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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESI 2011/2012

COURSE NAME	:	FOUNDATION ENGINEERING
COURSE CODE	:	BFC4043 / BFC~~41303~~ 43103
PROGRAMME	:	4 BFF
EXAMINATION DATE	:	JUNE 2012
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **Q1** AND OTHER **THREE (3)** QUESTIONS

THIS QUESTIONS PAPER CONSISTS OF FIFTEEN **(15)** PAGES

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Q1 (a) Describe the objectives of the dewatering and list **FIVE (5)** reasons this technique is used in civil engineering purposes.

(7 marks)

(b) The borrow material is to be excavated and transported to a construction site for use in a compacted fill. If the specification calls for the soil to be compacted to a minimum dry unit weight of at the same moisture content of 18.4 kN/m^3. Calculate how many cubic meters of soil from the excavation site are needed to produce 20,000 m^3 of compacted fill

The following are given borrow material properties:
Moist unit weight, γ = 17.8 kN/m^3
Moisture content, w = 14 %
Specific gravity, G_s = 2.7

(8 marks)

(c) One of housing area consists 20 blocks of 14 storey apartment, mosque, recreation park and 2 storey shops will construct at soft clay area 30 m depth. As a geotechnical engineer, propose a suitable method which commonly practiced in Malaysia for soil improvement for that particular area. Your proposal should include reasons that associate with cost, time and the efficiency

(10 marks)

Q2 (a) Syarikat Berjaya proposed to develop 300 m^2 housing project (single storey and double storey terrace house). Desk study shows that the area is soft clay area with high water table. Propose with explanation the required:

(i) number of borehole

(3 marks)

(ii) type of in-situ testing

(3 marks)

(iii) type of sampling

(2 marks)

(iv) type of laboratory testing

(2 marks)

(b) Table **1** shows result of a seismic refraction field work of a proposed site for a building project.

Table **1**: Result of a seismic refraction field survey

Distance from the point of impact (metres)	Time of first arrival of seismic wave (milliseconds)
2.5	10
5	24
7.5	34
10	42.
15	51
20	57
25	65
30	69
35	71
40	75
50	77

(i) Calculate the seismic velocity and thickness of the material encountered from the survey

(9 marks)

(ii) Evaluate the advantages and disadvantages of seismic refraction technique in the site investigation works.

(6 marks)

Q3 (a) Explain the differences between 'safe bearing capacity' and 'ultimate bearing capacity'.

(4 marks)

(b) Describe briefly **TWO (2)** methods or procedures for determining the design bearing capacity for shallow foundations. Include the advantages and disadvantages perceived for each methods.

(6 marks)

(c) A 1.5 m x 1.5 m square footing will be constructed as shown in Figure **Q3(c)**. A centric column load on the footing = 250 kN. A unit weight of soil, γ_{soil} = 18.8 kN/m^{3}where as the unit weight of concrete, $\gamma_{concrete}$ = 23.5 kN/m^3. Cohesive soil with unconfined compressive strength, UCS = 143.6 kN/m^3.

Examine;

(i) Soil contact pressure

(7 marks)

(ii) Factor of safety against bearing capacity failure

(8 marks)

Q4 (a) In order to have a good design for a group pile, the pile group efficiency should be considered. Explain the concept of pile group efficiency.

(5 marks)

(b) A 12 m long concrete pile having a cross section of 350 mm X 350 mm is fully embedded in a normally consolidated saturated clay layer for which γ_{sat} = 18 kN/m^3, $\phi = 0$, and c_u = 75 kN/m^2. Calculate the ultimate skin friction resistance by using Figure **Q4(b)**, considering:

(i) α method

(5 marks)

(ii) β method

(5 marks)

(iii) λ method

(5 marks)

(iv) Based on the ultimate skin friction from these three different methods, discuss your preference and explain the design implication from these different approaches

(5 marks)

Q5 (a) Due to clogging of drainage system, the water table has built up to a depth of 4m below the ground surface behind the retaining wall shown in Figure **Q5**. The soil above the water table is partially saturated and has a unit weight of 17 kN/ m^3. Below the water table, the soil is saturated and has a unit weight of 19 kN/ m^3. Calculate the total and effective vertical and horizontal stresses at point A under active conditions.

