Menoufia University
Faculty of Engineering
Shebin El-Kom
Department: Civil Eng.
First Semester Examination
Academic Year: 2015-2016

Subject: Foundation Engineering
Code: CVE412
Year: 4^{th} Civil
Time allowed: 3 hours
Total Marks: 100
Date: 10/1/2016

Attempt all questions. Any missing data may be reasonably assumed.

Marks

Question (1): **[20]**

a) List the types of foundations suitable for the following types of soil: (6)

- Rock.
- Deep dense sand.
- Deep fill followed with dense sand.

b) Prove that the net ultimate bearing capacity of an isolated footing resting on saturated clay is independent on footing dimensions and foundation depth [Using Terzaghi's B.C equation]. (6)

c) A square footing 1.50×1.50 m, carries a load of 25 ton. The foundation level is at 1.50 m below the ground surface, the ground water table is located at the ground surface. The subsoil strata consist of uniform deposit of soft clay ($C = 0.25$ kg/cm^2, $\gamma_{sat} = 1.90$ t/m^3). Compute the factor of safety against bearing capacity of soil. (8)

Question (2): **[20]**

a) Plot a curve showing the ultimate bearing capacity as a function of footing width for strip footing placed on the surface of: (6)

- A cohesive soil: ($C = 60$ kN/m^2, $\gamma = 17.0$ kN/m^3)
- A cohesionless soil: ($\phi = 30^0$, $\gamma = 17.0$ kN/m^3)

b) Write a short statements on what you know about the following: (4)

- Standard penetration test.
- Cone penetration test.

c) Design a square footing to support a column (30 × 30) cm carrying a load of 60 ton. The footing rested on cohesive soil in (Q2-a) at depth 1.00 m below the ground surface. ($f_c = 60$ kg/cm^2, $f_s = 2000$ kg/cm^2, $k_1 = 0.350$, $k_2 = 1790$). (10)

Question (3): **[20]**

a) For what cases the following foundations may be used and explain why? (4)

- Rectangular combined footing.
- Trapezoidal combined footing.
- Strap beam footing.

b) Two columns A and B carrying loads of 100 and 150 ton respectively. Column A is very near from a neighbor boundary, the distance center to center of columns is 4.0 m. A combined footing is required to support both columns. The footing depth (D_f) is at 1.50 m below the ground surface. The ground water table is located at 6.0 m below the ground surface. The soil data is as following: ($\phi = 30^0$, $C = 0.15$ kg/m^2, $\gamma_d = 1.58$ t/m^3, $\gamma_{sat} = 2.02$ t/m^3), the soil above the ground water table is 50% saturated. (F.O.S = 3.0, $f_c = 60$ kg/cm^2, $f_s = 2000$ kg/cm^2).Draw the shear and moment diagrams. (8)

c) Design the above combined footing in (Q3-b) and show the details of reinforcement. (8)

Question (4): **[20]**

b) What are the principal effect of negative skin friction? (4)

c) The mat foundation shown in figure (1) is resting on medium dense sand with N= 18. (12)
Find the following:
1) The allowable bearing capacity.
2) Stress distribution underneath the mat.
3) Mat thickness and reinforcement.

Question (5): [20]

a) What are the purposes for which the piles may be used? Classify the different types of piles. (4)

b) Show how you would evaluate the following: (8)

- Pile load test according to Egyptian code.
- Settlement of piles.
- The efficiency of piles group.

c) A column load is 400 ton and the soil profile shown in figure (2). The bottom of the pile cap would be at depth 1.50 m below ground surface, the diameter of the pile is 60 cm. It is required to: (8)

- Calculate the allowable bearing capacity of the pile shown in figure (2). (factor of safety equals to 3.0)
- Design the pile cap for this column.

