FOUNDATION ENGINEERING
(CIVL 3141)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) If the depth is less than the width of a foundation, then it is a
(a) Deep foundation (b) Shallow foundation
(c) Intermediate foundation (d) Small foundation.

(ii) For analysis of cantilever sheet pile wall, the point of rotation lies
(a) Above dredge level
(b) Between dredge level and toe of the wall
(c) Below the toe of the wall
(d) At the dredge level.

(iii) The ultimate bearing capacity of a circular footing of 1 m diameter, resting on the surface of a saturated clay of cohesion of 100 kN/m^2 according to Terzaghi's theory is
(a) 570 kN/m^2 (b) 530 kN/m^2 (c) 550 kN/m^2 (d) 590 kN/m^2

(iv) A rigid concrete footing, 1.5m × 1.5m in size founded at a depth of 1m in silty soil whose modulus of elasticity is 8829 kN/m^2. The footing is expected to transmit a pressure of 200 kN/m^2. If, Poisson's ratio of the foundation soil is 0.35 and influence factor of the footing may be taken as 0.82, then immediate settlement is
(a) 24.25 mm (b) 24.45 mm (c) 24.65 mm (d) 24.85 mm.

(v) If the permissible settlement is 25 mm, then the allowable bearing pressure according to Peck, Hansen and Thorburn procedure is
(a) $q_{a-net} = 2.2C_wN''$ t/m^2 (b) $q_{a-net} = 2.4C_wN''$ t/m^2
(c) $q_{a-net} = 1.8C_wN''$ t/m^2 (d) $q_{a-net} = 1.6C_wN''$ t/m^2
where, the symbols have their usual meanings.

(vi) Dilatancy correction is required when a strata is
(a) cohesive and saturated with $N > 15$
(b) saturated silt/fine sand with $N < 15$ after the overburden correction
(c) saturated silt/fine sand with $N > 15$ after the overburden correction
(d) coarse sand under dry condition with $N < 10$ after the overburden correction
where the symbol has its usual meaning.

(vii) A plate load test is carried out on a 300 mm × 300 mm plate placed at 2 m below the ground level to determine the bearing capacity of a 2 m × 2 m footing placed at same depth of 2 m on a homogeneous sand deposit extending 10 m below ground. The ground water table is 3 m below the ground level. Which of the following factors does not require a correction to the bearing capacity determined based on the load test
(a) Absence of the overburden pressure during the test
(b) Size of the plate is much smaller than the footing size
(c) Influence of the ground water table
(d) Settlement is recorded only over a limited period of one or two days.

(viii) The action of negative skin friction on the pile is to
(a) increase the ultimate load on the pile
(b) reduce the allowable load on the pile
(c) maintain the working load on the pile
(d) reduce the settlement of the pile.

(ix) Group I enlists in-situ field tests carried out for soil exploration, while Group II provides a list of parameters for sub-soil strength characterization. Match the type of tests with the characterization parameters.

Group I	Group II
P. Pressuremeter Test (PMT)	1. Menard's modulus (Em)
Q. Static Cone Penetration Test (SCPT)	2. Number of blows (N)
R. Standard Penetration Test (SPT)	3. Skin resistance (f_c)
S. Vane Shear Test (VST)	4. Undrained cohesion (c_u)

(a) P - 1; Q - 3; R - 2; S – 4 (b) P - 1; Q - 2; R - 3; S – 4
(c) P - 2; Q - 3; R - 4; S – 1 (d) P - 2; Q - 3; R - 4; S – 1.

(x) A soil sampler has inner and outer radius 25 and 30 mm, respectively. The area ratio of the sampler is
(a) 24% (b) 34% (c) 44% (d) 54%.

Group – B

2. (a) A 2 m wide continuous strip footing is founded at a depth of 1.5 m below the ground level in a homogeneous bed of dense sand ($\phi = 36°$, $\gamma = 18$ kN/m^3). Determine the net ultimate, net safe and safe bearing capacity of the footing. Assume a factor of safety of 3.0. Use IS code method. [Given: for $\phi = 36°$, $N_c = 50.59$, $N_q = 37.75$, $N_\gamma = 56.31$].

(b) A column of a building, carrying a safe load of 1500 kN has to be supported by a square footing. The footing is to be placed at 1.2 m below ground level in a soil

(ϕ = 30°, γ = 18.5 kN/m^3). Determine the minimum size of the footing to have a factor of safety of 2.5 against shear failure. Use Terzaghi's theory. [Given: for ϕ = 35°, N_c = 57.8, N_q = 41.3, N_γ = 42.4].

