FOUNDATION ENGINEERING
(CIVL 3202)

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.

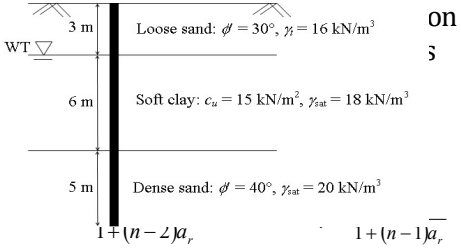
Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

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

(i) The field test(s) in ground investigation is (are)
(a) Standard Penetration Test (b) Dynamic Cone Penetration Test
(c) Plate Load Test (d) all of the above.

(ii) When a 62.5 mm diameter cone is driven dry upto 9 m without bentonite slurry, the dynamic cone penetration resis on resistance (N) upto depth of 4m and fro s
(a) $N_{cbr} = 1.5N$ and $N_{cbr} = 1.75N$
(c) $N_{cbr} = 1.5N$ and $N_{cbr} = 1.65N$



(iii) Settlement reduction ratio, β in st
(a) $\beta = \frac{2}{a_r + (n-1)}$ (b) $\beta = \frac{a_r}{1+(n-1)a_r}$ $1+(n-1)a_r$
where the symbols have their usual meanings.

(iv) The ultimate bearing capacity of strip foundation in cohesionless soil based on static cone penetration resistance (q_c) is given by
(a) $q_d = 28 - 0.0032(300 - q_c)^{1.5}$ kg/cm² (b) $q_d = 18 - 0.0052(300 - q_c)^{1.5}$ kg/cm²
(c) $q_d = 28 - 0.0056(300 - q_c)^{1.5}$ kg/cm² (d) $q_d = 28 - 0.0052(300 - q_c)^{1.5}$ kg/cm²

(v) A plate load test using a plate of size 30 cm × 30 cm was carried out at the level of a prototype foundation. The soil at the site was cohesionless and water table is at a great depth. The plate settled by 10 mm at a load intensity of 160 kN/m². The settlement of a square footing of size 2 m × 2 m under the same load intensity is
(a) 24.25 mm (b) 30.25 mm (c) 32.25 mm (d) 26.25 mm

(vi) If recovery ratio is 1.0, then the soil sample is subjected to
(a) compression (b) expansion
(c) no disturbance (d) either (a) or (b).

(vii) A group of 20 piles, each having a diameter of 40 cm and 10 m long are arranged in 4 rows at spacing of 1 m c/c. The efficiency of the pile group using Los Angeles formula is
(a) 77.25% (b) 77.35% (c) 77.15% (d) 77.55%.

(viii) As per recommendations given in IS code, the minimum spacing for friction and end-bearing piles are
(a) 2.5D and 3D, respectively (b) 3D and 2.5D, respectively
(c) 3.5D and 2.5D, respectively (d) 3D and 2D, respectively.
where D is the diameter of the pile.

(ix) For piles in sand and normally loaded clays the stiffness factor is given by
(a) $T = \sqrt[4]{\frac{EI}{\eta_h}}$ (b) $T = \sqrt[5]{\frac{EI}{\eta_h}}$ (c) $T = \sqrt[3]{\frac{EI}{\eta_h}}$ (d) $T = \sqrt[6]{\frac{EI}{\eta_h}}$
where the symbols have their usual meanings.

(x) Negative skin friction occurs when
(a) pile settles more relative to the soil (b) soil settles more relative to the pile
(c) pile and soil settle equally (d) either (a) or (b) is satisfied.

Group – B

2. (a) Determine the allowable pile load capacity of the 40 cm diameter driven concrete pile shown in the figure. [Given: N_q = 120, N_γ = 109.41, α = 0.95, δ/ϕ = 1]. Assume FOS as 2.5.

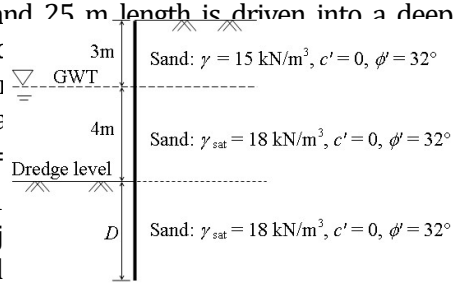
(b) A square pile group of 20 piles with 4 piles in a row passes through a recently filled up soil. The depth of fill is 4m. The diameter of each pile is 40 cm, and spaced at 90 cm apart. If the soil is cohesive with unconfined compressive strength as 65 kN/m² and unit weight as 16 kN/m³, compute the negative frictional load on the pile group.

