UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2010/2011

COURSE NAME	:	FOUNDATION ENGINEERING
COURSE CODE	:	BFC4043
PROGRAMME	:	4 BFF
EXAMINATION DATE	:	APRIL / MAY 2011
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER QUESTION Q1 AND OTHER THREE (3) QUESTIONS.

THIS PAPER CONSISTS OF THIRTEEN (13) PAGES

Q1 (a) Discuss in details stabilization of compressible surface layers by:

(i) Pre-loading method
(ii) Vertical drain methods

(10 marks)

(b) A proposal embankment fill required 10,000 $m^3$of compacted soil. The void ratio of the compacted fill is specified to be 0.65. **Table 1** shows four available borrow pits with the void ratios of the soil and the cost per cubic meter for moving the soil to the proposed construction site.

Table 1: Result for void ratio and cost for different borrow pit

Borrow pit	**Void ratio**	**Cost (RM/m^3)**
A	0.6	10
B	1.4	8
C	0.85	12
D	0.65	14

Make the necessary calculations to select the pit from which the soil should be brought to minimize the cost. Assume G_s to be the same for all borrow-pit soil.

(15 marks)

Q2 (a) Briefly describe the principles on which seismic refraction studies for subsurface explorations are based.

(4 marks)

(b) Explain a comparison between the static cone penetrometer and standard penetration tests methods for determining subsurface soil conditions

(8 marks)

(c) A seismic refraction study made for an area provides the following data details as shown in **Table 2**;

Table 2 : Results of a seismic refraction field survey

Distance from impact point to geophone (m)	**Time to Receive Sound Wave (s)**
10	0.025
20	0.05
30	0.10
40	0.11
50	0.12

(i) Plot graph of the distance-travel time and determine the seismic velocity for the surface layer and the underlaying layer

(6 marks)

(ii) Determine the thickness of the upper layer

(7 marks)

Q3 (a) Differentiate between general shear failure, local shear failure and punching shear failure in bearing capacity theory for foundation.

(6 marks)

(b) For the footing shown in Figure **Q3(b)**, the vertical load including column load, surcharge weight and weight of footing is 500 kN. The water table occurs at 0.7 m depth. Determine factor of safety against bearing capacity

(15 marks)

(c) Figure **Q3(c)** shows, a shallow foundation supported by a silty clay. Calculate the elastic settlement of the foundation.

(4 marks)

Q4 (a) Indentify **FIVE (5)** circumstances under which the pile foundations are used for building construction.

(5 marks)

(b) Piles can be categorized according to their material namely steel piles, concrete piles, wooden piles and composite piles. Explain the advantages and disadvantages of each pile for deep foundation construction.

(8 marks)

(c) The plan of a group pile is shown in Figure **Q4(c)**. Assume that piles are embedded in a saturated homogeneous clay having a $c_u = 86$ kN/m^2. Given: diameter of piles *(D)* = 316 mm, center to center spacing of piles = 600 mm, length of piles = 20 m. Find the allowable load carrying capacity of the pile group. Use FS = 3.

(12 marks)

Q5 (a) An anchored sheet pile bulkhead is shown in Figure **Q5(a).** Given $L_1 = 2$ m, $L_2 = 6$ m, $l_1 = 1$ m, $\gamma = 16$ kN/m^3, $\gamma_{sat} = 18.86$ kN/m^3, $\Phi = 32^o$ and c = 27 kN/m^2.

Determine:

(i) the theoretical depth of embedment, D

(9 marks)

(ii) the anchor force per unit length of the sheet pile.

(4 marks)

(b) Figure **Q5(b)** shows a braced cut system in sandy soil. The struts are spaced at 2.5 m center to center.

(i) draw the earth pressure envelope

(3 marks)

(ii) determine the strut loads at each level

(6 marks)

(iii) determine maximum moment

(3 marks)

S1 (a) Bincangkan dengan jelas penstabilan yang dilakukan terhadap lapisan tanah boleh mampat menggunakan;

(i) Kaedah Pra-Pembebanan
(ii) Kaedah Saliran Pugak

(10 markah)

(b) Satu cadangan kerja penambakan tanah memerlukan 10,000 m^3 tanah yang dipadatkan. Nisbah lompang bagi tanah yang dipadatkan ialah 0.65. **Jadual 1** menunjukkan terdapat empat "borrow pits" dijalankan dengan nisbah lompang yang berbeza beserta dengan kos satu meter padu tanah bagi mengalihkan tanah ke kawassan tapak pembinaan.