(c) The results of two plate load tests on a given location are as follows:
(i) Diameter = 750 mm; Settlement = 15 mm; Load = 150 kN
(ii) Diameter = 300 mm; Settlement = 15 mm; Load = 50 kN.
Determine the load on a circular footing of 1 m diameter that will cause a settlement of 15 mm.

4 + 4 + 4 = 12

3. (a) A 2.5 m square footing is located in dense sand (ϕ = 35°) at a depth of 1.5 m. Determine the safe bearing capacities for a factor of safety of 3 against shear failure when the water table is located at (i) ground surface, (ii) at footing level and (iii) at 1 m below the footing. The moist unit weight of sand above and saturated unit weight of sand below the water table are 18 kN/m^3 and 20 kN/m^3, respectively. [Given: for ϕ = 35°, N_q = 33.3, N_γ = 48.03]. Use IS code method.

(b) A raft foundation, 8 m × 12 m in plan is to be placed 2 m below ground level in the subsoil shown in the Fig.1. The net foundation pressure is 50 kN/m^2. Calculate the total settlement of the foundation. [Given: μ = 0.5, I_f = 1.36, λ = 0.8 and E = 500c].Take depth correction factor as 1. Assume the footing to be rigid.

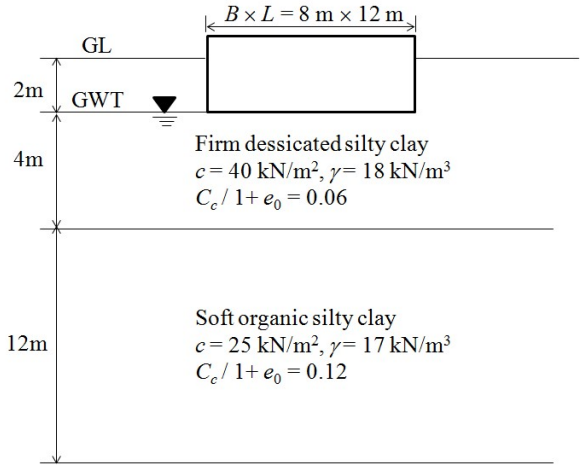

Fig.1

6 + 6 = 12

Group – C

4. (a) Discuss the difference between static cone penetration test and standard penetration test. How SCPT and DCPT correlated with SPT?

(b) If a deposit at a site happens to be a saturated overconsolidated clay with a value of q_c= 8.8 MN/m^2, determine the unconsolidated compressive strength of clay given overburden pressure p_0 = 127 kN/m^2. Take N_k = 18. If we neglect the overburden pressure then calculate unconsolidated compressive strength of clay.

(c) Distinguished between representative and undisturbed sample.

4 + 4 + 4 = 12

5. (a) What is a 'Bore log'? Sketch a typical 'Bore log'.

(b) Following results have obtained from a plate load test performed on a square plate of width 600 mm placed at the approximate depth in a loose sand deposit.

Applied pressure (kPa)	5	10	20	30	40	50
Settlement (mm)	2.08	4.03	7.88	12.08	19.47	30.51

(i) Plot the load versus settlement curve (ordinary graph) and determine the ultimate bearing capacity of the plate.

(ii) Determine the ultimate bearing capacity of a prototype square footing of width 2.5 mm.

(iii) Find out allowable load on the said footing if its permissible settlement is 25 mm.

4 + 8 = 12

Group – D

6. A group of 6 bored cast in-situ piles (diameter = 50 cm, length = 18 m, center to center distance = 1.0 m and cut off level 1.5 m) arranged in a square pattern pass through a sand layer overlaying a soft deposits which is consolidating under the fill load and rests in stiff clay strata. The soil properties of the different strata are given in Fig.2. The total load imposed on the foundation is 3000 kN.

