Dr Manendra Singh 22/11/2023 14

Roll Number:....................... Total number of printed Page: 4

End Semester Theory Examination, December 2023

Department of Civil Engineering- NIT Hamirpur

CE-433 Foundation Engineering **Marks 50** **Time: 3h**

Course coordinator: Dr. Manendra Singh, DoCE

Instructions: Read the instructions carefully.

- Write to the point only. Do not write anything which is not related to the question.
- Do all parts of a question in sequence order otherwise other parts may not be evaluated.
- There is no step marking therefore whatever you attempt try to do correctly.
- Codal provisions/charts/tables are given in Appendix.
- Assume missing data, if any.

Q. 1 A canal of 4 m deep has side slopes of 1:1. Determine the factor of safety with respect to cohesion, when the canal runs full. The properties of soil are c = 15 kN/m^2 , φ = 15 deg., e = 0.76 and G = 2.7. Taylor's stability number for that condition is 0.083. Also find the same in case of sudden drawdown, if Taylor's stability number for this condition is 0.136. (Unit weight of water = 9.81 kN/m^3)

5 marks

Q. 2 Derive the expression for Rankine's active earth pressure of c- φ soil (Backfill is horizontal). Also determine the depth of tension crack from the derived expression. *5 marks*

Q. 3 Explain the following:

a) Arching in soil

b) Braced sheeting in cuts

5 marks

Q. 4 Explain the design features affecting the sample disturbance as per IS 1892:1979.

5 marks

Q. 5 Determine the allowable bearing pressure for the rectangular footing of 3m x 5m ~~shown in Fig. 1~~ using IS code method. Depth of footing is 1.5m below the ground surface. Water table is at a depth of 0.5 m from the ground surface. Measured SPT (N) value are given in Table 1. Allowable settlement = 40 mm.

10 marks

Table 1

Soil Depth from G.S. (m)	Measured N Value (Nm)	Bulk Unit Weight (kN/m^3)	Soil Type
0.5	10	16	Fine Sand
1.5	12	18	
2.5	14		Course Sand
3.5	15		
4.5	16	20	Fine Sand
5.5	16		
6.5	17		
7.5	18		
8.5	19		
9.5	20		
10.5	22		

Q. 6 a) A square group of 9 piles was driven into soft clay extending to a large depth. The diameter and length of the piles were 30 cm and 9 m, respectively. The unconfined compression strength of clay with depth is given in Table 2 and the pile spacing is 100 cm centre to centre, what is the load carrying capacity of the group? Assume factor of safety of 2.5 and adhesion factor is given in Table 2.

Table 2

Soil Depth from G.S. (m)	Unconfined compression strength (t/m^2)	Adhesion factor
1.0	5.0	0.75
2.0	6.0	0.75
3.0	6.0	0.75
4.0	7.0	0.75
5.0	7.0	0.75
6.0	8.0	0.75
7.0	8.0	0.75
8.0	7.0	0.75
9.0	9.0	0.75
10.0 to rock strata	10.0	0.65

b) A square pile group of 16 piles penetrates through a filled-up soil of 3 m depth. The pile diameter is 250 mm, length is 9m, and pile spacing is 0.75 m. The unit cohesion of the material is given in table 2 and the unit weight of soil is 15 kN/m^3. Compute the negative skin friction on the group. Adhesion factor between individual pile and soil is given in Table 3.

Table 3

Soil Depth from G.S. (m)	Unit cohesion (t/m^2)	Adhesion factor
1.0	16.0	0.40
2.0	18.0	0.40
3.0	20.0	0.40
4.0	22.0	0.35
5.0	25.0	0.35
6.0	30.0	0.35
7.0	30.0	0.35
8.0	30.0	0.30
9.0	35.0	0.30
10.0 to rock strata	40.0	0.30

(5+5=10 marks)

Q. 7 The subsoil at the typical pier location of a major bridge consists of medium to coarse sand (N_{corr} = 11) upto a depth of 6 m from bed level (RL= + 9.2m). This is underlain by 9 m thick layer of very stiff to hard sandy silty clay (N_{cor}> 30), overlying highly weathered rock. Using Lacey's formula calculate the maximum scour depth and determine the founding level of the well. Also, estimate the allowable net bearing pressure if the diameter of the well is 6 m.

5 marks

Q. 8 a) Why circular shape is usually preferred for well foundation?

b) Explain the concept of 'critical depth' as related to the determination of point bearing and skin friction resistance in a pile.

c) How do you classify the pile foundation on the bases of i) load transfer, and ii) method of installation.

d) How is a pile load test data interpreted to estimate the allowable load on a pile and pile group?

e) Differentiate between general shear failure and local shear failure modes of shallow foundation.

