UNIVERSITI SAINS MALAYSIA

First Semester Examination
2011/2012 Academic Session

January 2012

EAG 345/3 – Geotechnical Analysis
[*Analisis Geoteknik*]

Duration : 3 hours
[*Masa : 3 jam*]

Please check that this examination paper consists of **SEVENTEEN (17)** pages of printed material including appendices before you begin the examination.
[*Sila pastikan bahawa kertas peperiksaan ini mengandungi **TUJUH BELAS (17)** muka surat yang bercetak termasuk lampiran sebelum anda memulakan peperiksaan ini.*]

Instructions : This paper contains **SIX (6)** questions. Answer **FIVE** questions.
[***Arahan** : Kertas ini mengandungi **ENAM (6)** soalan. Jawab **LIMA** soalan.*

You may answer the question either in Bahasa Malaysia or English.
[*Anda dibenarkan menjawab soalan sama ada dalam Bahasa Malaysia atau Bahasa Inggeris*].

All questions **MUST BE** answered on a new page.
[*Semua soalan **MESTILAH** dijawab pada muka surat baru*].

In the event of any discrepancies, the English version shall be used.
[*Sekiranya terdapat percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah diguna pakai*].

1. (a) A new embankment in Kerian irrigation scheme is proposed to consist of a homogeneous clay. The new embankment may become saturated by seepage during a prolonged high water level. If subsequently, the water level in the channel is drawn down faster than the pore water can escape, excess pore water pressures will result. One of the critical situations is the possible failure of the embankment due to the reduced in stability. As the geotechnical engineer involved in this project, you are required to determine the shear strength of the soil from triaxial test for the stability of the embankment. Determine the type of triaxial test that is most suitable for the above purpose and explain the reasons behind the selection.

[4 marks]

(b) An elevated water tower at a height sufficient to pressurize a water distribution system is planned to sit on a rock foundation. This structure will impose a normal effective stress of 250 kPa and a shear stress of 80 kPa on a fracture plane underneath the foundation inclined at 60^o to the horizontal. The friction angle of rock at the fracture surface is 30^o.

(i) Determine whether the fracture will fail in shear under the above condition. Use sketches to support your answer.

(ii) Calculate the factor of safety against failure due to sliding of the plane.

[6 marks]

(c) The following results were obtained from the consolidated-undrained tests carried out on a clay soil that is the foundation material for the new embankment in Kerian irrigation scheme.

Table 1

$\sigma_{3\ f}$ kPa	$\sigma_1 - \sigma_{3\ f}$ kPa	Δu_f kPa
400	431	111
500	520	160
700	587	322

(i) Plot the Mohr's circle for effective stress from the above data.

(ii) With the maximum confining pressure at the depth of interest is 400 kPa, determine the shear strength parameters to be used for the analyses.

[10 marks]

2. (a) List down **SIX (6)** main objectives of soil investigations for any civil engineering project.

[3 marks]

(b) Describe all stages of site investigation to be carried out prior to the start of any civil engineering construction.

[5 marks]

(c) Provide a proper and detail bore log based on the following information as obtained from a boring carried out for a proposed development at Transkrian, Pulau Pinang.

[12 marks]

Item	Depth of The Sample (m)	No. of Blows, N	Penetration Depth (mm)	Soil Classifications
1	1.5	1-2-2-2-4-6		Brown fine to medium sand
2	3.0	3-4-6-7-8-9		Brown fine to medium sand
3	4.5	5-6-6-8-9-10		Brown fine to medium sand in upper part samples : red-brown clay in lower part of sample
4	6.0	4-5-6-9-11-10		Red brown clay
5	7.5	4-6-8-9-12-11		Red brown clay
6	9.0	7-9-10-12-20-8	250	Grey fine to coarse sand, silt and clay, occasionally gravel
7	10.5	10-12-12-19-19	180	Grey fine to coarse sand, silt and clay, occasionally gravel
8	12.0	16-19-28-22	100	

3. (a) Having understood the importance of suction in enhancing the soil shear strength and thus maintaining the stability of slopes in unsaturated residual soils, explain briefly how the rainfall can affect the stability of slopes.

