UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2011/2012

COURSE NAME	:	GEOTECHNICS
COURSE CODE	:	BFC 3033/ BFC 31703
PROGRAMME	:	3 BFF
DATE	:	JUNE 2012
DURATION	:	3 HOURS
INSTRUCTIONS	:	ANSWER ANY **FOUR (4)** QUESTIONS

THIS QUESTION PAPER CONSISTS OF TWENTY FIVE (25) PAGES

Q1 (a) A saturated soil has a dry unit weight of 16.2 kN/m^3 and a moisture content of 23%. For the soil, determine,

(i) Saturated unit weight

(ii) Specific gravity

(iii) Void ratio.

(6 marks)

(b) The following results were obtained from a liquid limit test for a soil using the Casagrande cup device (**Table 1**);

Table 1

Number of blows (N)	Moisture content (%)
6	52.5
12	47.1
20	43.2
28	38.6
32	37.0

(i) Determine the liquid limit of the soil

(ii) If the plastic limit was 23% and the natural water content was 38%, calculate the plasticity, the liquidity and the flow indexes of the soil.

(9 marks)

(c) Parameters of a soil are as follows;

Percentage passing No. 10 sieve	=	90
Percentage passing No. 40 sieve	=	38
Percentage passing No. 200 sieve	=	15
Liquid limit (%)	=	23
Plastic limit (%)	=	19

(i) Classify the soil by using the Unified Soil Classification System (USCS) and the American Assoiation of State Highway and Transportation Officials (AASHTO) System

(8 marks)

(ii) Comment on the suitability of this soil to be used as a construction material of a subgrade.

(2 marks)

Q2 (a) There are **TWO (2)** types of flow of water between confined aquifer and unconfined aquifer.

For each type, sketch the complete diagram and equation required.

(5 marks)

(b) In **Figure Q2(b)**, impervious concrete dam with pile structures is shown. Pile structures were installed under the dam with 15 m length.

(i) To complete the graphic construction of a flow net, there are **TWO (2)** rules that we have to obey according to Das (2010). List those **TWO (2)** rules.

(3 marks)

(ii) Complete the flow lines for the water retention structure with the pile structures

(7 marks)

(iii) Calculate the q in mm per day

(4 marks)

(iv) Between Point A, B and C, which are two points that will create the major or higher pore water pressure or the uplift that acting at base of the dam, and along the pile structures?

Determine those major or higher pore water pressure or the uplift that acting at base of the dam, and along the pile structures

(5 marks)

(v) Imagine there is another row of pile structures were installed at point C, what would occur to the numbers of flow channels, N_f and potential drops, N_d.

(1 mark)

Take the permeability of the soil is 1×10^{-5} mm per second.

Q3 (a) In Chapter 3 (three) you have learned the Stress in Soils. Briefly, define how you will construct a pole inside a Mohr's circle. By using simple sketches, shows how those poles are apply in stress analysis.

(5 marks)

(b) The plan of flexible rectangular loaded area is shown in **Figure Q3(b)(i)**. The uniformly distributed load on the flexible area, q, are 250 kN/m^2 on AFGH, and 150 kN/m on DEFC and CAHB.

(i) Determine the increase in the increase in the vertical stress, $\Delta\sigma_z$, at a depth of z = 3.0 m below point B by using Fadum's method.

(7 marks)

(ii) Determine the increase in the increase in the vertical stress, $\Delta\sigma_z$, at a depth of z = 3.0 m below point B by using Boussinesq's method.

(5 marks)

You may refer to **Table 5** on the back page and **Figures Q3(b)(ii)** and **Q3(b)(iii)** to solve this problem.

(c) **Figure Q3(c)** shows a 6.0 m pile structures. The pile is restrained from yielding. The soil parameters are shown in **Table 6** down below. The water level was detected at 4.0 m above the ground at the back side of the pile and 4.5 m above the ground at the front side of the pile.

Table 6

Parameters	Back side	Front side
Soil thickness (m)	2.0	1.5
Uniform loads, q (kN/m^2)	75	0
Saturated unit weight of soil, γ_{sat} (kN/m^3)	19	19
Soil internal friction angle, ϕ' (°)	28	28
Soil cohesion, c (kN/m^2)	15	15

Determine Rankine active and passive force per unit length of the pile.

(8 marks)

Q4 (a) Shear strength of soils can be determined in the laboratory and in-situ. Describe **ONE (1)** of the commonly used method to determine the shear strength for both the laboratory and the in-situ.

(8 marks)

(b) A consolidated undrained triaxial test on a normally consolidated clay yielded the following results:

Chamber confining pressure	=	100 kPa
Deviator stress at failure	=	80 kPa
Pore pressure at failure	=	50 kPa

Determine the total and the effective internal friction angle of the soil.

(12 marks)

(c) A consolidated drained triaxial test was conducted on a normally consolidated clay. Plot the stress path diagram (p' versus q') and indicate on the diagram the ϕ' and the α.

(5 marks)

Q5 (a) Describe, wherever necessary with the aid of sketches, the following terms that were used to determine the primary consolidation settlement,

(i) Compression index, C_c
(ii) Coefficient of compressibility, a_v
(iii) Preconsolidation stress, σ_c
(iv) Overconsolidation ratio, OCR.

(8 marks)

(b) A soil profile is as shown in **Figure Q3(b)**. Results of a laboratory consolidation test conducted on a specimen collected from the middle of the clay layer are as shown in the **Figure Q3(b)**. Calculate the primary consolidation settlement of the clay layer if a uniformly distributed load, q, of 100 kPa is applied at the ground surface if,

(i) the clay is normally consolidated

(ii) the clay is overconsolidated with an over consolidation ratio of 1.4

(12 marks)

(c) During the construction of the major roads at UTHM new campus in Parit Raja, surcharge loads and vertical drains were used. Discuss the advantage of using these techniques.

(5 marks)

Q6 A soil slope will be made in a laterite soil in Southern of Johor. **Figure Q6(a)** shows some parts of Johor's area. With a plan that will be develops, those slope is assumed to be deforms, which is from its original slope (**Figure Q6(b)**), either in **Figures Q6(c)** or **Q6(d)**. From a soil investigation that has been carried out, parameters of soil for the stability analysis purposes as such:-

Table 7

Parameters	**Figure Q6(b)**	**Figure Q6(c)**	**Figure Q6(d)**
Soil cohesion, c (kN/m^2)	18.5	18.5	18.5
Soil internal friction angle, ϕ (°)	0	0	0
Radius of the circle, R (m)	10	10	10
The angle covered in a failure circle, θ (°)	121	121	121
Gravity centre of the sliding mass, G (m)	3	3	3.25
Unit weight of soil, γ (kN/m^3)	19.75	19.75	19.75
The area within the failure circle, A (m^2)	67	67	61
Storage uniform loads at the downstream of the slope (kN/m^2)	Nil	50	50
Gravity centre of the storage uniform loads (m)	Nil	5.5	5.5

As an engineer, you have to:

(a) Determine the factor of safety for the **Figure Q6(b)** by using effective and total stress method.