(10 marks)

(b) The Gravity Retaining Wall shown in Figure **Q5** is to be constructed of concrete having a unit weight of 24 kN/m^3. The foundation soil's ultimate bearing capacity is 800 kN/m^2 while value of k_1 and k_2 are 2/3. By using Rankine's theory, examine factor of safety against:

(i) sliding

(5 marks)

(ii) overturning

(5 marks)

(iii) bearing capacity failure

(5 marks)

S1 (a) Bincangkan tujuan penyahairan dan senaraikan **LIMA (5)** sebab kegunaan teknik ini digunakan didalam kerja-kerja kejuruteraan awam.

(7 markah)

(b) Tanah pinjam dikorek dan dibawa ke tapak pembinaan bagi digunakan sebagai tanah tambak terpadat. Tanah tambakan akan dipadatkan kepada berat unit kering minimum sebanyak 18.4 kN/m3 dan mempunyai kadar lembapan yang sama. Kirakan berapa banyak isipadu tanah yang perlu dikorek daripada tapak pinjam bagi menghasilkan 20,000 m3 tanah terpadat

.

Diberi butiran bagi tanah pinjam korek:
Berat unit basah,γ = 17.8 kN/m^3
Kandungan lembapan, w = 14 %
Graviti tertentu, G_s = 2.7

(8 markah)

(c) Satu projek perumahan yang terdiri daripada 20 blok bangunan apartment 14 tingkat, masjid, kawasan rekreasi dan bangunan kedai 2 tingkat, akan dibina diatas tanah liat lembut yang mempunyai kedalaman 30 m dalam. Sebagai seorang jurutera geoteknikal, cadangkan kaedah yang sesuai yang selalu diamalkan di Malaysia bagi kerja baikpulih tanah bagi tapak pembinaan tersebut. Cadangan anda perlulah merangkumi kos, masa and keberkesanannya.

(10 markah)

S2 (a) Syarikat Berjaya bercadang untuk membangunkan sebuah kawasan seluas $300m^2$ bagi projek perumahan (rumah teres setingkat dan dua tingkat). Desk study menunjukkan bahawa kawasan tersebut merupakan kawasan tanah liat lembut dan mempunyai water table yang tinggi. Cadangkan beserta dengan penjelasan, keperluan:

(i) bilangan lubang jara

(3 markah)

(ii) jenis ujikaji tapak

(3 markah)

(iii) jenis pensampelan

(2 markah)

(iv) jenis ujikaji makmal

(2 markah)

(b) Jadual 1 menunjukan keputusan dari satu kerja lapangan pembiasan seismik di atas satu tapak cadangan sebuah projek bangunan.

Jadual 1: Keputusan pembiasan seismik

Jarak dari sumber seismik (metres)	Masa ketibaan pertama gelombang seismik (milliseconds)
2.5	10
5	24
7.5	34
10	42.
15	51
20	57
25	65
30	69
35	71
40	75
50	77

(i) Kirakan halaju seismik dan ketebalan lapisan bahan-bahan yang ditemui dari kerja tersebut.

(9 markah)

(ii) Nyatakan pendapat anda mengenai kebaikan dan keburukan teknik pembiasaan seismik dalam kerja-kerja penyiasatan tapak.

(6 markah)

S3 (a) Terangkan perbezaan di antara 'keupayaan galas selamat' dan 'keupayaan galas muktamad'.

(4 markah)

(b) Huraikan dengan ringkas **DUA (2)** kaedah atau prosedur bagi menentukan kapasiti keupayaan galas bagi asas cetek. Nyatakan juga kelebihan dan kelemahan bagi setiap kaedah tersebut.

(6 markah)

(c) Satu asas 1.5 m x 1.5 m segiempat sama akan dibina seperti ditunjukkan dalam Rajah **Q3(c)**. Beban tiang sebanyak 250 kN dikenakan ditengah-tengah. Berat unit tanah, γ_{tanah} = 18.8 kN/m^3. Berat unit konkrit, $\gamma_{konkrit}$ = 23.5 kN/m^3. Kekuatan mapatan tak terkurung, UCS = 143.6 kN/m^3.

Tentukan :

(i) Tekanan permukaan tanah

(7 markah)

(ii) Faktor keselamatan terhadap kegagalan keupayaan galas

(8 markah)

S4 (a) Bagi memastikan rekabentuk cerucuk berkumpulan direkabentuk dengan baik, keefisianan cerucuk berkumpulan itu perlu dipertimbangkan. Terangkan konsep keefisianan cerucuk berkumpulan ini.