[4 marks]

(b) In the construction of earth dam, it must be safe against embankment failure for all operating conditions. There are four (4) generally recognized critical stages based on pore pressure conditions for which the stability of the embankment should be ascertained. Name and explain briefly these four (4) situations.

[4 marks]

(c) A contractor attempts to cut a slope in soft clay with an angle of 60^o for a temporary excavation in the hillside of a housing sub-division (Figure 1). However, when the excavation reaches a height of 10 m, the cut slope fail. An investigation carried out after the failure shows that the soil has failed along a circular arc with the critical circle forming a toe circle. Given: $c_u = 35$ kN/m^2 and $\gamma = 18.5$ kN/m^3. (Refer Appendix 1 and 2)

(i) Determine the maximum depth up to which the excavation can be carried out.

[3 marks]

(ii) Calculate the radius, r, of the critical circle when the factor of safety is equal to 1.

[3 marks]

(iii) Find the unsafe working distance $\overline{BC}$ at the crest of the slope.

[3 marks]

(iv) If the cut is made to a depth of 9 m, calculate the safety factor of the slope against sliding.

[3 marks]

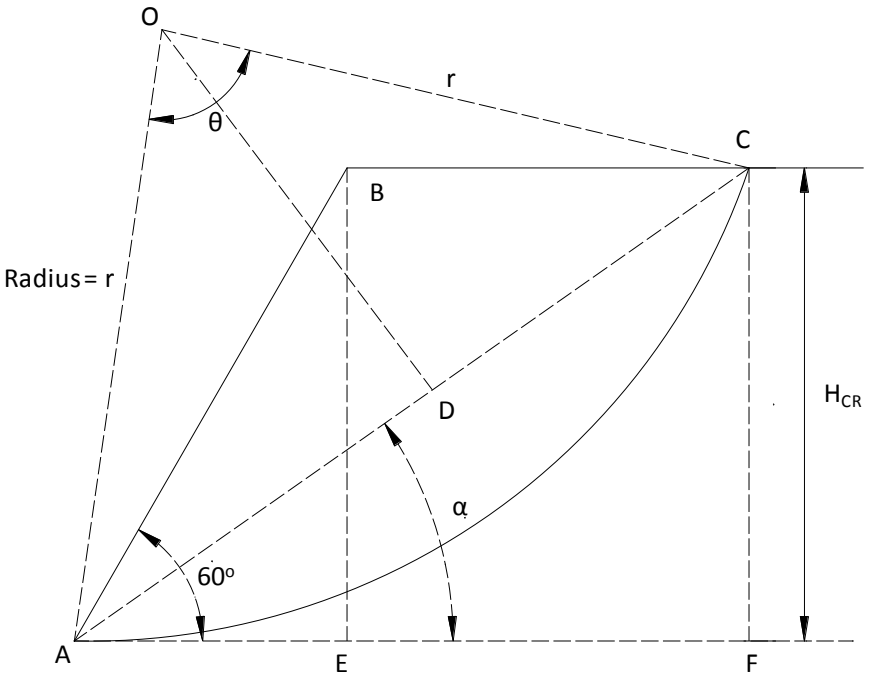


Figure 1

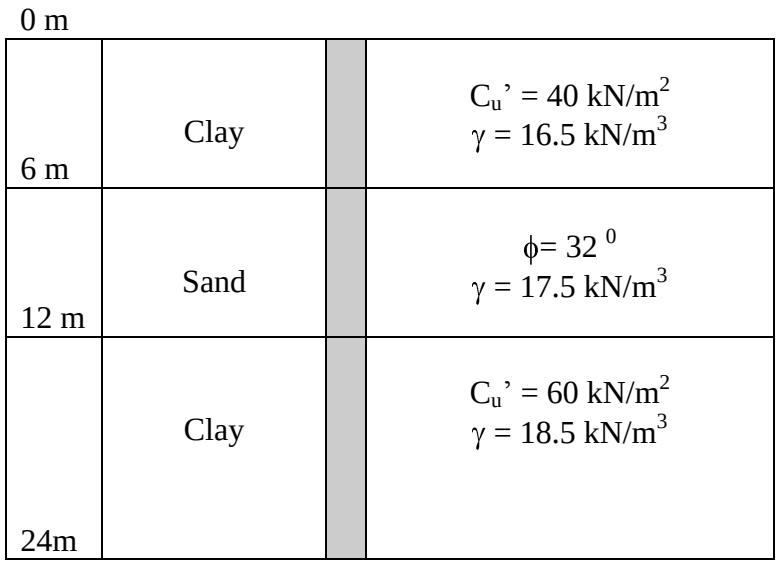
4. (a) A strip footing is designed to carry a load of 650 kN/m at a depth of 1.2 m below ground level. The cohesion of the soil is found to be 50 kN/m^2 and the angle of internal friction is 28^0. Determine the width of the footing if a factor of safety of 2.5 used. The water table is at 10 m below ground level. Assumed the bulk density and saturated density of the soil are 16.8 kN/m^3 and 20.5 kN/m^3 respectively.

[8 marks]

(b) Describe three (3) method of classification of piles which are normally used in geotechnical engineering. Use sketches and diagrams to support your answer.

[4 marks]

(c) A concrete pile of 450 mm diameter was driven into a layer of non homogenous soil to a depth of 24 m as shown in a diagram below:-



Determine :-

(i) Skin Friction of the pile.

[2 marks]

(ii) End bearing of the pile.

[2 marks]

(iii) The ultimate capacity of the pile.

[2 marks]

(iv) The ultimate capacity of a group of 2 x 2 piles as above with a distance 1 m c/c.

[2 marks]

5. The retaining wall shown in Figure 2 is planned to be of concrete with unit weight as given. The soil to be retained is sand with properties as given. The coefficient of base friction is 0.55. The ultimate bearing capacity of foundation is 700 kPa. Check the Factor of Safety against

(i) Sliding

[7 marks]

(ii) Overturning

[7 marks]

(iii) Bearing Capacity Failure

[6 marks]