Jadual 1: Keputusan nisbah lompang serta kos bagi "borrow pit" berbeza

"Borrow pit"	**Nisbah lompang**	**Kos (RM/m^3)**
A	0.6	10
B	1.4	8
C	0.85	12
D	0.65	14

Tunjukkan pengiraan yang penting bagi memilih "borrow pit" yang memerlukan kos yang minima bagi pengantian tanah. Andaikan nilai G_s adalah sama bagi semua "borrow-pit" tanah.

(15 markah)

S2 (a) Bincangkan dengan ringkas prinsip penggunaan pembiasan seismik bagi penyiasatan sub tanah.

(4 markah)

(b) Terangkan perbandingan antara ujian kon statik penusukan dan ujian penusukan piawai bagi menentukan keadaan sub tanah.

(8 markah)

(c) Satu kajian menggunakan kaedah pembiasan seismik dilakukan dan keputusan adalah seperti di dalam **Jadual 2;**

Jadual 2 : Keputusan kaedah pembiasan seismik

Jarak daripada titik hentaman ke Geophone(m)	Masa Penerimaan Gelombang Bunyi (s)
10	0.025
20	0.05
30	0.10
40	0.11
50	0.12

(i) Plot graf perjalanan-masa dan tentukan kelajuan seismik pada lapisan permukaan dan lapisan seterusnya

(6 markah)

(ii) Tentukan ketebalan lapisan atas

(7 markah)

S3 (a) Bezakan diantara kegagalan ricih am, kegagalan ricih tempatan dan kegagalan ricih menebuk dalam teori keupayaan galas untuk asas.

(6 markah)

(b) Sebuah papak sebagaimana Rajah **Q3(b)** menanggung beban pugak termasuk berat papak dan berat tanah tambak sebanyak 500 kN. Aras air bumi pada kedalaman 0.7m. Tentukan faktor keselamatan terhadap keupayaan galas tanah

(15 markah)

(c) Rajah **Q3(c)** menunjukkan sebuah papak yang disokong oleh tanah liat berkelodak. Kirakan enapan elastik papak tersebut.

(4 markah)

S4 (a) Kenalpasti **LIMA (5)** keadaan di mana memerlukan asas cerucuk bagi pembinaan bangunan.

(5 markah)

(b) Asas cerucuk boleh dikategorikan berdasarkan bahan yang digunakan iaitu asas keluli, asas konkrit, asas kayu dan asas komposit. Terangkan kelebihan dan kelemahan bagi setiap kategori asas yang digunakan bagi pembinaan asas dalam.

(8 markah)

(c) Satu pelan asas cerucuk berkumpulan ditunjukkan dalam Rajah **Q4(c)**. Andaikan asas tersebut ditanam dalam tanah liat yang homogen serta tepu dengan nilai c_u = 86 kN/m^2. Diberi : diameter asas *(D)* = 316 mm, jarak antara cerucuk pada tengah asas = 600 mm, panjang asas = 20 m. Tentukan beban yang dibenarkan yang boleh ditanggung oleh asas berkumpulan ini. Gunakan Faktor Keselamatan bersamaan dengan 3.