(5 markah)

(b) Sebatang cerucuk konkrit sepanjang 12 m dan mempunyai keratan rentas 350 mm X 350 mm tertanam sepenuhnya pada tanah liat terkukuh biasa dengan γ_{sat} = 18 kN/m^3, ϕ = 0, dan c_u = 75 kN/m^2. Kirakan keupayaan galas geseran cerucuk dengan menggunakan Rajah **Q4(b),** mempertimbangkan:

(i) kaedah α

(5 markah)

(ii) kaedah β

(5 markah)

(iii) kaedah λ

(5 markah)

(iv) Berdasarkan keupayaan galas geseran yang diperolehi melalui kaedah-kaedah di atas, bincangkan rekabentuk yang bakal anda pertimbangkan dan implikasi rekabentuk yang dapat dilihat melalui kaedah-kaedah ini.

(5 markah)

Q5 (a) Sistem penyaliran yang tersumbat menyebabkan paras air bumi telah naik hingga 4 m di bawah permukaan atas tanah di belakang tembok penahan seperti yang ditunjukkan dalam Rajah Q5. Tanah dibahagian adalah separa tepu dan mempunyai berat unit sebanyak 17 kN/m3. Manakala tanah dibawah aras air bumi adalah tanah tepu yang mempunyai berat unit sebanyak 19 kN/m3. Kirakan tekanan aktif jumlah, tekanan aktif berkesan secara pugak dan sisi pada titik A.

(10 markah)

(b) Tembok penahan graviti yang ditunjukkan dalam Rajah (b) dibina dengan konkrit yang mempunyai berat unit = 24 kN/m^3. Keupayaan galas tanah di bawah dasar tembok adalah 800 kN/m^2 manakala nilai k_1 dan k_2 adalah 2/3. Dengan menggunakan Kaedah Rankine, periksa faktor keselamatan terhadap

(i) gelinciran (5 markah)

(ii) keterbalikan (5 markah)

(iii) keupayaan galas (5 markah)

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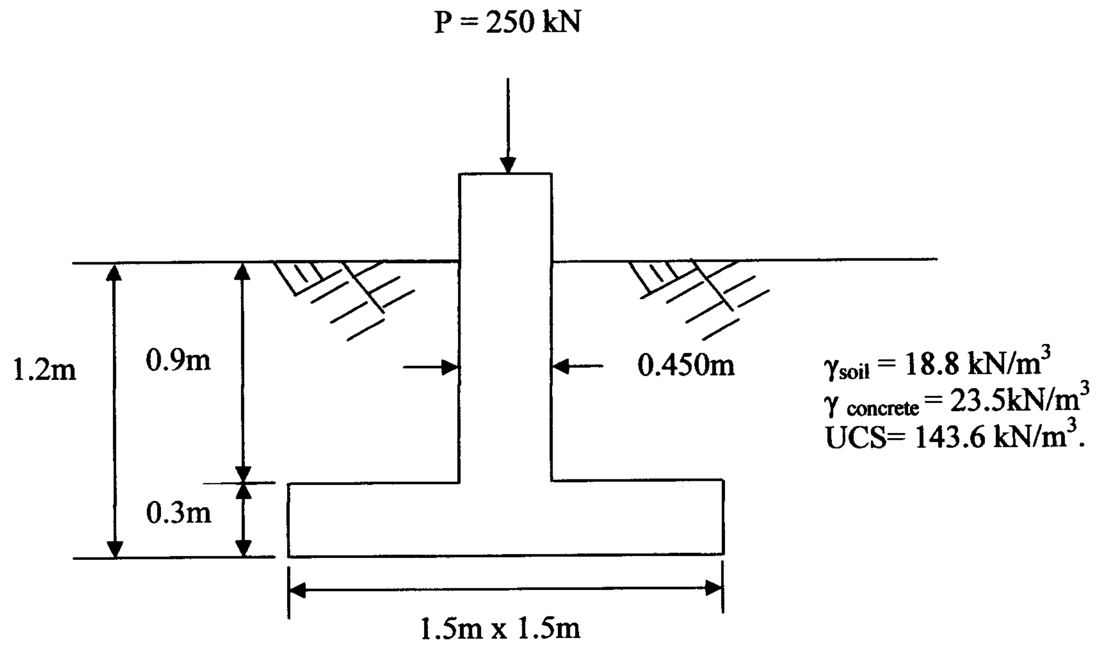

FIGURES Q3(c)