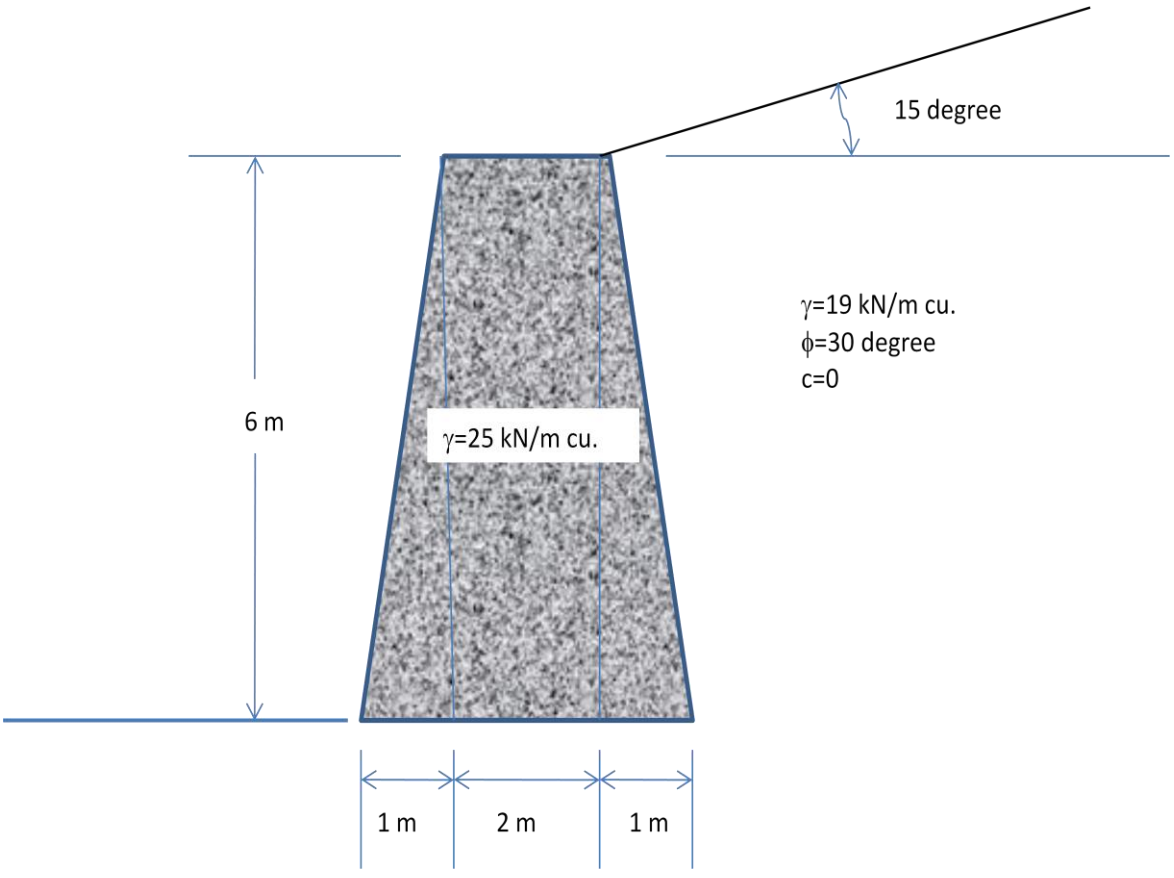


Figure 2

6. In Figure 3(a), the solid line represents a retaining wall when the retained soil is in stable condition. The dashed line represents the same retaining wall that has shifted away and caused failure to the retained soil. Water is not present in this problem. The Mohr Circles of Figure 3(b) describe the stresses involved by Unit A (shown by square box in Figure 3(a). Determine:

(i) Vertical stress on Unit A when retained soil is in stable condition

[3 marks]

(ii) Horizontal stress on Unit A when retained soil is in stable condition

[3 marks]

(iii) Vertical stress on Unit A when retained soil is about to fail

[3 marks]

(iv) Horizontal stress on Unit A when retained soil is about to fail

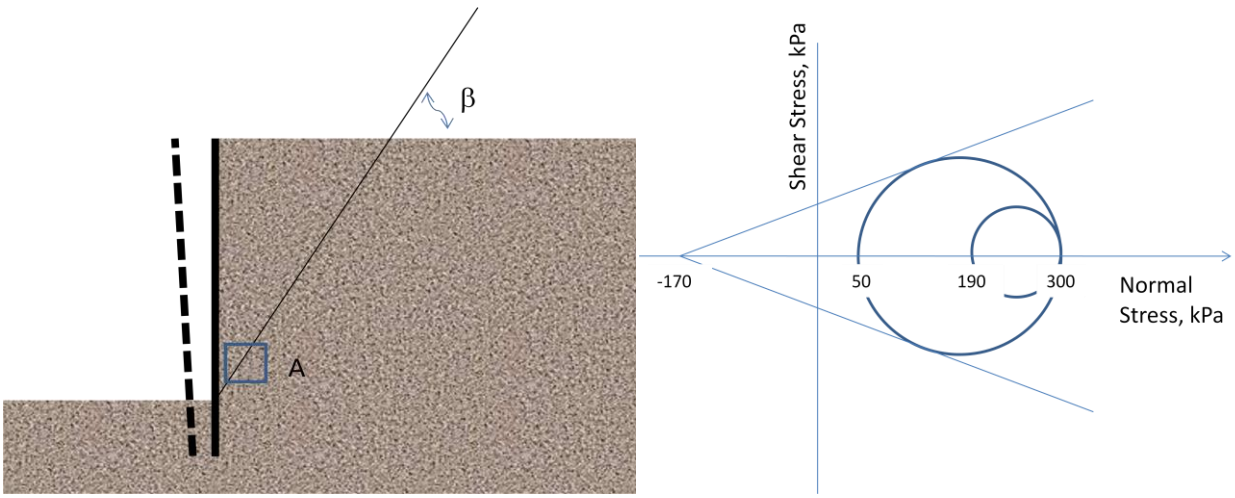
[3 marks]