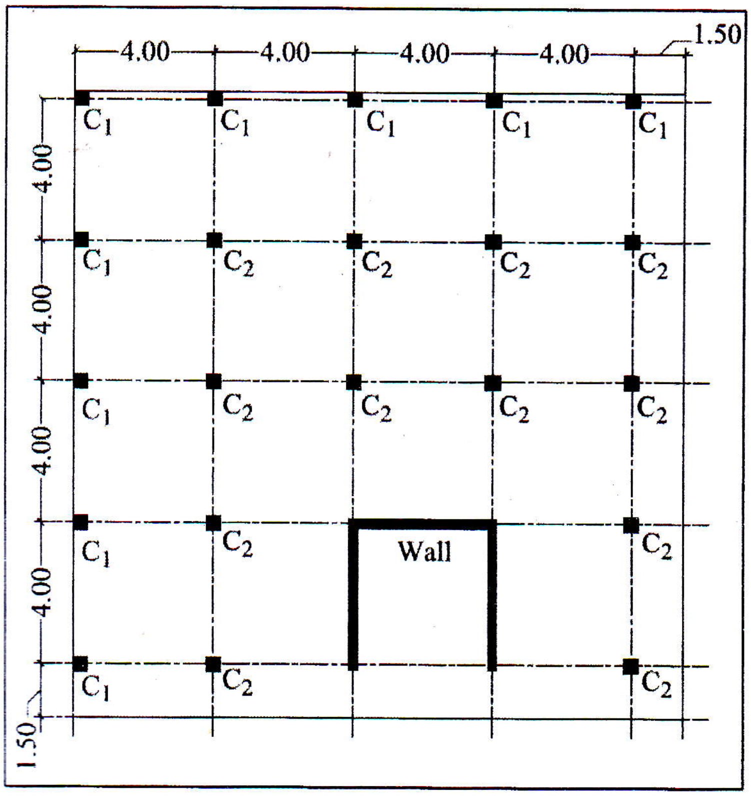


Figure (1)