(5 marks)

(b) To improve the slope instability in **Figure Q6(b)**, there are several methods can apply. There are either by placing a uniform loads at the toe as showed in **Figure Q6(c)**, or placing a uniform loads at the toe together with excavation on the slope itself as showed in **Figure Q6(d)**.

(i) Between by placing a uniform loads at the toe as showed in **Figure Q6(c)**, or placing a uniform loads at the toe together with excavation on the slope itself as showed in **Figure Q6(d)**, which one will shows a higher of factor of safety value? Briefly explains why.

(3 marks)

(ii) Based on the answer on **Q6(b)(i)**, determine its factor of safety by using effective and total stress method.

(7 marks)

(iii) Based on the calculated answer on **Q6(b)(ii)**, if the designated slopes that require to fulfill in a permanent excavated slope, what is the cohesion of the soil that have to be for that slope. Take $F_{s\ permanent} = 1.40$

(6 marks)

(c) Based on the analysis that has been made, it can be assumed that its only safe based on the critical or short term stability only. For a long term stability, lists out **FOUR (4)** methods or approaches that can be implied on these slope.

(4 marks)

Effective and total stress method, the general factor of safety, $F_s = cR^2\theta/Wx$.

S1 (a) Suatu tanah tepu sepenuhnya mempunyai berat unit kering bernilai 16.2 kN/m^3 dan kandungan lembapan bernilai 23%. Untuk tanah berkenaan, tentukan,

(i) Berat unit tepu

(ii) Graviti tentu

(iii) Nisbah lompang.

(6 markah)

(b) Berikut adalah keputusan yang diperolehi dari ujikaji penentuan had cecair untuk sesuatu tanah mengunakan peranti Casagrande (**Jadual 1**);

Jadual 1

Number of blows (N)	Moisture content (%)
6	52.5
12	47.1
20	43.2
28	38.6
32	37.0

(i) Tentukan had cecair tanah berkenaan

(ii) Jika had plastik tanah berkenaan ialah 23% dan kandungan lembapan biasa ialah 38%, kirakan indeks keplastikan, kececairan dan aliran bagi tanah berkenaan.

(9 markah)

(c) Parameter sesuatu sampel tanah adalah seperti berikut;

Peratus lulus ayak No. 10	=	90
Peratus lulus ayak No. 40	=	38
Peratus lulus ayak No. 200	=	15
Had cecair (%)	=	23
Had plastik (%)	=	19

(i) Kelaskan tanah berkenaan menggunakan Sistem Pengkelasan Tanah Bersekutu (USCS) dan Sistem Pengkelasan Pertubuhan Pegawai-pegawai Lebuhraya Persekutuan dan Pengangkutan Amerika (AASHTO)

(8 markah)

(ii) Komen tentang kesesuaian tanah ini digunakan sebagai bahan pembinaan dalam subgred.

(2 markah)

S2 (a) Ada **DUA (2)** jenis aliran air ke dalam telaga pengepaman, samada akuifer terkukuh dan akuifer tak terkukuh.

Bagi setiap jenis, lakarkan rajah sepenuhnya dan persamaan yang berkaitan.

(5 markah)

(b) Dalam **Rajah Q2(b)** menunjukkan empangan dengan struktur cerucuk di bawah dasarnya. Cerucuk-cerucuk tersebut ditanam sedalam 15 m panjang.

(i) Untuk menyempurkan binaan grafik jejaring aliran, terdapat **DUA (2)** syarat yang perlu kita patuhi menurut Das (2010). Senaraikan **DUA (2)** syarat tersebut

(3 markah)

(ii) Lengkapkan garisan aliran bagi empangan bercerucuk tersebut

(7 markah)

(iii) Kirakan q dalam mm per hari

(4 markah)

(iv) Antara Titik A, B dan C, yang manakah dua titik yang akan memberikan tekanan air liang atau tegasan angkatan yang paling tinggi atau major yang bertindak di sepanjang dasar empangan, dan di sepanjang cerucuk tersebut?

Tentukan tekanan air liang atau tegasan angkatan yang paling tinggi atau major yang bertindak di sepanjang dasar empangan, dan di sepanjang cerucuk tersebut.

(5 markah)

(v) Bayangkan terdapat sebaris struktur cerucuk ditanam pada titik C. Apakah yang akan berlaku kepada jumlah saluran aliran, N_f dan susut upaya, N_d.

(1 markah)

Ambil nilai kebolehtelapan tanah tersebut dengan 1×10^{-5} mm per saat.

S3 (a) Dalam Bab 3 (tiga), anda telah mempelajari Tegasan di dalam Tanah. Secara ringkas, nyatakan bagaimana anda membina kutub di dalam bulatan Mohr. Dengan menggunakan lakaran mudah, tunjukkan bagaimana kutub ini digunakan dalam analisis tegasan.

(5 markah)

(b) Satu pandangan pelan bagi segiempat tepat terbeban boleh lentur ditunjukkan dalam **Rajah Q3(b)(i)**. Beban teragih seragam yang dibebankan ke atas luas boleh lentur, q, tersebut adalah 250 kN/m^2 pada pelan AFGH, dan 150 kN/m pada pelan DEFC dan CAHB.

(i) Tentukan pertambahan dalam tegasan menegak, $\Delta\sigma_z$, pada kedalaman z = 3.0 m di bawahn titik B menggunakan kaedah Fadum

(7 markah)

(ii) Tentukan pertambahan dalam tegasan menegak, $\Delta\sigma_z$, pada kedalaman z = 3.0 m di bawahn titik B menggunakan kaedah Boussinesq.

(5 marks)

Anda boleh merujuk **Jadual 5** dan **Rajah Q3(b)(ii)** dan **Q3(b)(iii)** untuk menyelesaikan masalah ini.

(c) **Rajah Q3(c)** menunjukkan struktur cerucuk yang berketinggian 6.0 m. Cerucuk tersebut dihalang daripada mengalami alahan. Parameter tanah ditunjukkan dalam **Jadual 6** di bawah. Aras airbumi didapati berada 4.0 m di atas tanah di bahagian belakang cerucuk, manakala 4.5 m di atas tanah di bahagian depan cerucuk.

Jadual 6

Parameter	Bahagian belakang	Bahagian depan
Ketebalan tanah (m)	2.0	1.5
Beban teragih seragam, q (kN/m^2)	75	0
Unit berat tepu tanah, γ_{sat} (kN/m^3)	19	19
Sudut geseran tanah, ϕ' (°)	28	28
Sudut kelejeketan tanah, c (kN/m^2)	15	15

Tentukan jumlah daya aktif dan pasif Rankine per unit panjang cerucuk tersebut.