(12 markah)

S5 (a) Sebuah tembok cerucuk keping tertambat seperti Rajah **Q5(a).** Diberi L_1 = 2 m, L_2 = 6 m, l_1 = 1 m, γ = 16 kN/m^3, γ_{tepu} = 18.86 kN/m^3, Φ = 32^o and c = 27 kN/m^2. Kirakan :

(i) kedalaman teoritikal, D

(9 markah)

(ii) daya pada setiap ikatan per unit panjang cerucuk keping

(4 markah)

(b) Rajah **Q5(b)** menunjukkan sebuah tembok korekan berembat dalam tanah pasir. Jarak topang adalah 2.5 m pusat-ke-pusat;

(i) lakarkan rajah tekanan tanah

(3 markah)

(ii) tentukan beban bagi setiap topang

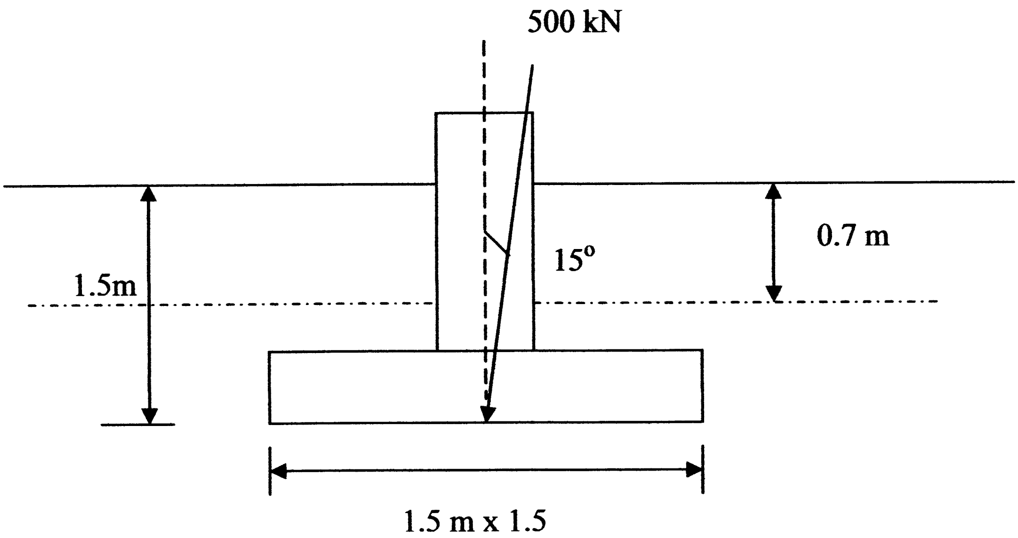
(6 markah)

(iii) tentukan momen maksima

(3 markah)

FINAL EXAMINATION

SEMESTER/SESSION : SEM II/2010/2011 PROGRAMME : 4 BFF
COURSE : FOUNDATION ENGINEERING COURSE CODE : BFC4043



Soil properties
Unit weight, $\gamma = 19$ kN/m^3
Saturated unit weight = 22 kN/m^3
Angle of friction = 15°
$q_u = 100$ kN/m^2

FIGURE Q3 (b)