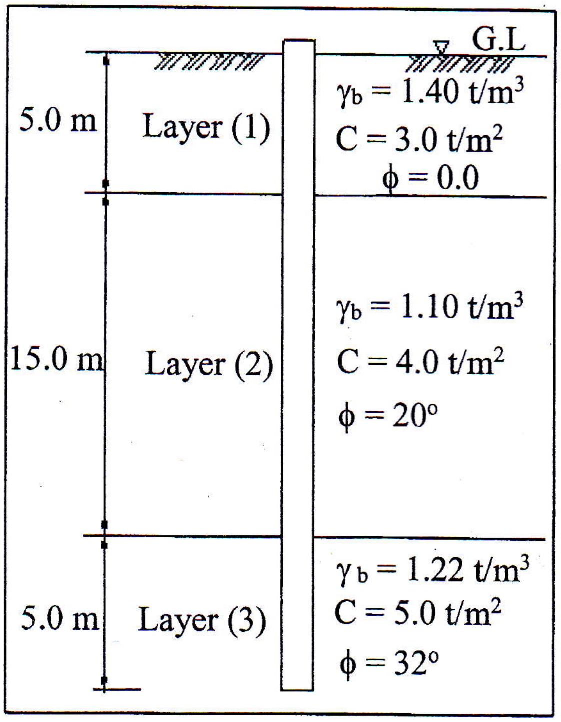


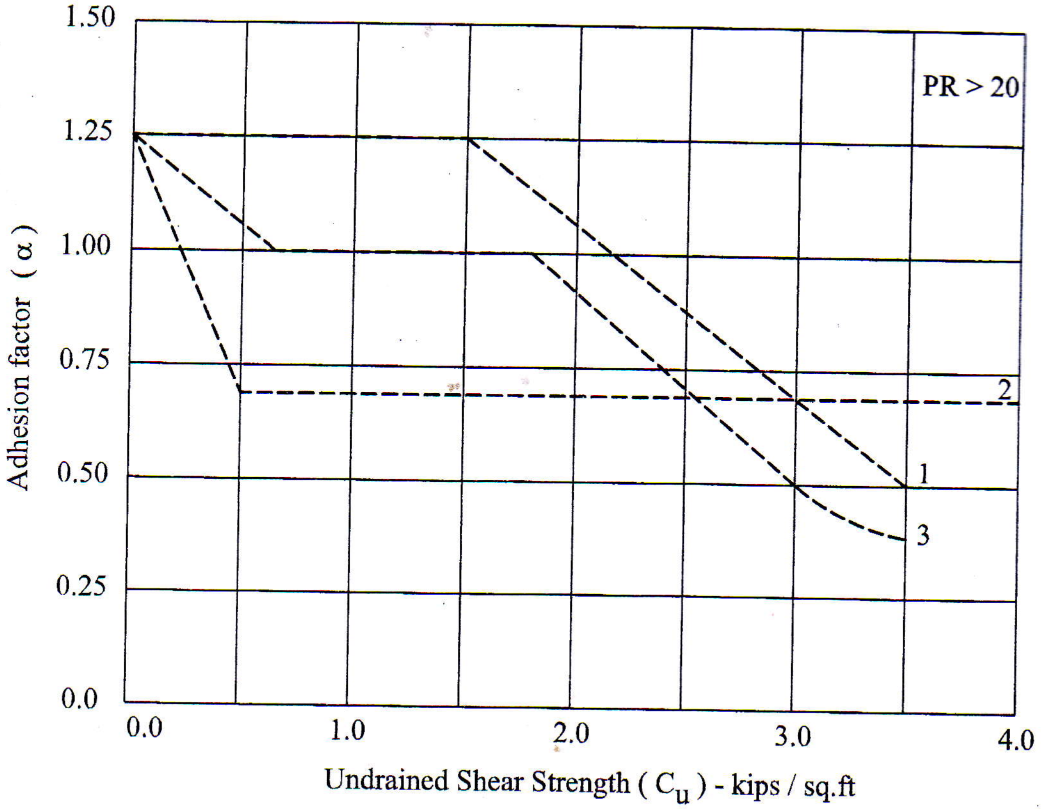
Figure (2)

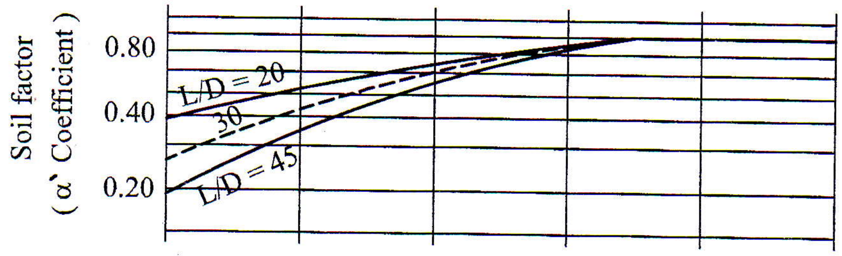
Column	Dimensions (cm)	Load (ton)
C1	30 × 40	55
C2	40 × 40	80
Wall	25 thickness	25 t/m'