(8 markah)

S4 (a) Kekuatan tanah boleh ditentukan di makmal atau di tapak bina. Terangkan **SATU (1)** kaedah yang biasa digunakan untuk menentukan kekuatan tanah bagi setiap tempat iaitu dimakmal dan ditapak bina

(8 markah)

(b) Satu ujikaji tiga paksi terkukuh tak tersalir keatas tanah liat terkukuh biasa telah menghasilkan keputusan seperti berikut;

Tekanan kurungan sel	=	100 kPa
Tegasan sisih ketika gagal	=	80 kPa
Tekanan air liang ketika gagal	=	50 kPa

Tentukan sudut geseran dalam kesan dan jumlah untuk tanah tersebut.

(12 markah)

(c) Suatu ujikaji tiga paksi terkukuh tersalir telah dijalankan keatas tanah liat terkukuh biasa. Plot rajah laluan tegasan (p' berbanding q') dan tunjukkan diatas rajah berkenaan sudut-sudut Φ' dan α.

(5 markah)

S5 (a) Terangkan, di mana perlu menggunakan lakaran-lakaran, istilah-istilah berikut yang digunakan bagi menentukan pengenapan pengukuhan primer;

(i) Index mampatan, C_c
(ii) Pekali ketermampatan, a_v
(i) Tegasan prapengukuhan, σ_c
(ii) Nisbah terkukuh lebih, OCR.

(8 markah)

(b) Suatu profail tanah adalah seperti yang ditunjukkan dalam **Rajah Q5(b)**. Keputusan-keputusan ujikaji pengukuhan yang dilakukan keatas sampel tanah yang diambil dari tengah-tengah lapisan tanah liat adalah seperti yang ditunjukkan diatas rajah berkenaan. Kira pengeapan pengukuhan primer jika beban teragih seragam, q, bernilai 100 kPa dikenakan diatas permukaan tanah dan jika;

(i) tanah liat berkenaan ialah tanah terkukuh biasa
(ii) tanah liat berkenaan ialah tanah terkukuh lebih dan nisbah terkukuh lebih ialah 1.4.

(12 markah)

(c) Semasa pembinaan jalan-jalan utama di kampus baru UTHM di Parit Raja, beban surcaj dan aliran pugak telah digunakan. Bincangkan kelebihan pengunaan teknik-teknik ini.

(5 markah)

S6 Sebuah cerun telah dipotong di satu kawasan tanah laterit di Selatan Johor. **Rajah Q6(a)** menunjukkan sebahagian peta bagi kawasan Johor. Dengan perancangan yang akan dijalankan, cerun tersebut dijangka akan berubah bentuk, iaitu daripada cerun asal (**Rajah Q6(b)**), samada dalam bentuk **Rajah Q6(c)** atau Rajah **Q6(d)**.Daripada penyiasatan tapak yang dijalankan, didapati parameter untuk tujuan analisis kestabilan cerun ialah:-

Jadual 7

Parameter	**Rajah Q6(b)**	**Rajah Q6(c)**	**Rajah Q6(d)**
Kejeleketan tanah, c (kN/m^2)	18.5	18.5	18.5
Sudut geseran tanah, ϕ (°)	0	0	0
Jejari pusat bulatan, R (m)	10	10	10
Sudut yang tercangkum dalam bulatan kegagalan, θ (°)	121	121	121
Pusat graviti bagi jisim gelangsar, G (m)	3	3	3.25
Unit berat tanah, γ (kN/m^3)	19.75	19.75	19.75
Luas kawasan dalam bulatan kegagalan, A (m^2)	67	67	61
Beban stor simpanan bahan di bahagian hilir (kN/m^2)	Nil	50	50
Pusat graviti bagi beban stor simpanan bahan (m)	Nil	5.5	5.5

Sebagai seorang jurutera,

(a) Kirakan faktor keselamatan bagi Rajah **Q6(b)** dengan menggunakan kaedah tegasan jumlah dan berkesan.

(5 markah)

(b) Bagi memperbaiki ketakstabilan cerun dalam **Rajah Q6(b)**, terdapat beberapa kaedah boleh digunakan. Kaedah tersebut adalah samada meletakkan beban teragih seragam di kaki cerun tersebut seperti yang ditunjukkan di dalam **Rajah Q6(c)**, ataupun gabungan beban teragih seragam di kaki cerun bersama dengan pengorekan pada cerun seperti yang ditunjukkan dalam **Rajah Q6(c)**.

(i) Samada meletakkan beban teragih seragam di kaki cerun tersebut seperti yang ditunjukkan di dalam **Rajah Q6(c)**, ataupun gabungan beban teragih seragam di kaki cerun bersama dengan pengorekan pada cerun seperti yang ditunjukkan dalam **Rajah Q6(c)**, yang mana satukah akan memberikan nilai faktor keselamatan yang paling tinggi? Jelaskan secara ringkas mengapa.

(3 markah)

(ii) Berdasarkan jawapan pada **Q6(b)(i)**, tentukan faktor keselematan cerun yang dipilih dengan menggunakan kaedah jumlah tegasan dan berkesan.

(7 markah)

(iii) Berdasarkan kepada kiraan jawapan pada **Q6(b)(ii)**, jika cerun anda perlu memenuhi syarat daam nilai faktor keselamatan bagi cerun potongan kekal (FS = 1.40), apakah nilai kejeleketan tak tersalir, c_u, cerun tanah tersebut.

(8 marks)

(c) Berdasarkan kepada F_s yang telah anda analisis, didapati ianya adalah selamat berdasarkan nilai F_s yang kritikal sahaja. Bagi tujuan cerun potongan kekal, senaraikan **EMPAT (4)** langkah/kaedah yang boleh digunakan supaya ia selamat.

(4 markah)

Gunakan kaedah tegasan jumlah, dan persamaannya ialah $F_s = cR^2\theta/Wx$.

