(vi) The problem of anchored bulkhead with fixed earth support may be solved by
(a) equivalent beam method (b) elastic line method
(c) conjugate beam method (d) both (a) and (b).

(vii) The degree of consolidation due to radial drainage is given by

(a) $U_R = 1 - \exp\left[-\frac{2T_r}{F_a}\right]$ (b) $U_R = 1 - \exp\left[+\frac{8T_r}{F_a}\right]$

(c) $U_R = 1 - \exp\left[-\frac{8T_r}{F_a}\right]$ (d) $U_R = 1 - \exp\left[-\frac{4T_r}{F_a}\right]$

where the symbols have their usual meanings.

(viii) The ultimate load capacity of a 10 m long concrete pile of square cross section 500 mm × 500 mm driven into a homogeneous clay layer having undrained cohesion value of 40 kPa is 700 kN. If the cross section of the pile is reduced to 250 mm × 250 mm and the length of the pile is increased to 20 m, the ultimate load capacity will be
(a) 350 kN (b) 63.5 kN (c)722.5 kN (d) 1440 kN.

(ix) 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.

(x) Match the List I (Boring methods) with List II (Field conditions) and select the correct answer using the codes given below the lists :

List I	**List II**
A. Auger Boring	1. Below water table in all soil types except hard soils and rocks
B. Wash Boring	2. Large diameter bore holes over 150 mm in size
C. Percussion Drilling	3. Exploration for shallow foundations and highways
D. Rotary Drilling	4. Boulder and gravelly strata

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

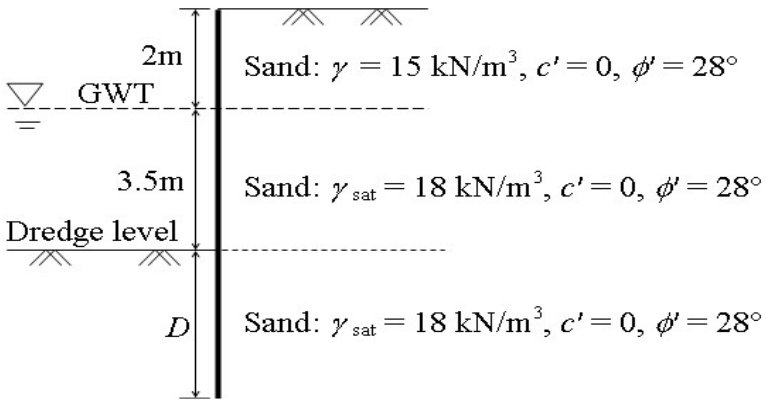

Figure 2

2 + (6+1+3) = 12

7.(a) 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	40	30
0.6 m × 0.6 m	100	30

If a square footing has to carry a load of 1000 kN, determine the required size of the footing for the same settlement of 30 mm.

(b) Determine the theoretical depth of embedment, actual depth of embedment [$D_{actual} = 1.4D_{theory}$] and force in the tie rod for the anchored bulkhead shown in the Fig. 3 which has fixed earth support. The backfill and the soil below the dredge line are sand, having the following properties: G = 2.6, e = 0.75 and ϕ = 25°. Use equivalent beam method considering the point of zero moment as lying at a depth of 0.1 H (where, H is the depth of dredge level below original ground level) below the dredge level. Assume the soil above the water table is dry. [Take γ_w as 10 kN/m^3]

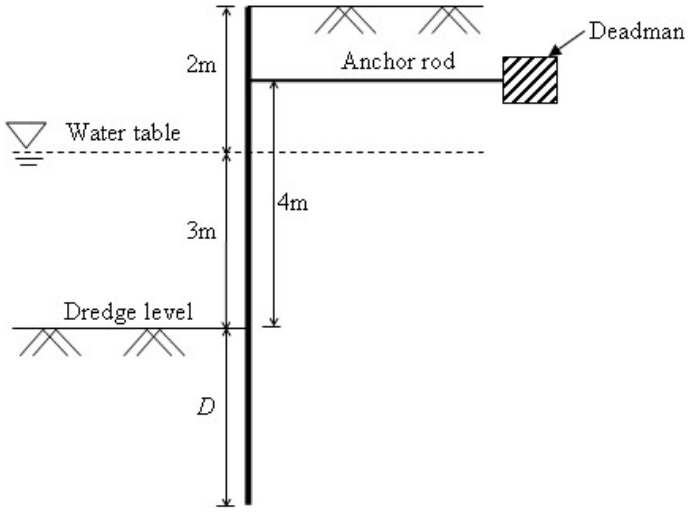

Figure 3

3 + 9 = 12

Group – E

8. (a) What are geonets and geocomposites?
   (b) Describe compaction piles.
   (c) Describe the design principle of preconsolidation with vertical drains.

4 + 4 + 4 = 12

9. (a) Describe drainage function of geosynthetics with application.
   (b) Describe dynamic compaction method of ground improvement.
   (c) What is ground anchor? State any three applications of ground anchor with neat sketches.

4 + 4 + 4 = 12

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) In anchored bulkhead, the tie is in a state of
   (a) tension (b) compression (c) bending (d) all of the above.

   (ii) Ground improvement by vibroflotation is one type of
   (a) vibration methods (b) displacement methods
   (c) loading methods (d) inclusion methods .