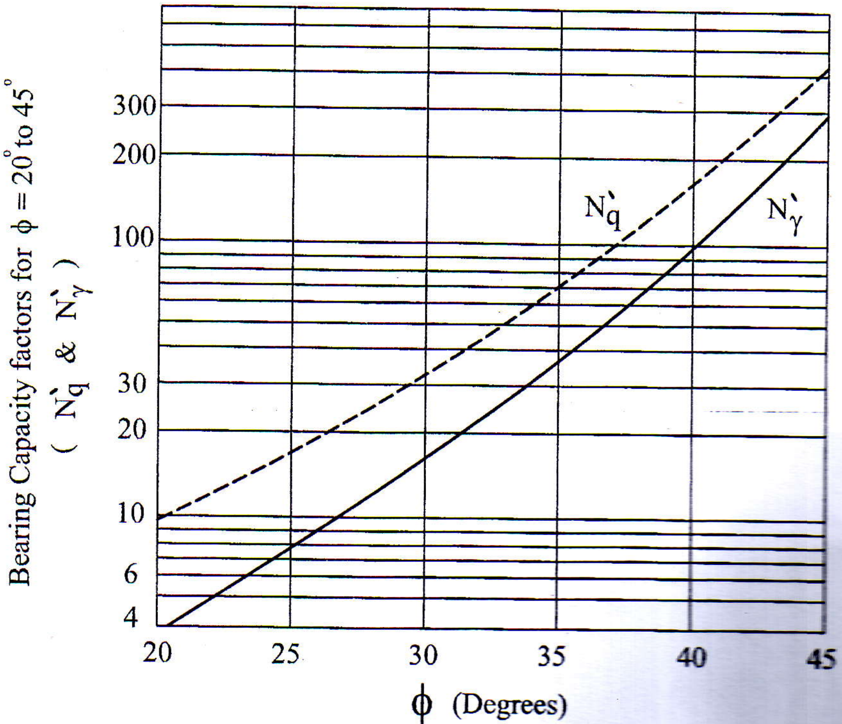
With my best wishes,
Dr.Mohammed Abou Rayia

This exam measures the following ILOs

Question Number	Q1-b	Q3-a	Q4-a	Q5-a	Q1-a	Q1-c	Q2-b	Q4-b	Q5-c	Q2-a	Q2-c	Q3-b	Q3-c	Q4-c	Q5-b
	a-13-2	a-13-1	a-13-1	a-13-1	b-2-1	b-3-1	b-15-1	b-3-1	b-15-2	c-1-1	c-3-1	c-3-1	c-3-1	c-3-1	c-3-1
Skills	Knowledge &Understanding				Intellectual Skills					Professional Skills					





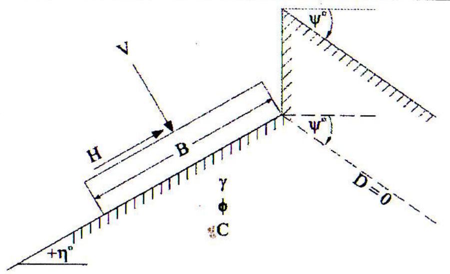


Area of reinforcing steel bars:

ϕ (mm)	8	10	12	16	18	22	25	32
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

1): Shape, depth, Inclination and other factors for use in the Hansen bearing capacity equation:

ombined from Hansen (1970), De Beer (1970) and Vesic (1973). Primed factors for undrained (U) conditions and $\phi = 0.0$

hape factor	Depth factor		Inclination factors	Ground factors (see figure)	Base factors (see figure)
.2 B'/L'	$d'_c = 0.4\,D/B$ $d'_c = 0.4\tan^{-1}(D/B)$	$D \le B$ $D > B$	$i'_c = 0.5 - 0.5\sqrt{1 - H/A_f C_a}$	$g'_c = \psi^\circ / 147^\circ$ For horizontal ground use $g'_c = 0.0$	$b'_c = \eta^\circ / 147^\circ$ For horizontal ground use $b'_c = 0.0$
$1 + \frac{N_q}{N_c}\frac{B'}{L'}$	$d_c = 1 + 0.4\,(D/B)$ $d_c = 1 + 0.4\tan^{-1}(D/B)$	$D \le B$ $D > B$	$i_c = i_q - \left(\frac{1 - i_q}{N_q - 1}\right)$	$g_c = 1 - \psi^\circ / 147^\circ$	$b_c = 1 - \eta^\circ / 147^\circ$
$1 + \left(\frac{B'}{L'}\right)\tan\phi$	$d_q = 1 + 2\tan\phi\,(1-\sin\phi)^2\,(D/B)$ $d_q = 1 + 2\tan\phi\,(1-\sin\phi)^2\tan^{-1}(D/B)$	$D \le B$ $D > B$	$i_q = \left(1 - \frac{0.5H}{V + A_f C_a \cot\phi}\right)^5$	$g_q = g_\gamma = (1 - 0.5\tan\psi^\circ)^5$	$b_q = b_\gamma = \exp(-2\eta\tan\phi)$ η = radians for b_q
$1 - 0.40\left(\frac{B'}{L'}\right)$	$d_\gamma = 1.00$ for all ϕ		Horizontal ground: $i_\gamma = \left(1 - \frac{0.7H}{V + A_f C_a \cot\phi}\right)^5$ Sloping ground: $i_\gamma = \left(1 - \frac{(0.7 - \eta^\circ/450^\circ)H}{V + A_f C_a \cot\phi}\right)^5$		