FINAL EXAMINATION

SEMESTER/SESSION : SEM II/2010/2011
COURSE : FOUNDATION ENGINEERING

PROGRAMME : 4 BFF
COURSE CODE : BFC4043

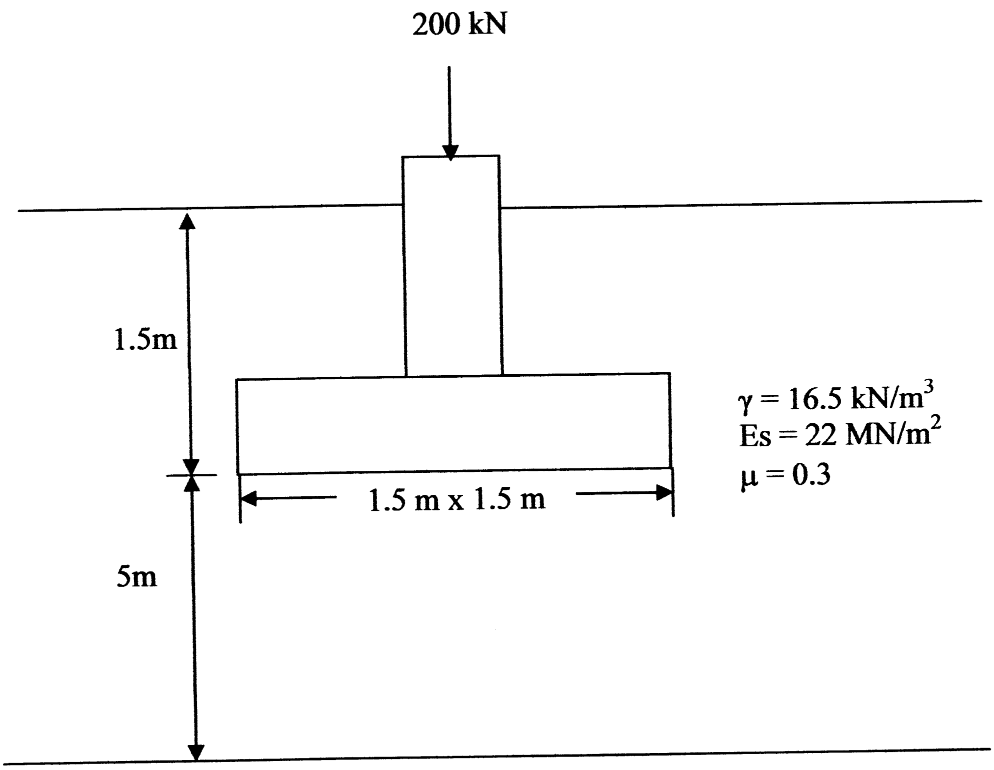


FIGURE Q3(c)

FINAL EXAMINATION

SEMESTER/SESSION : SEM II/2010/2011
COURSE : FOUNDATION ENGINEERING

PROGRAMME : 4 BFF
COURSE CODE : BFC4043

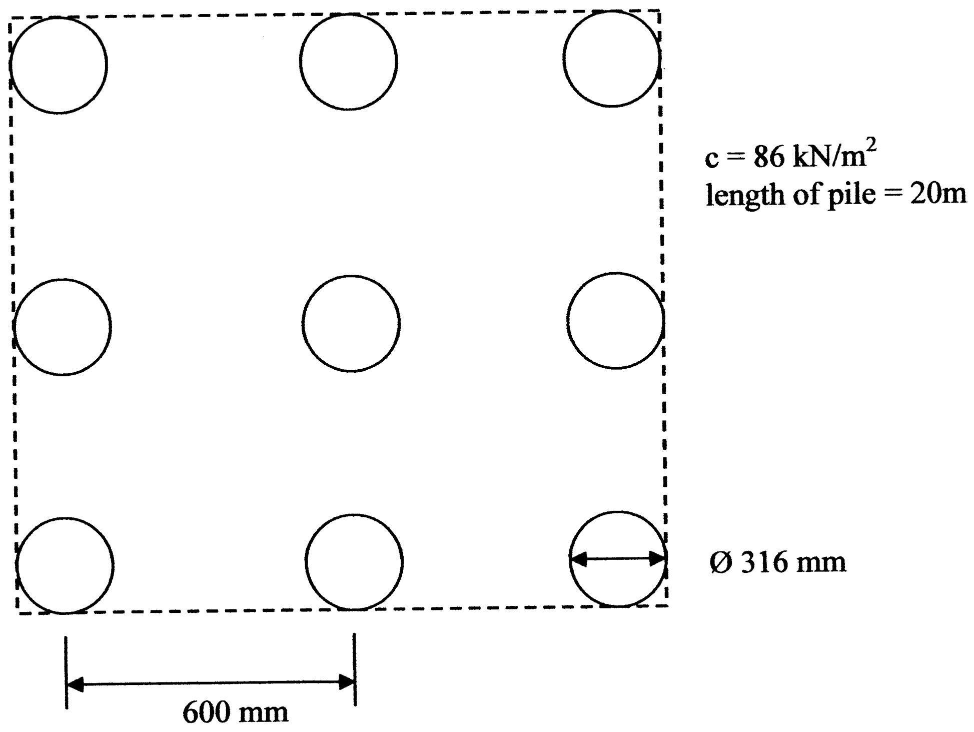


FIGURE Q4 (c)

