Q_{up} = \alpha \bar{c} \times \pi d L$
$= 0.6 \times 30 \times \pi \times 0.6 \times 10 = 339.29$ kN
$nQ_{up} = 339.29 \times 16 = 5428.64$ kN
$Q_{ug} = \alpha \bar{c} \times 4B \times L$
$= 1 \times 30 \times (3s + d) 4 \times 10$
$= 30 \times 4 \times 4.2 \times 10 = 5040$ kN

25. (b)
Individual pile:

$$Q_u = \frac{1}{2}\times 60 = 30 \text{ kN/m}^2$$

Negative skin friction,
$Q_{ng} = nPD_n \times C$
$= 9 \times \pi \times 0.30 \times 4.5 \times 30 = 1145$ kN

26. (c)
Block width, $B = 2s + d$
$= 2 \times 0.90 + 0.30 = 2.1$ m
Perimeter, $P_g = 4B = 8.4$ m
Area, $A_g = B^2 = 4.41$ m^2
Negative skin friction,
$Q_{ng} = CD_n P_g + \gamma D_n A_g$
$= 30 \times 4.5 \times 8.4 + 15 \times 4.5 \times 4.41$
$= 1134 + 298 = 1432$ kN

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