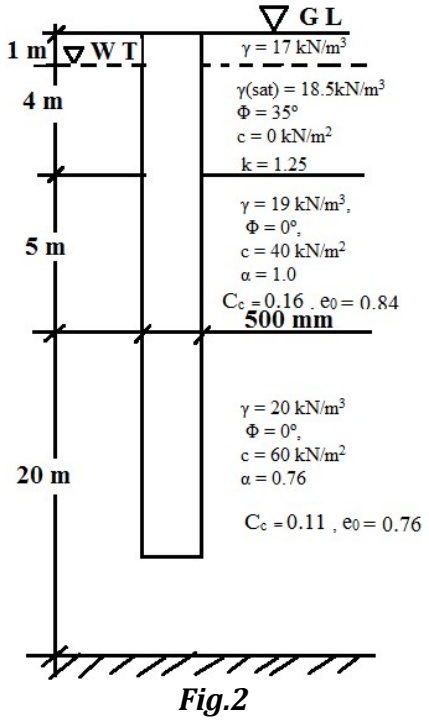

Fig.2

Estimate (i) the ultimate load carrying capacity $(Q_u)_{group}$ and (ii) settlement of the pile group.

8 + 4 = 12

7. (a) A group of 20 piles, each having a diameter of 400 mm and length of 15 m, is arranged in 4 rows. The centre to canter spacing between the piles is 1.8 m. The estimated load carrying capacity of each pile is 380 kN. Determine the load capacity of the group using (i) Felds' rule (ii) Converse-Labarre's formula.

(b) It is required to construct a pile foundation compressed of 20 piles arranged in 5 columns at distance of 90 cm centre to centre. The diameter and lengths of the piles are 30 cm and 9 m respectively. The bottom of the pile cap is located at a depth 2 m from the ground surface. The details of the soil properties are given below with reference to ground level as the datum. The water table was found at a depth of 4 m from ground level.

Thickness (m)	Soil properties	γ (kN/m^3)	q_u (kN/m^2)	e_0	C_c
2	Silt	16.0	-	-	-
2	Clay	19.2	120	0.80	0.23
8	Clay	19.2	120	0.80	0.23
2	Clay	18.24	90	1.08	0.34
3	Clay	20.0	180	0.70	0.20
10	Rocky layer	-	-	-	-

Compute the consolidation settlement of the pile foundation if the total load imposed on the foundation is 750 kN.

6 + 6 = 12

Group – E

8. Fig.3 shows a cantilever sheet pile wall penetrating a granular soil. Determine (i) Theoretical depth of embedment (D), (ii) The total length of sheet piles for a 30% increase in D and (iii) The minimum section modulus of the sheet piles if allowable bending stress is 175 MPa.

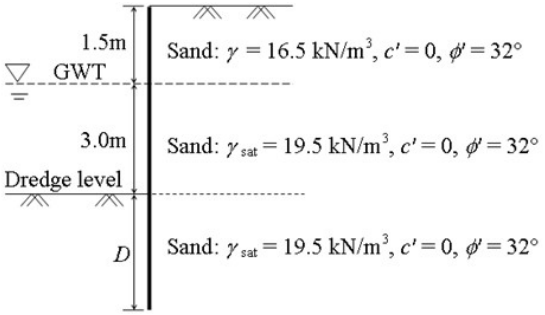

Fig.3

(9 + 1 + 2) = 12

9. Determine the theoretical depth of embedment, actual depth of embedment [$D_{actual} = 1.4D_{theory}$], the force in the tie rod for the anchored bulkhead shown in Fig.4, which has fixed earth support. The backfill and the soil below the dredge line are sand, having the following properties: G = 2.65, e = 0.80 and ϕ = 30°. Use equivalent beam method considering the point of zero moment as lying at a depth of 0.1H (where, H is the depth of dredge level below original ground level) from the level of dredge line. Assume the soil above the water table is dry.

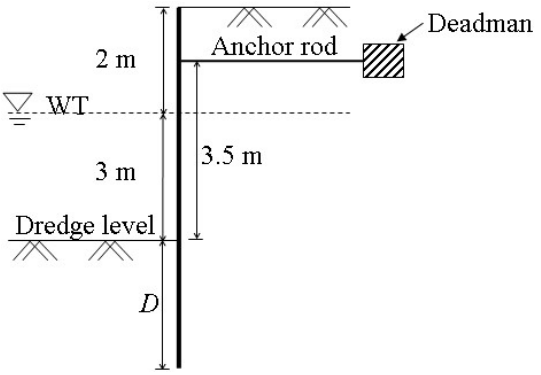

Fig.4

(9 + 1 + 2) = 12

Department & Section	Submission Link
CE A	https://classroom.google.com/c/MjQwMzA5MzM1Nzcy/a/MjcxNDI4Nzg2ODU5/details

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