FINAL EXAMINATION

SEMESTER/SESSION : SEM II/2010/2011 PROGRAMME : 4 BFF
COURSE : FOUNDATION ENGINEERING COURSE CODE : BFC4043

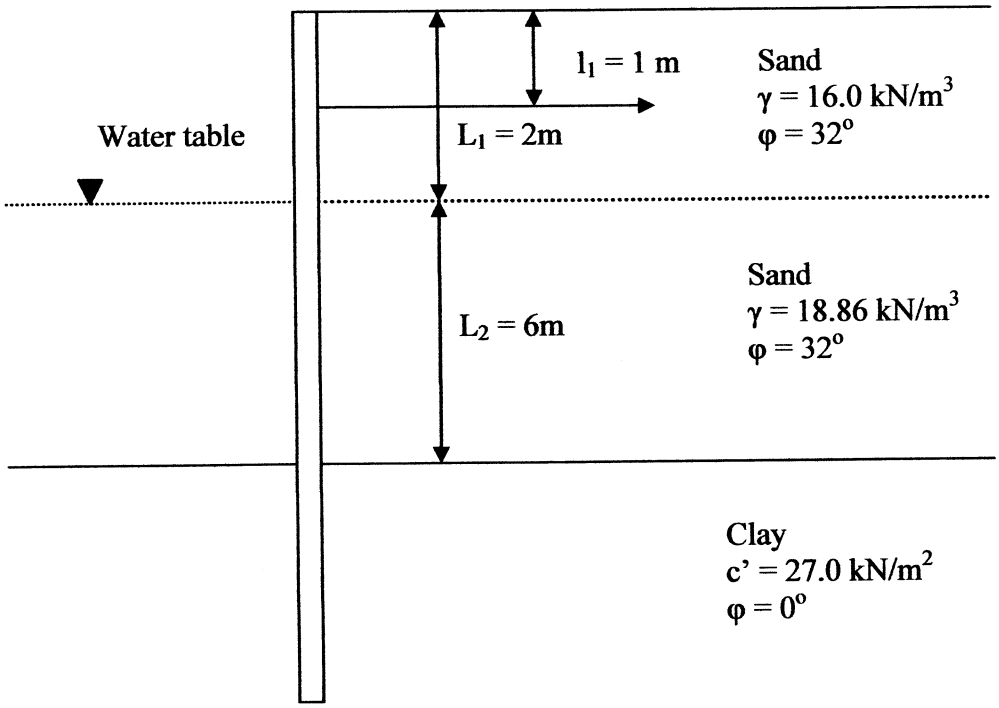


FIGURE Q5(a)

FINAL EXAMINATION

SEMESTER/SESSION : SEM II/2010/2011 PROGRAMME : 4 BFF
COURSE : FOUNDATION ENGINEERING COURSE CODE : BFC4043

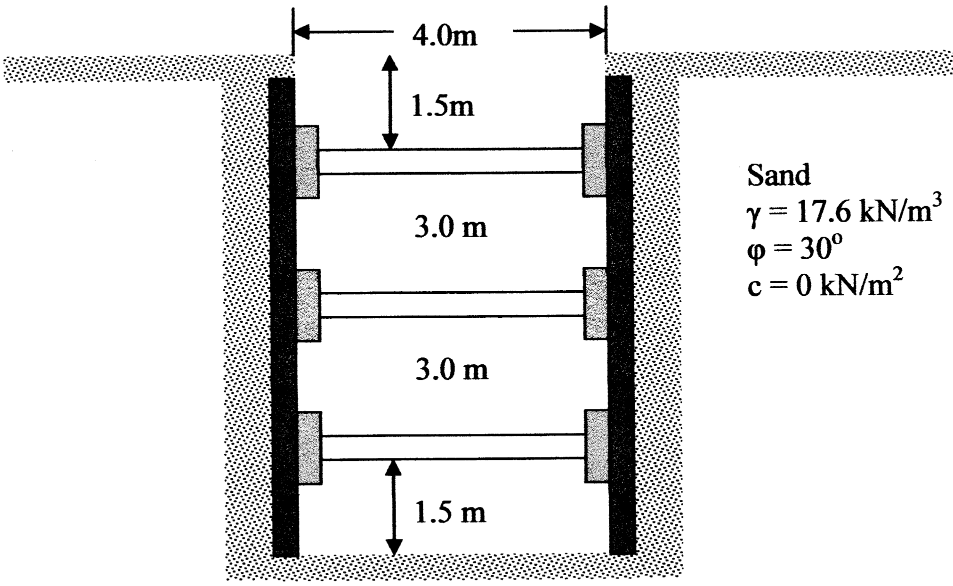


FIGURE 5 (b)