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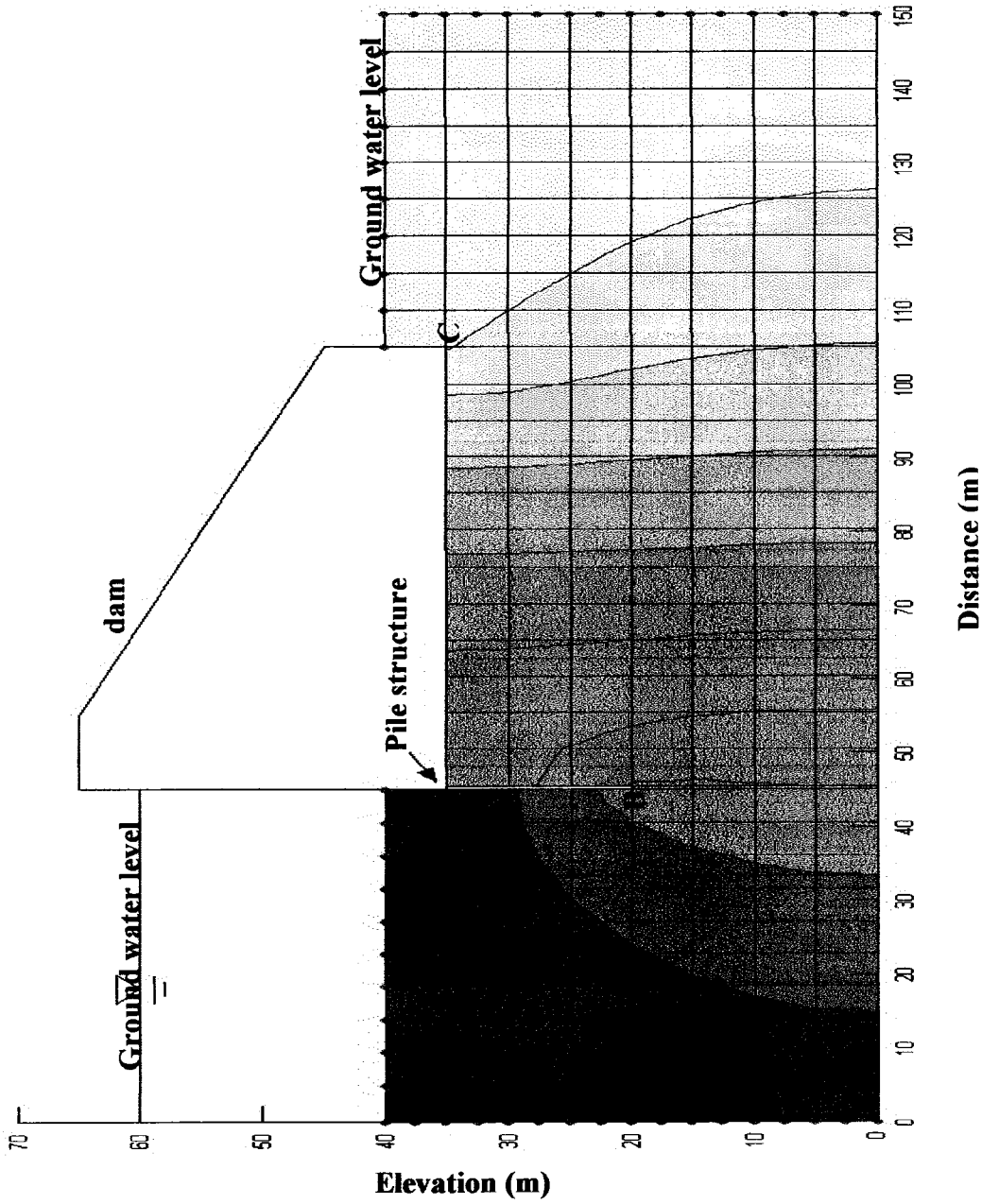

FIGURE Q2(B)

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TABLE 2: AASHTO CLASSIFICATION SYSTEM

General Classification	Granular Materials (35% or less passing the 0.075 mm sieve)						
Group Classification	A-1		A-3	A-2			
	A-1-a	A-1-b		A-2-4	A-2-5	A-2-6	A-2-7
Sieve Analysis, % passing							
2.00 mm (No. 10)	50 max	...	...	...	...	...	...
0.425 (No. 40)	30 max	50 max	51 min	...	...	...	...
0.075 (No. 200)	15 max	25 max	10 max	35 max	35 max	35 max	35 max
Characteristics of fraction passing 0.425 mm (No. 40)							
Liquid Limit	...		...	40 max	41 min	40 max	41 min
Plasticity Index	6 max		N.P.	10 max	10 max	11 min	11 min
Usual types of significant constituent materials	stone fragments, gravel and sand		fine sand	silty or clayey gravel and sand			
General rating as a subgrade	excellent to good						

Note (1): Plasticity index of A-7-5 subgroup is equal to or less than the LL - 30. Plasticity index of A-7-6 subgroup is greater than LL - 30

GI for A-2-6 and A-2-7: $0.01(F_{200} - 15)(PI - 10)$, and for other group classifications are $(F_{200} - 35)(0.2 + 0.005(LL - 40)] + 0.01(F_{200} - 15)(PI - 10)$

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TABLE 3: AASHTO CLASSIFICATION SYSTEM

General Classification	**Silt-Clay Materials (>35% passing the 0.075 mm sieve)**			
Group Classification	A-4	A-5	A-6	A-7 A-7-5 A-7-6
Sieve Analysis, % passing				
2.00 mm (No. 10)	...	...	...	...
0.425 (No. 40)	...	...	...	...
0.075 (No. 200)	36 min	36 min	36 min	36 min
Characteristics of fraction passing 0.425 mm (No. 40)				
Liquid Limit	40 max	41 min	40 max	41 min
Plasticity Index	10 max	10 max	11 min	11 min[1]
Usual types of significant constituent materials	silty soils		clayey soils	
General rating as a subgrade	fair to poor			

Note (1): Plasticity index of A-7-5 subgroup is equal to or less than the LL - 30. Plasticity index of A-7-6 subgroup is greater than LL - 30

GI for A-2-6 and A-2-7: $0.01(F_{200} - 15)(PI - 10)$, and for other group classifications are $(F_{200} - 35)(0.2 + 0.005(LL - 40)] + 0.01(F_{200} - 15)(PI - 10)$

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TABLE 4: USCS CLASSIFICATION SYSTEM

UNIFIED SOIL CLASSIFICATION AND SYMBOL CHART			
COARSE-GRAINED SOILS (more than 50% of material is larger than No. 200 sieve size.)			
GRAVELS More than 50% of coarse fraction larger than No. 4 sieve size	Clean Gravels (Less than 5% fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines
		GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines
	Gravels with fines (More than 12% fines)	GM	Silty gravels, gravel-sand-silt mixtures
		GC	Clayey gravels, gravel-sand-clay mixtures
SANDS 50% or more of coarse fraction smaller than No. 4 sieve size	Clean Sands (Less than 5% fines)	SW	Well-graded sands, gravelly sands, little or no fines
		SP	Poorly graded sands, gravelly sands, little or no fines
	Sands with fines (More than 12% fines)	SM	Silty sands, sand-silt mixtures
		SC	Clayey sands, sand-clay mixtures
FINE-GRAINED SOILS (50% or more of material is smaller than No. 200 sieve size.)			
SILTS AND CLAYS Liquid limit less than 50%		ML	Inorganic silts and very fine sands, rock flour, silty of clayey fine sands or clayey silts with slight plasticity
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
		OL	Organic silts and organic silty clays of low plasticity
SILTS AND CLAYS Liquid limit 50% or greater		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
		CH	Inorganic clays of high plasticity, fat clays
		OH	Organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS		PT	Peat and other highly organic soils

