UNIVERSITY OF SOUTH AUSTRALIA

SCHOOL OF NATURAL AND BUILT ENVIRONMENTS

JUNE EXAMINATIONS 2004 ROCK AND SOIL MECHANICS (CIVE 3008)

UNIT TWO - SOIL MECHANICS (Civil Engineering only)

GENERAL INSTRUCTIONS TO CANDIDATES:	Reading Time: 5 mins
Lecturer: Don Cameron	Exam Duration: 1 hour

1. **Attempt all questions**
2. **Marks for questions are shown in brackets (total 40 marks)**
3. **Only one A4 sheet of notes is permissible for this unit**

QUESTIONS

(a) A circular footing, one metre in diameter, is founded in clay to a depth of 5 m, which has an undrained shear strength of 110 kPa ($\phi_u = 0$). Estimate the ultimate load in kN that the footing can sustain. Bearing capacity factors are attached. The unit weight of the surrounding soil is, $\gamma = 18$ kN/m^3.

Ultimate bearing capacity for a soil is given by the formula:

$$q_u = s_c d_c (c_u N_c) + s_q d_q (q_o N_q) + s_\gamma d_\gamma (0.5\gamma B N_\gamma)$$

What is the value of $s_c d_c N_c$? (8 marks)

(b) A strip footing, 3 m wide, is founded 1.5 m below the surface of a soil whose properties are estimated as : $\gamma = 18$ kN/m^3 $\phi' = 35°$

The soil beside the footing has the properties: $\gamma = 16$ kN/m^3 $\phi' = 30°$

A water table sits at the base of the strip footing.

Calculate the ultimate bearing capacity of the footing. Ultimate bearing capacity for a soil is given by the formula:

$$q_u = s_c d_c (c_u N_c) + s_q d_q (q_o N_q) + s_\gamma d_\gamma (0.5\gamma B N_\gamma)$$

(9 marks)

(c) Why is knowledge of overconsolidation ratio important when estimating consolidation settlements of soils from consolidometer testing? (4 marks)

(d) Table I provides values of the settlement influence factor, I_{rc}, for soil with a Poisson's ratio of 0.3 from Ueshita and Meyerhof (1968). The influence factor is implemented in the equation below to derive the settlement of a corner of a uniformly loaded rectangle above a finite layer of thickness of soil, h, below the footing;

$$s_{cnr} = \frac{qB}{E} I_{rc}$$

Consider a flexible rectangular footing, 10 m x 20 m, sitting on a 2–layered soil profile, with layer thicknesses of 5 and 10 m for the top and the bottom layers (i.e. maximum depth of soil is 15 m). The Young's moduli of the first and second layers are 15 and 30 MPa, respectively. Both soils have a Poisson's ratio of 0.3. If the footing carries a uniform load of 120 kPa, <u>what is the the settlement of the mid-point of the short side of the rectangular footing</u>? (10 marks)

e) Calculate the ultimate vertical load capacity in MN of a 0.4 m circular pile driven 15 metres into medium dense sand which has the following properties:

SOIL		**PILE-SOIL**		
γ (kN/m3)	**ϕ'**	**K_s**	**tanδ**	**N_q**
18	38°	0.9	0.56	120

Draw the distribution of skin friction with depth (*4 marks*).

NOTE: $Q_u = \Sigma F_s A_s + f_b A_b$

<u>**Note:**</u> Ignore water table

APPLY limits of 15 MPa to f_b and 110 kPa to f_s

K_s = lateral earth pressure coefficient for soil-pile system

tanδ = pile-soil interface coefficient of friction

N_q = bearing capacity factor, i.e. $q_u = q_o N_q$ (9 marks)

TABLE I. Settlement Influence Factors I_{rc} for $\nu = 0.3$

Ueshita and Meyerhof (1968)

h/B	RATIO OF LENGTH TO WIDTH OF FOOTING, L/B		
	1	2	5
0.1	0.02	0.02	0.02
0.25	0.05	0.04	0.04
0.5	0.10	0.10	0.10
0.75	0.16	0.15	0.15
1	0.20	0.20	0.20
1.5	0.27	0.29	0.29
2	0.32	0.36	0.36
2.5	0.36	0.41	0.42
3	0.38	0.45	0.47
5	0.43	0.54	0.61

BEARING CAPACITY EQUATIONS

Reference : Fang (1991) Foundation Engineering Handbook

ϕ, (degrees)	N_c	N_q	N_γ	N_q / N_c	$2 \tan\phi(1-\sin\phi)^2$
0	5.14	1	0	0.19	0
30	30.1	18.4	15.1	0.61	0.29
35	46.1	33.3	33.9	0.72	0.25

Footing Depth Bearing Capacity Modifiers

<u>For D < B:</u>

$d_c = 1 + 0.4\,\frac{D}{B}$ ($\phi = 0°$)

$d_c = d_q - \frac{1-d_q}{N_c \tan\phi}$ ($\phi > 0°$)

$d_q = 1 + 2\tan\phi\,(1-\sin\phi)^2\,\frac{D}{B}$

$d_\gamma = 1$

<u>For D > B:</u>

$d_c = 1 + 0.4(\tan^{-1}\frac{D}{B})$ *radians*

$d_\gamma = 1$

$d_q = 1 + 2\tan\phi\,(1-\sin\phi)^2.\,\frac{D}{B}.\tan^{-1}\frac{D}{B}$

Footing shape bearing capacity modifiers

$s_c = 1 + \frac{B}{L}\frac{N_q}{N_c}$

$s_q = 1 + \frac{B}{L}\tan\phi$

$s_\gamma = 1 - 0.4\,\frac{B}{L}$

For circular footing use $\frac{B}{L} = 1$