FINAL EXAMINATION

SEMESTER/SESSION : SEM II/2010/2011
COURSE : FOUNDATION ENGINEERING

PROGRAMME : 4 BFF
COURSE CODE : BFC4043

Terzaghi's Bearing Capacity's Factors

Ø	N_c	N_q	N_γ	Ø	N_c	N_q	N_γ
0	5.70	1.00	0.00	26	27.09	14.21	9.84
1	6.00	1.10	0.01	27	29.24	15.90	11.60
2	6.30	1.22	0.04	28	31.61	17.81	13.70
3	6.62	1.35	0.06	29	34.24	19.98	16.18
4	6.97	1.49	0.10	30	37.16	22.46	19.13
5	7.34	1.64	0.14	31	40.41	25.28	22.65
6	7.73	1.81	0.20	32	44.04	28.52	26.87
7	8.15	2.00	0.27	33	48.09	32.23	31.94
8	8.60	2.21	0.35	34	52.64	36.50	38.04
9	9.09	2.44	0.44	35	57.75	41.44	45.41
10	9.61	2.69	0.56	36	63.53	47.16	54.36
11	10.16	2.98	0.69	37	70.01	53.80	65.27
12	10.76	3.29	0.85	38	77.50	61.55	78.61
13	11.41	3.63	1.04	39	85.97	70.61	95.03
14	12.11	4.02	1.26	40	95.66	81.27	115.31
15	12.86	4.45	1.52	41	106.81	93.85	140.51
16	13.68	4.92	1.82	42	119.67	108.75	171.99
17	14.60	5.45	2.18	43	134.58	126.50	211.56
18	15.12	6.04	2.59	44	151.95	147.74	261.60
19	16.56	6.70	3.07	45	172.28	173.28	325.34
20	17.69	7.44	3.64	46	196.22	204.19	407.11
21	18.92	8.26	4.31	47	224.55	241.80	512.84
22	20.27	9.19	5.09	48	258.28	287.85	650.67
23	21.75	10.23	6.00	49	298.71	344.63	831.99
24	23.36	11.40	7.08	50	347.50	415.14	1072.80
25	25.13	12.72	8.34				

From Kumbhojkar (1993)

Terzaghi's Modified Bearing Capacity's Factors

Ø	N'_c	N'_q	N'_γ	Ø	N'_c	N'_q	N'_γ
0	5.70	1.00	0.00	26	15.53	6.05	2.59
1	5.90	1.07	0.005	27	16.30	6.54	2.88
2	6.10	1.14	0.02	28	17.13	7.07	3.29
3	6.30	1.22	0.04	29	18.03	7.66	3.76
4	6.51	1.30	0.055	30	18.99	8.31	4.39
5	6.74	1.39	0.074	31	20.03	9.03	4.83
6	6.97	1.49	0.10	32	21.16	9.82	5.51
7	7.22	1.59	0.128	33	22.39	10.69	6.32
8	7.47	1.70	0.16	34	23.72	11.67	7.22
9	7.74	1.82	0.20	35	25.18	12.75	8.35
10	8.02	1.94	0.24	36	26.77	13.97	9.41
11	8.32	2.08	0.30	37	28.51	15.32	10.90
12	8.63	2.22	0.35	38	30.43	16.85	12.75
13	8.96	2.38	0.42	39	32.53	18.56	14.71
14	9.31	2.55	0.48	40	34.87	20.50	17.22
15	9.67	2.73	0.57	41	37.45	22.70	19.75
16	10.06	2.92	0.67	42	40.33	25.21	22.50
17	10.47	3.13	0.76	43	43.54	28.06	26.25
18	10.90	3.36	0.88	44	47.13	31.34	30.40
19	11.36	3.61	1.03	45	51.17	35.11	36.00
20	11.85	3.88	1.12	46	55.73	39.48	41.70
21	12.37	4.17	1.35	47	60.91	44.45	49.30
22	12.92	4.48	1.55	48	66.80	50.46	59.25
23	13.51	4.82	1.74	49	73.55	57.41	71.45
24	14.14	5.20	1.97	50	81.31	65.60	85.75
25	14.80	5.60	2.25				