LABORATORY CLASSIFICATION CRITERIA		
GW	$C_U = \frac{D_{60}}{D_{10}}$ greater than 4; $C_C = \frac{D_{30}}{D_{10} \times D_{60}}$ between 1 and 3	
GP	Not meeting all gradation requirements for GW	
GM	Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
GC	Atterberg limits above "A" line with P.I. greater than 7	
SW	$C_U = \frac{D_{60}}{D_{10}}$ greater than 4; $C_C = \frac{D_{30}}{D_{10} \times D_{60}}$ between 1 and 3	
SP	Not meeting all gradation requirements for GW	
SM	Atterberg limits below "A" line or P.I. less than 4	Limits plotting in shaded zone with P.I. between 4 and 7 are borderline cases requiring use of dual symbols.
SC	Atterberg limits above "A" line with P.I. greater than 7	

Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows:

Less than 5 percent ..... GW, GP, SW, SP
More than 12 percent ..... GM, GC, SM, SC
5 to 12 percent ..... Borderline cases requiring dual symbols

PLASTICITY CHART

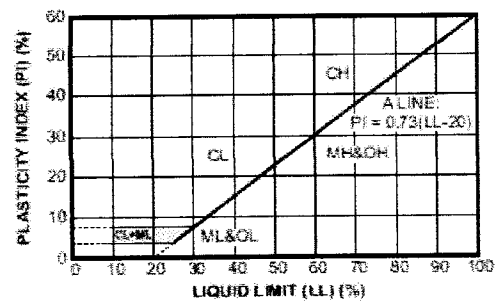

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TABLE Q1(D): USCS CLASSIFICATION SYSTEM