l (1): *continued* where:

= effective footing contact area = B'L'
= Effective footing length = $L - 2e_L$
= Effective footing width = $B - 2e_B$
= Depth of footing in ground
$_L$ = Eccentricity of load with respect to center of footing area
= Cohesion of base soil
= angle of internal friction of soil
= Load components parallel and perpendicular to footing, respectively
= Coefficient of friction between footing and base soil {use $\delta = \phi$ for concrete poured on ground [Schultze and Horn (1967)]}
= as shown in accompanying figure with positive direction shown

Table (2): Bearing capacity factors for the Meyerhof and Hansen bearing-capacity equations

Note that N_c and N_q are same for both equations

ϕ, deg	N_c	N_q	$N_{\gamma(H)}$	N_q/N_c	$2\tan\phi(1-\sin\phi)^2$	$N_{\gamma(M)}$
0	5.14	1.0	0.0	0.19	0.0	0.0
5	6.5	1.6	0.1	0.24	0.15	0.1
10	8.3	2.5	0.4	0.30	0.24	0.4
15	11.0	3.9	1.2	0.36	0.29	1.1
20	14.8	6.4	2.9	0.43	0.32	2.9
25	20.7	10.7	6.8	0.51	0.31	6.8
30	30.1	18.4	15.1	0.61	0.29	15.7
35	46.1	33.3	33.9	0.72	0.25	37.1
40	75.3	64.2	79.5	0.85	0.21	93.7
45	133.9	134.9	200.8	1.01	0.17	262.7
50	266.9	319.0	568.5	1.20	0.13	873.7

$N_{\gamma(M)}$ = Meyerhof value.

Table (3): Bearing capacity factors for the Terzaghi equations

Values for Ng for f 34° and 48° are original Terzaghi values and used to back – computed K_{PT} for forward computations of N_T by author

ϕ, deg	N_c	N_q	N_γ	K_{PT}
0	5.7	1.0	0.0	10.8
5	7.3	1.6	0.5	12.2
10	9.6	2.7	1.2	14.7
15	12.9	4.4	2.5	18.6
20	17.7	7.4	5.0	25.0
25	25.1	12.7	9.7	35.0
30	37.2	22.5	19.7	52.0
34	52.6	36.5	36.0	
35	57.8	41.4	42.4	82.0
40	95.7	81.3	100.4	141.0
45	172.3	173.3	297.5	298.0
48	258.3	287.9	780.1	
50	347.5	415.1	1153.2	800.0

: Do not use shape factors in combination with inclination factors. Use d_i and i_i only in combination or s_i with d_i, g_i and b_i.
triaxial ϕ is used for plane-strain conditions, one may adjust to obtain: $\phi_{ps} = 1.1\,\phi_{traixial}$ (author's suggestion only for $\phi_{traixial} > 30^\circ$).
ations: $H \le V\tan\delta + C_a A_f$, $i_q, i_\gamma > 0$, $\psi \le \phi$, $\eta + \psi \le 90^\circ$