FINAL EXAMINATION

SEMESTER/SESSION : SEM II/2010/2011 PROGRAMME : 4 BFF

COURSE : FOUNDATION ENGINEERING COURSE CODE : BFC4043

Meyerhof's Bearing Capacity Factors for General Equation (1973)

Ø	N_c	N_q	N_γ	N_q/N_c	Tan Ø	Ø	N_c	N_q	N_γ	N_q/N_c	Tan Ø
0	5.14	1.00	0.00	0.20	0.00	26	22.25	11.85	12.54	0.53	0.49
1	5.38	1.09	0.07	0.20	0.02	27	23.94	13.20	14.47	0.55	0.51
2	5.63	1.20	0.15	0.21	0.03	28	25.80	14.72	16.72	0.57	0.53
3	5.90	1.31	0.24	0.22	0.05	29	27.86	16.44	19.34	0.59	0.55
4	6.19	1.43	0.34	0.23	0.07	30	30.14	18.40	22.40	0.61	0.58
5	6.49	1.57	0.45	0.24	0.09	31	32.67	20.67	25.99	0.63	0.60
6	6.81	1.72	0.57	0.25	0.11	32	35.49	23.18	30.22	0.65	0.62
7	7.16	1.88	0.71	0.26	0.12	33	38.64	26.09	35.19	0.68	0.65
8	7.53	2.06	0.86	0.27	0.14	34	42.16	29.44	41.06	0.70	0.67
9	7.92	2.25	1.03	0.28	0.16	35	46.12	33.30	48.03	0.72	0.70
10	8.35	2.47	1.22	0.30	0.18	36	50.59	37.75	56.31	0.75	0.73
11	8.80	2.71	1.44	0.31	0.19	37	55.63	42.92	66.19	0.77	0.75
12	9.28	2.97	1.69	0.32	0.21	38	61.35	48.93	78.03	0.80	0.78
13	9.81	3.26	1.97	0.33	0.23	39	67.87	55.96	92.25	0.82	0.81
14	10.37	3.59	2.29	0.35	0.25	40	75.31	64.20	109.41	0.85	0.84
15	10.98	3.94	2.65	0.36	0.27	41	83.86	73.90	130.22	0.88	0.87
16	11.63	4.34	3.06	0.37	0.29	42	93.71	85.38	155.55	0.91	0.90
17	12.34	4.77	3.53	0.39	0.31	43	105.11	99.02	186.54	0.94	0.93
18	13.10	5.26	4.07	0.40	0.32	44	118.37	115.31	224.64	0.97	0.97
19	13.93	5.80	4.68	0.42	0.34	45	133.88	134.88	271.76	1.01	1.00
20	14.83	6.40	5.39	0.43	0.36	46	152.10	158.51	330.35	1.04	1.04
21	15.82	7.07	6.20	0.45	0.38	47	173.64	187.21	403.67	1.08	1.07
22	16.88	7.82	7.13	0.46	0.40	48	199.26	222.31	496.01	1.12	1.11
23	18.05	8.66	8.20	0.48	0.42	49	229.93	265.51	613.16	1.15	1.15
24	19.32	9.60	9.44	0.50	0.45	50	266.89	319.07	762.89	1.20	1.19
25	20.72	10.66	10.88	0.51	0.47						

$$q_u = cN_c + qN_q + 0.5\gamma BN_\gamma ....(strip.foundation)$$

$$q_u = 1.3cN_c + qN_q + 0.4\gamma BN_\gamma ....(square.foundation)$$

$$q_u = 1.3cN_c + qN_q + 0.3\gamma BN_\gamma ....(circular.foundation)$$

$$q_u = cN_c F_{cs} F_{cd} F_{ci} + qN_q F_{qs} F_{qd} F_{qi} + \frac{1}{2}\gamma BN_\gamma F_{\gamma s} F_{\gamma d} F_{\gamma i}$$