(c) How safe load on a single pile is determined in initial test?

6 + 4 + 2 = 12

3. (a) A 400 mm diameter concrete pile, 12 m long, was driven by a McKiernan and Terry double acting hammer (total mass 2500 kg) falling through a height of 110 cm. The driving was done with a short dolly and cushion of 2.5 m. The average penetration in the last five blows was 3 mm/blow. Calculate the safe pile load for FOS as 2.5. Assume unit weight of concrete as 24 kN/m³. [Given: coefficient of restitution = 0.65 and hammer efficiency = 92%]. Use modified Hiley's method.

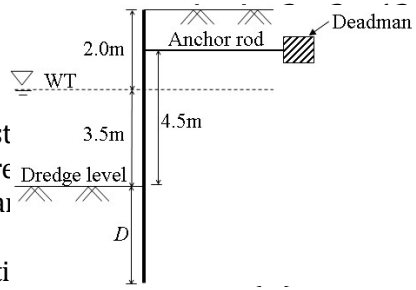
(b) A concrete pile of 50 cm diameter and 25 m length is driven into a deep stratum of loose to medium dense sand
the length of the pile is 18 kN/m³ a
Determine the safe load that can be ca
water table is located at GL. [Given: K_s =



(c) A 14 m long RCC pile (EI = 4.5 × 1
uniform sand. The pile head is subj
Calculate the deflection of the pil
What will be the change in the deflection, if the pile head is fixed? [Given: coefficient of subgrade modulus = 10×10^6 N/m³].

(d) How safe load on a pile group is determined in initial test?

Group – C



4. (a) The observed standard penetration test
loose and dense sand were 30 and 45, re
dry unit weights of loose and dense sa
respectively. The other data given are:
factor = 0.8, (ii) drill rod length correcti
correction factor = 1.05. Determine the corrected SPT value for standard energy ratio of 60% and 70%. The sampler used was with liner.

(b) Define inside clearance, outside clearance and area ratio with the help of a neat sketch.

(c) Define cone resistance (q_c), local side friction (f_c) and friction ratio (R_f) related to static cone penetration test.

(d) What are hand augers?

4 + 3 + 3 + 2 = 12

5. (a) What are thin walled and split-spoon samplers?

(b) Write short notes on:
(i) Percussion boring and
(ii) Electrical resistivity method.

(2 + 2) + (4 + 4) = 12

Group – D

6. (a) A square footing of size 4 m × 4 m is founded at a depth of 2 m below ground level in loose to medium dense sand ($N_{corr.}$ = 11). Compute the safe bearing pressure by modified Teng's method. The water table is at the base level of the foundation.

(b) The following figure shows a cantilever sheet pile wall penetrating a granular soil. Determine (i) theoretical depth of embedment (D), (ii) total length of sheet piles for a 30% increase in D and (iii) minimum section modulus of the sheet piles if allowable bending stress is 160 MPa.

2 + (7 + 1 + 2) = 12

7. (a) Determine the depth of embedment and the force in the tie rod for the anchored bulkhead shown in the figure by applying directly a factor of safety of 2.0 to the passive pressure using free earth support method. The backfill and the soil below the dredge line is sand, having the following properties: G = 2.6, e = 1.0 and ϕ = 30°. Assume the soil above the water table is dry. [Take γ_w as 10 kN/m³]

(b) Two plate load tests were conducted at the level of prototype foundation in cohesionless soil. The following data are given:

Size of plate	Load applied (kN)	Settlement recorded (mm)
0.3 m × 0.3 m	30	25
0.6 m × 0.6 m	90	25

If a square footing has to carry a load of 800 kN, determine the required size of the footing for settlement of 35 mm.

(7 + 1) + 4 = 12

Group – E

8. (a) Derive the relation between settlement reduction ratio (β), stress concentration factor (n) and replacement ratio (a_r).

(b) State design aspect of preconsolidation with vertical drains.

(c) Briefly describe geotextile and geocomposite.

4 + 4 + (2 + 2) = 12

9. Write short notes on the following:
(i) Dynamic compaction (ii) Soil nailing.

6 + 6 = 12