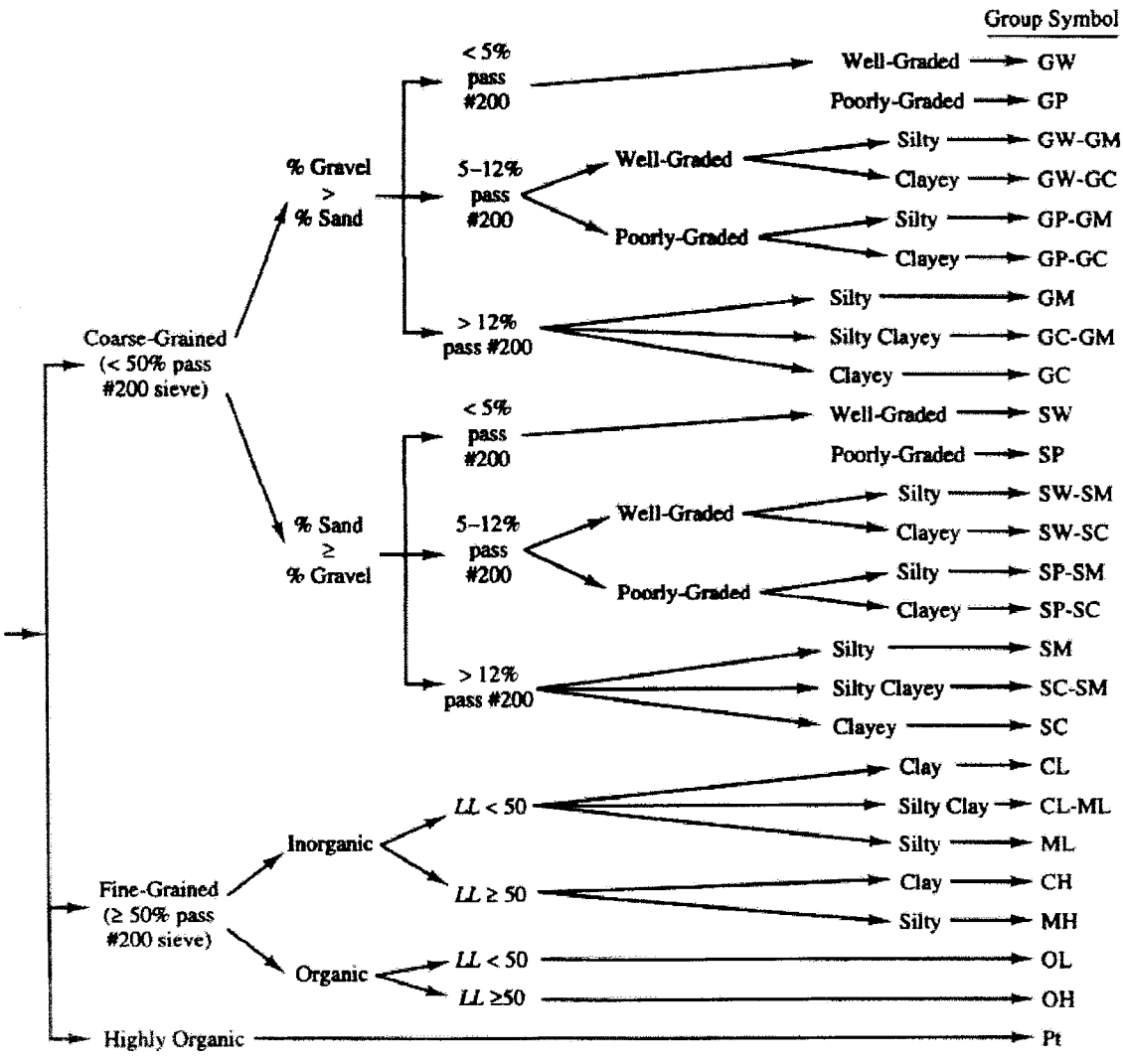

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TABLE 5: FADUM'S METHOD

B/z \ L/z	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.4	2.0	3.0	5.0	∞
0.1	0.0047	0.0092	0.0132	0.0168	0.0198	0.0222	0.0242	0.0258	0.0270	0.0279	0.0301	0.0311	0.0315	0.0316	0.0316
0.2	0.0092	0.0179	0.0259	0.0328	0.0387	0.0435	0.0474	0.0504	0.0528	0.5470	0.0589	0.6100	0.0620	0.0620	0.0620
0.3	0.0132	0.0259	0.0374	0.0474	0.5600	0.0630	0.0686	0.0731	0.0765	0.0794	0.0856	0.0887	0.0898	0.0901	0.0902
0.4	0.0168	0.0328	0.0474	0.0602	0.0711	0.0801	0.0873	0.0931	0.0977	0.1013	0.1094	0.1134	0.1150	0.1154	0.1154
0.5	0.0198	0.0387	0.0560	0.0711	0.0840	0.9470	0.1034	0.1104	0.1158	0.1202	0.1300	0.1350	0.1368	0.1374	0.1375
0.6	0.0222	0.0435	0.0629	0.0801	0.0947	0.1069	0.1168	0.1247	0.1310	0.1361	0.1475	0.1533	0.1555	0.1561	0.1562
0.7	0.0240	0.0474	0.0686	0.8730	0.1034	0.1168	0.1277	0.1365	0.1436	0.1491	0.1620	0.1686	0.1711	0.1719	0.1720
0.8	0.2580	0.0504	0.0731	0.0931	0.1104	0.1247	0.1365	0.1461	0.1537	0.1598	0.1739	0.1812	0.1841	0.1849	0.1850
0.9	0.0270	0.0528	0.0766	0.0977	0.1158	0.1311	0.1436	0.1537	0.1619	0.1684	0.1836	0.1915	0.1947	0.1956	0.1958
1.0	0.0279	0.0547	0.0794	0.1013	0.1202	0.1361	0.1491	0.1598	0.1684	0.1752	0.1914	0.1999	0.2034	0.2044	0.2046
1.4	0.0301	0.0589	0.0856	0.1094	0.1300	0.1475	0.1620	0.1739	0.1836	0.1914	0.2102	0.2206	0.2250	0.2263	0.2266
2.0	0.0311	0.0610	0.0887	0.1134	0.1350	0.1533	0.1686	0.1812	0.1915	0.1999	0.2206	0.2325	0.2378	0.2395	0.2399
3.0	0.0315	0.0618	0.0898	0.1150	0.1368	0.1555	0.1711	0.1841	0.1947	0.2034	0.2250	0.2378	0.2420	0.2461	0.2465
5.0	0.0316	0.0620	0.0901	0.1154	0.1374	0.1561	0.1719	0.1849	0.1956	0.2044	0.2263	0.2395	0.2461	0.2486	0.2491
∞	0.0316	0.0620	0.0902	0.1154	0.1375	0.1562	0.1720	0.1850	0.1958	0.2046	0.2266	0.2399	0.2465	0.2492	0.2500

$\sigma_z = q I_\sigma$

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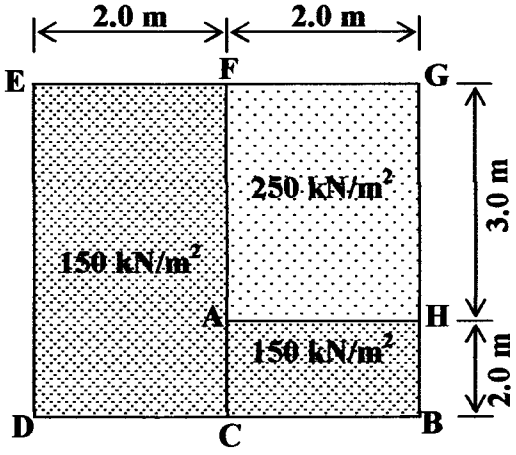

FIGURE Q3(b)(i)