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Table Q1 (a): Variation of á (Interpolated values based on Terzaghi, Peck and Mesri, 1996)

$\frac{c_u}{p_a}$	α
≤ 0.1	1.00
0.2	0.92
0.3	0.82
0.4	0.74
0.6	0.62
0.8	0.54
1.0	0.48
1.2	0.42
1.4	0.40
1.6	0.38
1.8	0.36
2.0	0.35
2.4	0.34
2.8	0.34

Note: p_a = atmospheric pressure $\approx 100\ \text{kN/m}^2$

Table Q1 (b): Variation of ë with pile embedment length, L

Embedment length, L (m)	λ
0	0.5
5	0.336
10	0.245
15	0.200
20	0.173
25	0.150
30	0.136
35	0.132
40	0.127
50	0.118
60	0.113
70	0.110
80	0.110
90	0.110

FIGURE Q4(b)

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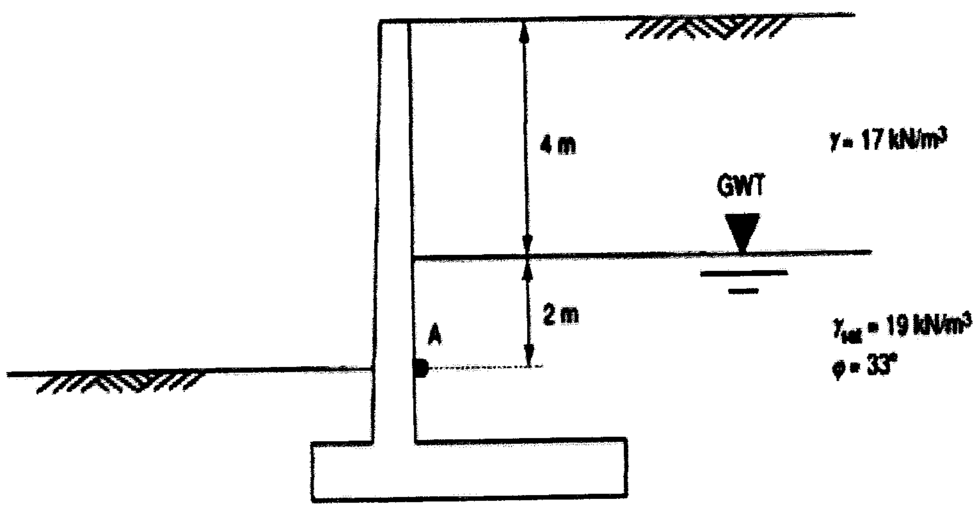

FIGURE Q5: Retaining Wall

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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				

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						

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$$v = \sqrt{\frac{E}{\left(\frac{\gamma}{g}\right)} \frac{(1-\mu)}{(1-2\mu)(1+\mu)}} \qquad Z_1 = \frac{1}{2}\sqrt{\frac{v_2 - v_1}{v_2 + v_1}} x_c$$

$$z_2 = \frac{1}{2}\left[T_{i2} - 2Z_1 \frac{\sqrt{v_3^2 - v_1^2}}{v_3 v_1}\right] \frac{v_3 v_2}{\sqrt{v_3^2 - v_2^2}}$$

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

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

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

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

(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)

(II) depth

if $D_f/B \le 1$

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

if $D_f/B > 1$

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

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

(III) inclination

$$F_{ci} = F_{qi} = \left(1 - \frac{\beta^\circ}{90^\circ}\right)^2 \qquad F_{\gamma i} = \left(1 - \frac{\beta}{\phi}\right)^2 \qquad S_e = A_1 A_2 \frac{q_0 B}{E_s}$$

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λ method:

$$f_{av} = \lambda\left(\overline{\sigma'_o} + 2c'_u\right)$$

$$Q_s = pLf_{av}$$

$$\overline{\sigma'_o} = \frac{A_1 + A_2 + A_3 + \ldots}{L}$$

α method:

$$f = \alpha c_u$$

β method:

$$f = \beta \sigma'_o$$

$$\beta = K \tan \phi'_R$$

$$K = 1 - \sin \phi'_R$$ (For normally consolidated clay)

$$K = (1 - \sin \phi'_R)\sqrt{OCR}$$ (For overconsolidated clay)

$$FS_{(sliding)} = \frac{\left(\sum V\right)\tan(k_1\phi'_2) + Bk_2c'_2 + P_p}{P_a \cos\alpha}$$

$$e = B/2 - \frac{\sum M_R - \sum M_O}{\sum V}$$

$$q_{min,max} = \frac{\sum V}{B}\left(1 \pm \frac{6e}{B}\right)$$

$$K_a = K\alpha\left(\frac{\cos\alpha - \sqrt{\cos^2\alpha - \cos^2\phi'}}{\cos\alpha + \sqrt{\cos^2\alpha - \cos^2\phi'}}\right)$$