(v) Shear strength equation of the soil

[4 marks]

(vi) Angle β, which defines the failure surface

[4 marks]



(a) **(b)**

Figure 3

1. (a) *Sebuah benteng baru yang mengandungi tanah liat seragam telah dicadangkan di skim pengairan Kerian. Benteng baru tersebut dijangka akan menjadi tepu disebabkan oleh resapan semasa ketinggian aras air berpanjangan. Jika kemudiannya aras air di dalam saluran tersebut turun lebih cepat daripada perlepasan air liang, lebihan tekanan air liang akan berlaku. Salah satu keadaan kritikal yang mungkin berlaku adalah kegagalan benteng tersebut disebabkan oleh pengurangan kestabilan. Sebagai jurutera geoteknik yang terlibat di dalam projek ini, anda diminta untuk menentukan kekuatan ricih tanah tersebut daripada ujian tiga paksi bagi menentukan kestabilan benteng tersebut. Tentukan ujian tiga paksi yang paling sesuai untuk tujuan di atas dan jelaskan sebab-sebab di sebalik pemilihan tersebut.*

[4 markah]

(b) *Sebuah menara air yang mempunyai ketinggian yang mencukupi untuk tekanan sistem agihan air telah dicadangkan dibina di atas tapak batuan. Struktur ini akan mengenakan tegasan berkesan normal sebanyak 250 kPa dan tegasan ricih sebanyak 80 kPa di atas satah suatu rekahan pada tapak batuan yang condong pada 60^o daripada permukaan mendatar. Sudut geseran batuan pada rekahan tersebut tersebut adalah 30^o.*

(i) *Tentukan samada rekahan tersebut akan gagal secara ricih berdasarkan keadaan di atas. Gunakan lakaran untuk menyokong jawapan anda.*

(ii) *Tentukan faktor keselamatan terhadap kegagalan disebabkan oleh gelongsoran satah tersebut.*

[6 markah]

(c) *Keputusan berikut diperolehi daripada ujian terkukuh tak tersalir yang dilakukan terhadap tanah liat yang merupakan bahan asas kepada benteng baru di skim pengairan Kerian.*

Jadual 1

$\sigma_{3\ f}$ kPa	$\sigma_1 - \sigma_{3\ f}$ kPa	Δu_f kPa
400	431	111
500	520	160
700	587	322

(i) *Plot bulatan Mohr's dengan tegasan berkesan daripada data di Jadual 1.*

(ii) *Dengan tekanan mengekang pada kedalaman yang dinginkan adalah sebanyak 400 kPa, tentukan nilai kekuatan ricih yang akan digunakan untuk tujuan analisa.*

[10 markah]

2. (a) *Senaraikan **ENAM (6)** objektif utama penyiasatan tapak yang dijalankan untuk projek-projek kejuruteraan awam.*

[3 markah]

(b) *Huraikan semua peringkat penyiasatan tapak yang perlu dijalankan sebelum sebarang kerja-kerja kejuruteraan awam bermula.*

[5 markah]

(c) *Sediakan log penggerudian yang lengkap daripada maklumat berikut yang diperolehi dari pengerudian salah satu lubang jara untuk satu tapak cadangan pembangunan projek di Transkrian, Pulau Pinang.*