- shape

$$F_{cs} = 1 + \frac{B}{L}\frac{N_q}{N_c} \qquad F_{qs} = 1 + \frac{B}{L}\tan\phi \qquad F_{\gamma s} = 1 - 0.4\frac{B}{L}$$

Where : L – length of the foundation and (L>B)

- depth

if $D_f/B \leq 1$

$$F_{cd} = 1 + 0.4\frac{D_f}{B} \qquad F_{qd} = 1 + 2\tan\phi(1-\sin\phi)^2\frac{D_f}{B} \qquad F_{\gamma d} = 1$$

if $D_f/B > 1$

$$F_{cd} = 1 + (0.4)\tan^{-1}\left(\frac{D_f}{B}\right) \qquad F_{qd} = 1 + 2\tan\phi(1-\sin\phi)^2\tan^{-1}\left(\frac{D_f}{B}\right) \qquad F_{\gamma d} = 1$$

FINAL EXAMINATION

SEMESTER/SESSION : SEM II/2010/2011 PROGRAMME : 4 BFF
COURSE : FOUNDATION ENGINEERING COURSE CODE : BFC4043

NOTE : $\tan^{-1}(D_f/B)$ is in **radian**

- inclination

$$F_{ci} = F_{qi} = \left(1 - \frac{\beta^\circ}{90^\circ}\right)^2 \qquad F_{\gamma i} = \left(1 - \frac{\beta}{\phi}\right)^2$$

$$q = \frac{Q}{A} \pm \frac{M_x y}{I_x} \pm \frac{M_y x}{I_y}$$

$$Q_p = A_p\left[0.4 p_a N_{60}\left(\frac{L}{D}\right)\right] \leq A_p(4 p_a N_{60})$$

$$p_1 = \gamma L_1 K_a \quad \text{and} \quad p_2 = (\gamma L_1 + \gamma' L_2)K_a$$

$$P_1 = \tfrac{1}{2} p_1 L_1 + p_1 L_2 + \tfrac{1}{2}(p_2 - p_1)L_2 \quad \text{and} \quad \bar{z}_1 = \frac{\sum M_E}{P_1}$$

(**use:** $D = \dfrac{-b \pm \sqrt{(b^2 - 4(a)(c))}}{2(a)}$)

$$D^2[4c - (\gamma L_1 + \gamma' L_2)] - 2DP_1 - \frac{P_1(P_1 + 12c\bar{z}_1)}{(\gamma L_1 + \gamma' L_2) + 2c} = 0$$

$$L_4 = \frac{D[4c - (\gamma L_1 + \gamma' L_2)] - P_1}{4c}$$

$$p_6 = 4c - (\gamma L_1 + \gamma' L_2) \quad \text{and} \quad p_7 = p_p - p_a = 4c + (\gamma L_1 + \gamma' L_2)$$

$$D_{actual} = 1.4 \ldots to \ldots 1.6D$$

$$M_{max} = P(L + z') - \frac{\gamma z'^3 (K_p - K_a)}{6} \qquad z' = \sqrt{\frac{2P}{\gamma(K_p - K_a)}}$$

$$\frac{wtf_y}{\sigma_a S_V S_H} \qquad \frac{2 l_e w \sigma_v \tan\phi_u}{\sigma_a S_V S_H} \qquad L = l_r + l_e = \frac{(H - z)}{\tan\left(45 + \frac{\phi_1}{2}\right)} + \frac{FS_{(P)}\sigma_a S_V S_H}{2w\sigma_v \tan\phi_\mu}$$

$$\sigma_a = K_a \gamma_1 z + M\left[\frac{2q}{\pi}(\beta - \sin\beta\cos 2\alpha)\right] \qquad T = \sigma_a(S_v S_H) \qquad t = \frac{(\sigma_a S_V S_H)[FS_{(B)}]}{wf_y}$$