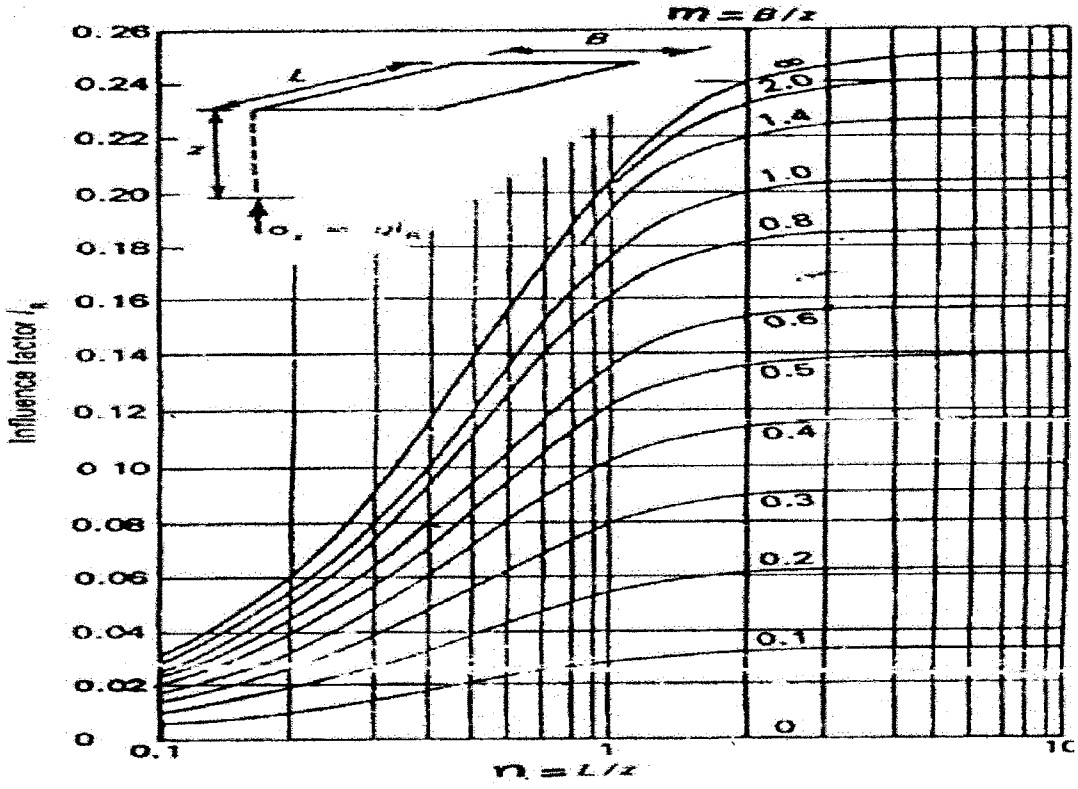

FIGURE Q3(b)(ii): FADUM'S METHOD

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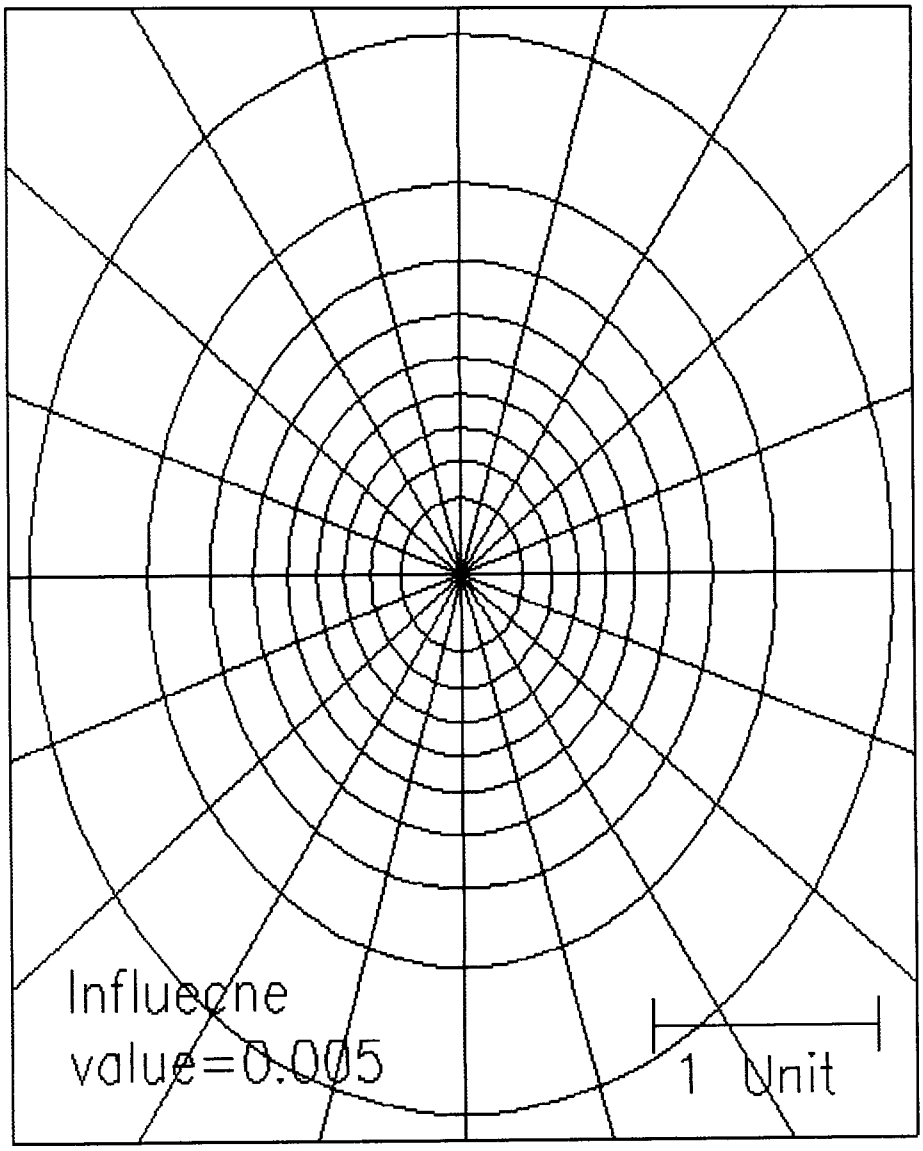

FIGURE Q3(b)(iii): BOUSSINESQ'S METHOD

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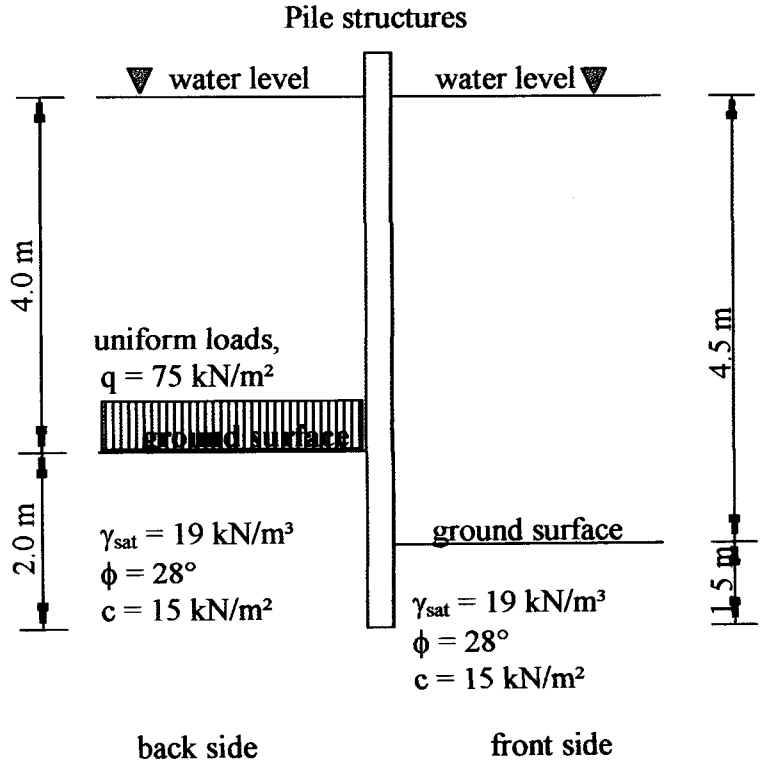

FIGURE Q3(c): WATER FRONT PILE STRUCTURE

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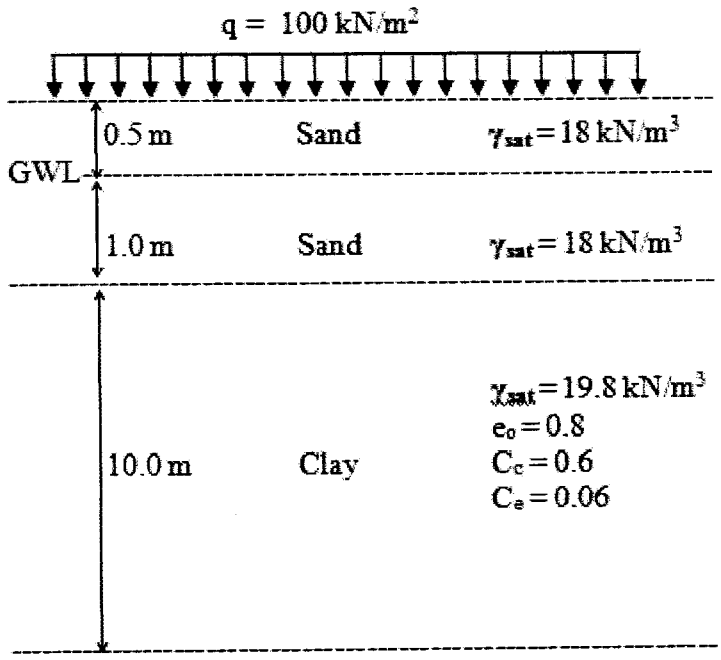

FIGURE Q5(B)

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FIGURE Q6(a)