[12 markah]

Bil	***Kedalaman Sampel (m)***	***Kiraan Hentaman, N***	***Kedalaman Penusukan (mm)***	***Klasifikasi Tanah***
1	*1.5*	*1-2-2-2-4-6*		*Pasir perang halus ke sederhana*
2	*3.0*	*3-4-6-7-8-9*		*Pasir perang halus ke sederhana*
3	*4.5*	*5-6-6-8-9-10*		*Pasir halus ke sederhana di bahagian atas sampel dan perang kemerahan lempung di bahagian bawah sampel*
4	*6.0*	*4-5-6-9-11-10*		*Lempung merah keperangan*
5	*7.5*	*4-6-8-9-12-11*		*Lempung merah keperangan*
6	*9.0*	*7-9-10-12-20-8*	*250*	*Pasir, kelodak dan lempung kekelabuan dari halus ke kasar dan terdapat kelikir*
7	*10.5*	*10-12-12-19-19*	*180*	*Pasir, kelodak dan lempung kekelabuan dari halus ke kasar dan terdapat kelikir*
8	*12.0*	*16-19-28-22*	*100*	

3. *(a)* *Dengan memahami kepentingan sedutan di dalam peningkatan kekuatan ricih tanah dan seterusnya pengekalan kestabilan cerun di tanah baki tak tepu, jelaskan secara ringkas bagaimana hujan dapat memberi kesan kepada kestabilan cerun.*

[4 markah]

(b) *Di dalam pembinaan empangan tanah, ia perlu selamat daripada kegagalan benteng bagi semua keadaan operasi. Secara umumnya terdapat empat (4) tahap kritikal berdasarkan kepada keadaan tekanan liang yang mana kestabilan benteng empangan tersebut perlu dipastikan. Namakan dan jelaskan secara ringkas keempat-empat (4) keadaan tersebut.*

[4 markah]

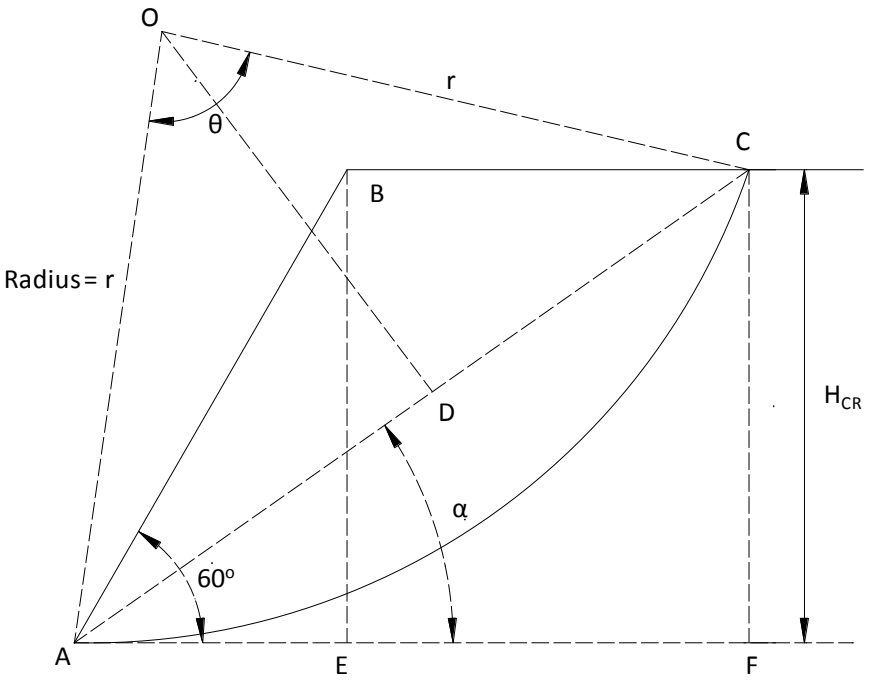
(c) *Sebuah kontraktor cuba memotong cerun pada tanah liat lembut dengan sudut sebanyak 60^o bagi pengorekan sementara di pembangunan perumahan lereng bukit (Rajah 1). Namun begitu, apabila pengorekan tersebut mencapai 10 m, cerun tersebut gagal. Penyiasatan yang dilakukan sejurus selepas kegagalan tersebut berlaku menunjukkan bahawa cerun tersebut telah gagal selari dengan lengkok bulatan dengan bulatan kritikal adalah bulatan tapak luar. Diberi* $c_u = 35\ \text{kN/m}^2$ *and* $\gamma = 18.5\ \text{kN/m}^3$. *(Rujuk lampiran 1 dan 2)*