*(5*1=5 marks)*

Roll Number:...................... Total number of printed Page: 4

Appendix

Table A 1: Bearing capacity Factors (IS:6403:1981)

$\varphi°$	N_c	N_q	N_γ	$\varphi°$	N_c	N_q	N_γ
0	5.14	1.0	0.0	30	30.14	18.40	22.40
5	6.49	1.57	0.45	35	46.12	33.30	48.03
10	8.35	2.47	1.22	40	75.31	64.20	109.41
15	10.98	3.94	2.65	45	133.88	134.88	271.76
20	14.83	6.40	5.39	50	266.89	319.07	762.89
25	20.72	10.66	10.88				

Table A 2: Shape, depth, Inclination Factors (IS:6403:1981)

Factor	*Value or expression*	
s_c	$s_c = 1 + 0.2 \cdot \frac{B}{L}$	for rectangle
	$s_c = 1.3$	for square and circle
s_q	$s_q = 1 + 0.2 \cdot \frac{B}{L}$	for rectangle
	$s_q = 1.2$	for square and circle
s_γ	$s_\gamma = 1 - 0.4 \cdot \frac{B}{L}$	for rectangle
	$s_c = 0.8$	for square and circle
d_c	$d_c = 1 + 0.2\frac{D_f}{B}\tan\left(45 + \frac{\varphi}{2}\right)$	
d_q, d_γ	$d_q = d_\gamma = 1 + 0.1\frac{D_f}{B}\tan\left(45 + \frac{\varphi}{2}\right)$	for $\varphi > 10°$
	$d_q = d_r = 1$	for $\varphi < 0°$
i_s, i_q	$i_c = i_q = \left(1 - \frac{\alpha}{90°}\right)^2$	where, α in degree
i_γ	$i_\gamma = \left(1 - \frac{\alpha}{\varphi}\right)^2$	

Table A 3: Correlation between N(corrected) and φ (IS: 6403:1981)

Standard penetration resistance (N value)	*Angle of internal friction (φ)*
5	29
10	30.5
20	33.2
30	36
40	38.8
50	41
60	43.2
70	44

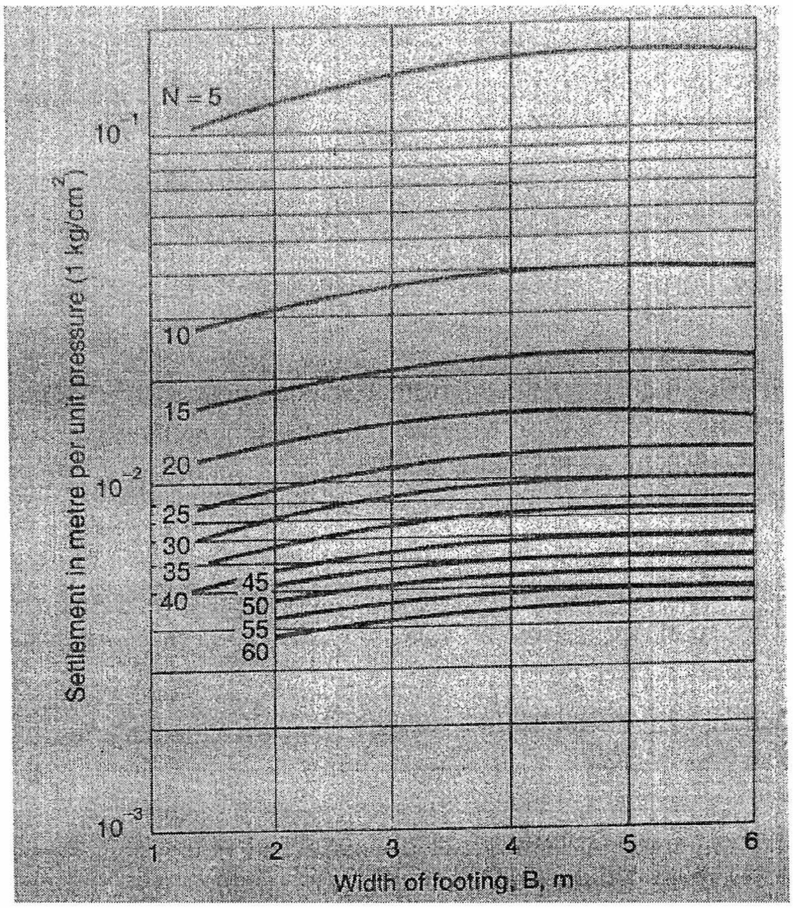

Fig. A 1: Settlement of footings on sand from N-values (IS:800-Part1-1976)