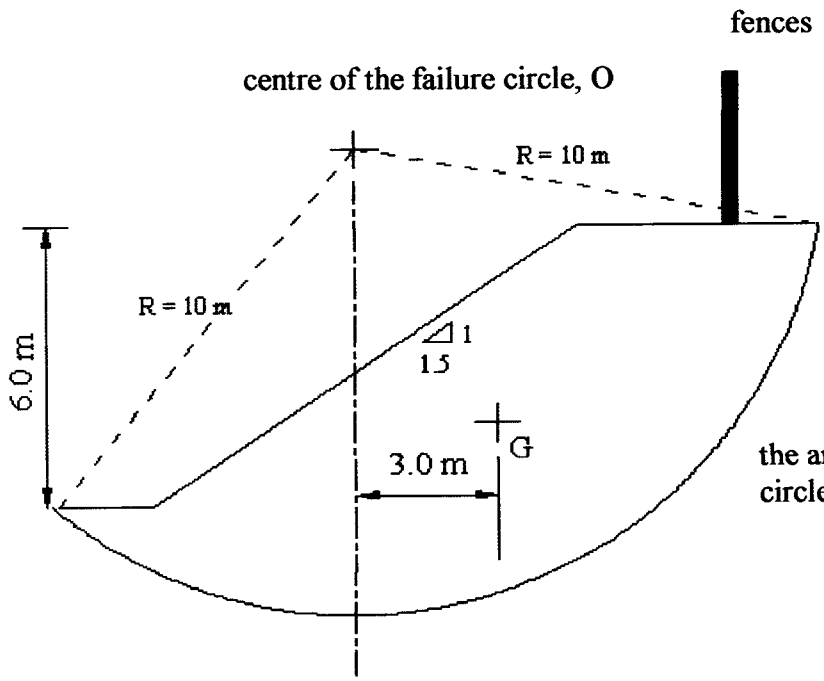

FIGURE Q6(b)

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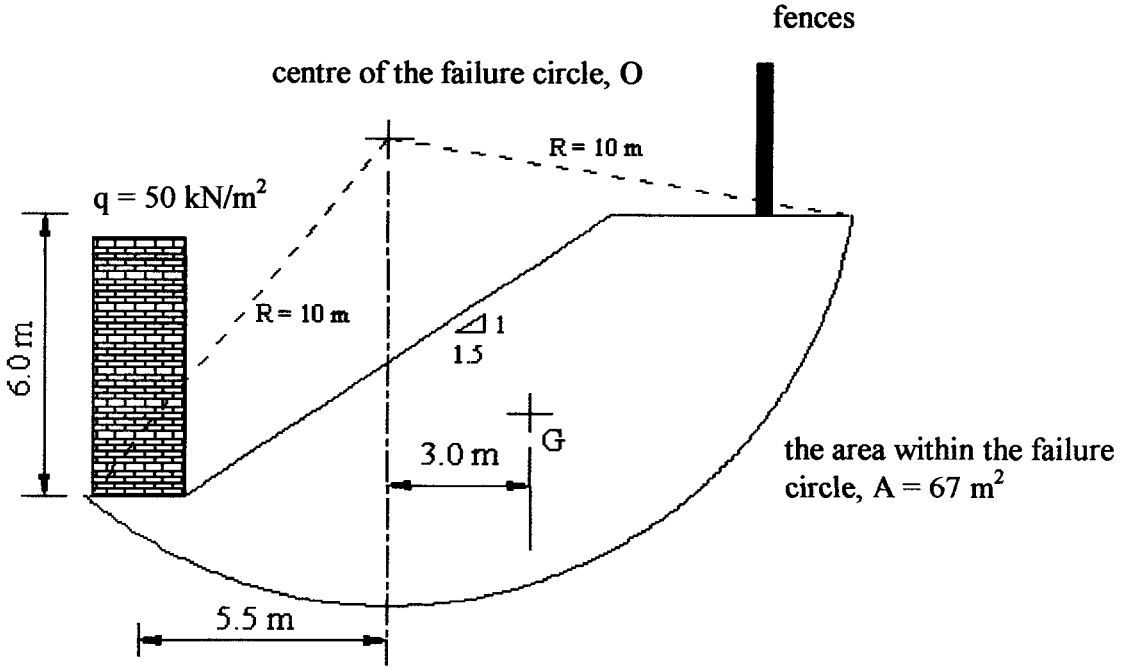

FIGURE Q6(c)

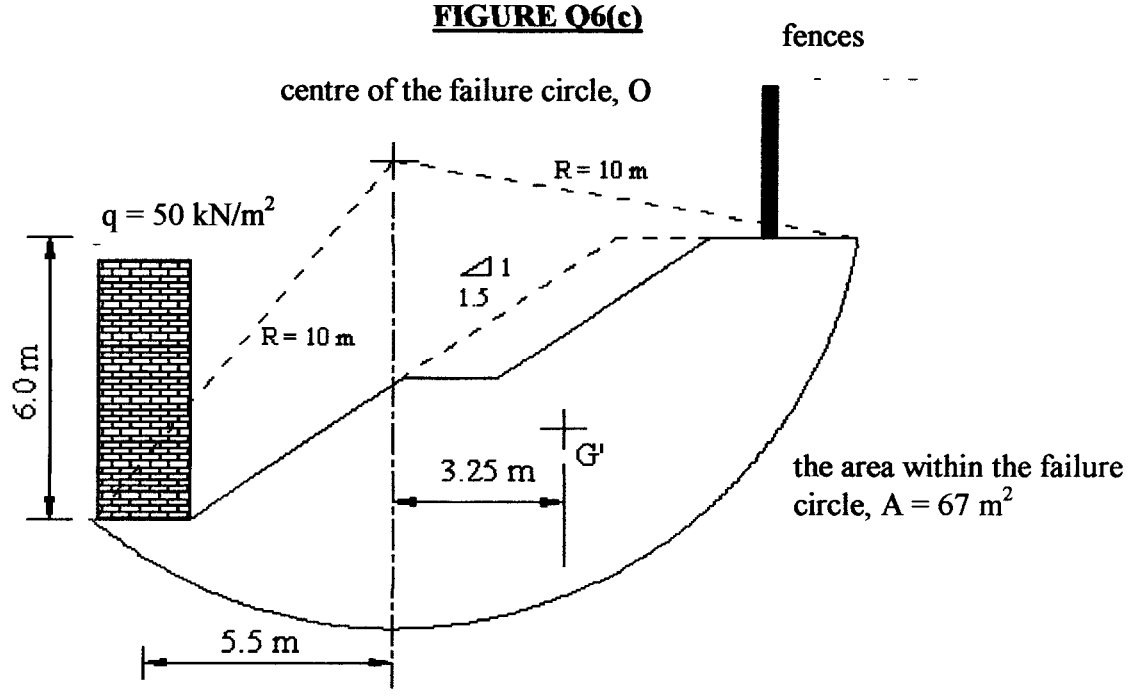

FIGURE Q6(d)