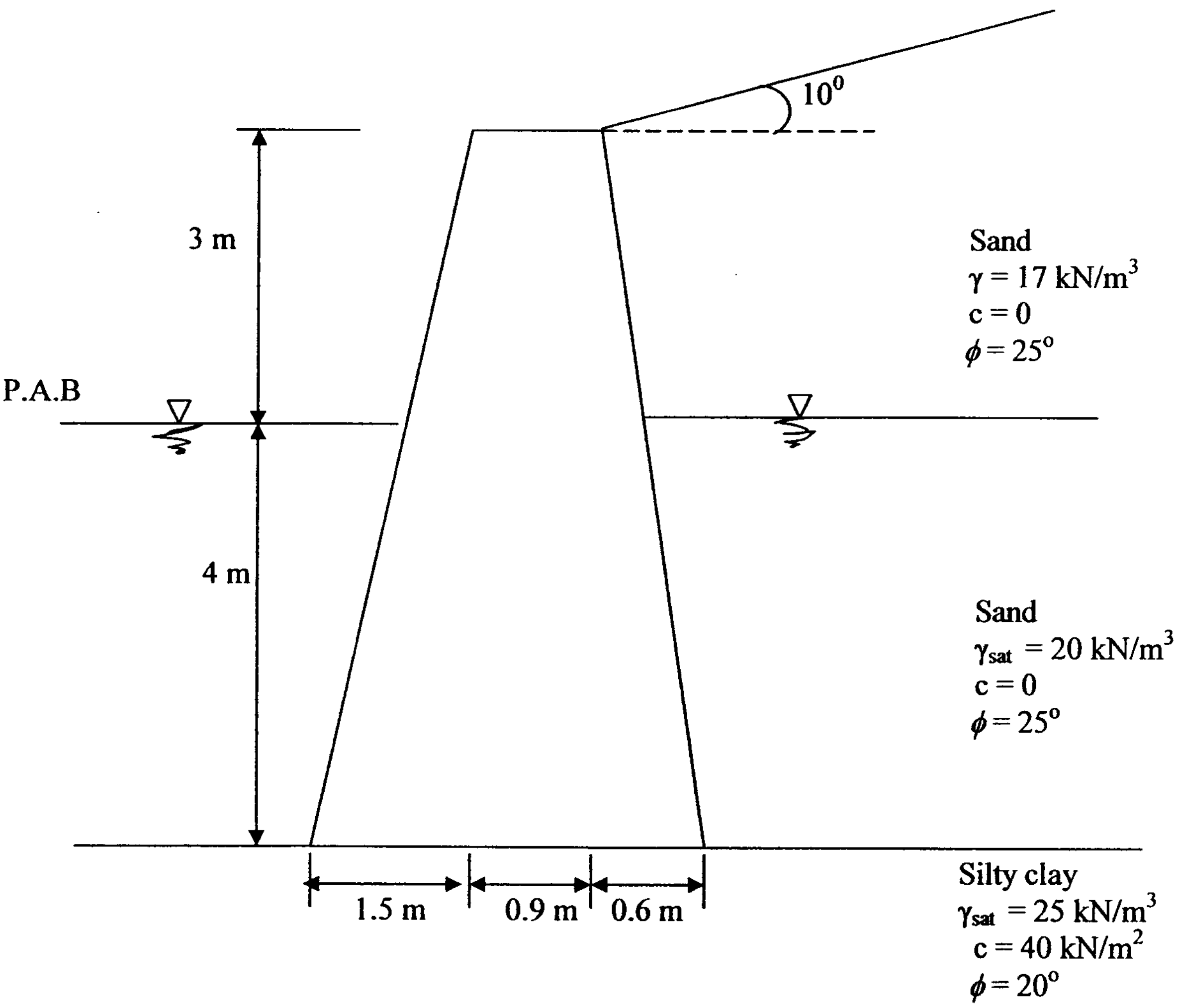

Figure Q5(b) Gravity Retaining Wall