   (iii) If the spacing of stone column is *S*, then the equivalent diameter for square pattern of stone column arrangement is given by
   (a) $D_e = 1.03S$ (b) $D_e = 1.13S$ (c) $D_e = 0.95S$ (d) $D_e = 1.23S$

   (iv) An approximate estimate of the depth of compaction in dynamic compaction is given by
   (a) $D = 0.5\sqrt{10WH}$ (b) $D = 0.4\sqrt{10WH}$
   (c) $D = 0.5\sqrt{5WH}$ (d) $D = 0.7\sqrt{10WH}$

   (v) Identify the two true statements from the following four statements:
   I. Negative skin friction is higher on floating piles than on end bearing piles.
   II. All other things remaining same, a footing with smaller width will have lower settlement at the same net pressure if it is constructed in sand.
   III. The void ratio of soils in always less than 1.
   IV. For determining the depth of embedment of anchored sheet piles, net moment at the anchor elevation is set to zero.
   (a) I and IV (b) I and III
   (c) II and IV (d) II and III.

Group – B

2. A ten storey building is to be constructed at a site where the water table is close to the ground surface. The foundation of the building will be supported on 30 cm diameter pipe piles. The bottom of the pile cap will be at a depth of 1 m below ground level. The soil investigation at the site and laboratory tests have provided the saturated unit weights, the shear strength values under undrained condition (average), the corrected SPT values, and the soil profile of the soil to a depth of about 32 m. The soil profile and the other details are given below:

Thickness (m)	Soil	γ_{sat} (kN/m³)	N_{corr}	C_u (kN/m²)	K_s	ϕ (°)	Adhesion parameter (α)
1	Fill	16.5	4	-	-	10°	-
5	Sand	17.5	18	-	1.2	33°	-
10	Stiff clay	18.2	15	60		-	0.75
16	Sand	19.6	25	-	1.2	35°	-

$\phi = 35°$, $N_q = 58$, $N_\gamma = 48.03$

Determine the ultimate bearing capacity of a single pile for length of (i) 15 m, and (ii) 25 m below the bottom of the cap. (Given, $N_c = 9$)

6 + 6 = 12

3.(a) A group of 9 bored cast in-situ piles (diameter = 60 cm, length = 16 m, center to center distance = 1.8 m and cut off level 1.2 m) arranged in a square pattern pass through a clay layer overlaying a soft deposits which is consolidating under the fill layer and rests in stiff clay strata. The soil properties of the different strata are given in Figure 1.

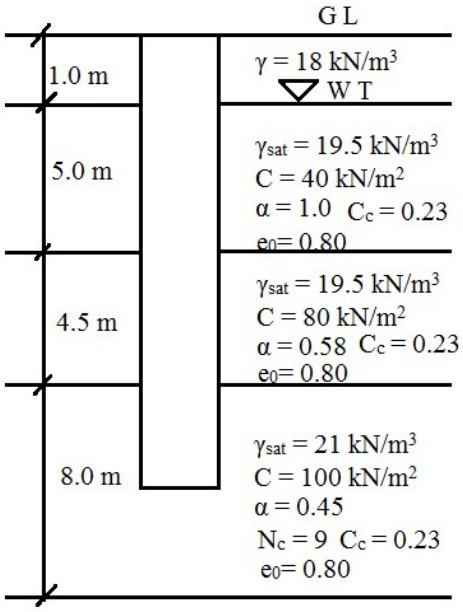

Figure 1

Estimate the total group and individual load carrying capacity of pile by IS: 2911.

(b) If the total load imposed on the foundation is 2500 kN, estimate settlement of the pile group.

9 + 3 = 12

Group – C

4.(a) A 30 cm × 30 cm square bearing plate settles by 10 mm in the plate load test on cohesionless soil, when the load intensity is 160 kN/m².
(i) Estimate the settlement of a square footing of size 2 m × 2 m under the same load intensity.
(ii) What are the limitations of plate load test?

(b) Write a short note on seismic refraction method.

(c) Draw a typical cutting edge of a sampler and explain inside clearance, outside clearance and area ratio.

(4 +2) + 3 + 3 = 12

5.(a) The observed standard penetration test value in a deposit of fully submerged sand was 45 m at a depth of 6.4 m. The average effective unit weight of the soil is 9.69 kN/m³. The other data given are (i) hammer efficacy = 0.8. (ii) drill rod length correction factor = 0.9, and (iii) borehole correction factor = 1.05. Determine the corrected SPT value for standard energy 60%.

(b) A site consists of a deposit of saturated over consolidated clay with a value of q_c = 8.4 MN/m². Determine the unconfined compressive strength of clay, given p_0 = 127 kN/m². If the overburden pressure is neglected then determine the unconfined compressive strength. Assume, N_k = 15.

(c) Describe any method of geophysical exploration.

5 + 3 + 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 = 11). Compute the safe bearing pressure by modified (i) Teng's method and (ii) Meyerhof's method. The water table is at the base level of the foundation.

(b) Fig. 2 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 20% increase in D and (iii) minimum section modulus of the sheet piles, if allowable bending stress is 160 MPa.

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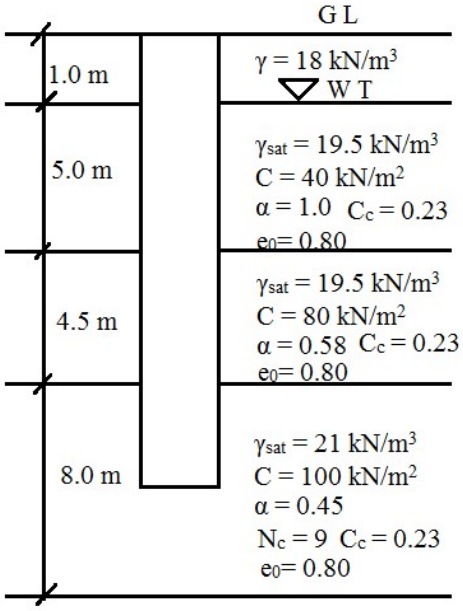

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