(i) *Tentukan kedalaman maksimum yang dapat dikorek tanpa kegagalan.* *[3 markah]*

(ii) *Kira jejari, r, untuk bulatan kritikal apabila faktor keselamatan cerun tersebut bersamaan dengan 1.* *[3 markah]*

(iii) *Cari jarak kerja tidak selamat* $\overline{BC}$ *pada puncak cerun tersebut.* *[3 markah]*

(iv) *Jika potongan dilakukan pada kedalaman 9 m, tentukan faktor keselamatan cerun tersebut terhadap gelinciran.* *[3 markah]*



Rajah 1

4. (a) *Suatu asas jalur perlu direkabentuk untuk menampung beban sebesar 650 kN/m pada kedalaman 1.2 m di bawah paras bumi. Nilai kejelikitan tanah adalah 50 kN/m^2 manakala sudut geseran dalam adalah 28 darjah. Tentukan lebar asas yang diperlukan untuk menanggung beban di atas sekiranya faktor keselamatan sebesar 3.0 digunakan. Paras air bumi didapati berada pada paras 10 m di bawah paras bumi.Nilai ketumpatan pukal dan tepu tanah adalah masing-masing 1.68 kN/m^3 and 2.05 kN/m^3.*

[8 markah]

(b) *Huraikan tiga (3) kaedah pengelasan cerucuk yang selalunya digunakan dalam kejuruteraan geoteknikal. Gunakan lakaran untuk menyokong jawapan anda.*

[4 markah]

(c) *Satu cerucuk konkrit bergaris pusat 450 mm telah dipacu ke dalam satu lapisan tanah tak homogenous pada kedalaman 24 m seperti rajah di bawah.*

0 m

6 m	*Lempung*		$C_u' = 40$ kN/m^2 $\gamma = 16.5$ kN/m^3
12 m	*Pasir*		$\phi = 32^0$ $\gamma = 17.5$ kN/m^3
24m	*Lempung*		$C_u' = 60$ kN/m^2 $\gamma = 18.5$ kN/m^3

Tentukan :-

(i) Nilai geseran kulit cerucuk

[2 markah

(ii) Nilai galas hujung cerucuk

[2 markah]

(iii) Nilai keupayaan muktamad cerucuk tunggal

[2 markah]

(iv) *Nilai keupayaan muktamad cerucuk kumpulan 2 x 2 yang berjarak 1 m c/c.*

[2 markah]

5. *Tembok penahan di Rajah 2 akan dibina menggunakan konkrit yang mempunyai berat unit dinyatakan di rajah. Tanah yang hendak ditahan pasir dengan nilai-nilai seperti diberi. Pekali geseran pada tapak tembok 0.55. Keupayaan galas muktamad tapak 700 kPa. Tentukan Faktor Keselamatan tembok penahan daripafa:*

(i) *Gelongsoran*

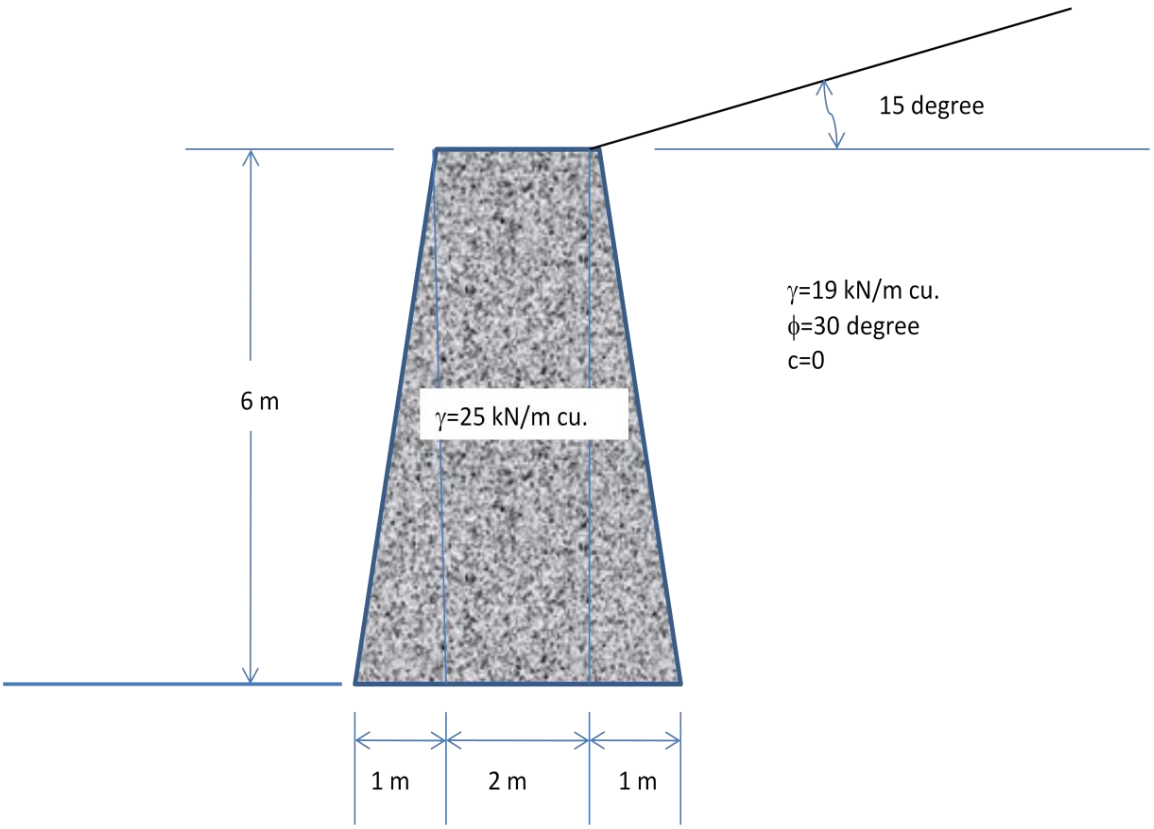
[7 markah]

(ii) *Tumbang*

[7 markah]

(iii) *Keupayaan Galas*

[6 markah]



Rajah 2

6. *Rajah 3 (a), garisan pejal menunjukkan kedudukan dinding pada keadaan stabil. Garisan putus-putus pula menunjukkan kedudukan tembok yang telah teranjak dan menyebabkan tanah di belakang tembok gagal. Tiada masaalah air di soalan ini. Bulatan Mohr pada Rajah 3(b) menerangkan apa yang berlaku pada Unit A (ditunjukkan sebagai kotak kecil di Rajah 3(a). Tentukan:*

(i) Tegasan pugak pada Unit A apabila tanah dalam keadaan stabil

[3 markah]

(ii) Tegasan mendatar pada Unit A apabila tanah dalam keadaan stabil

[3 markah]

(iii) Tegasan pugak pada Unit A apabila tanah sedang hampir gagal

[3 markah]

(iv) Tegasan mendatar pada Unit A apabila tanah sedang hampir gagal

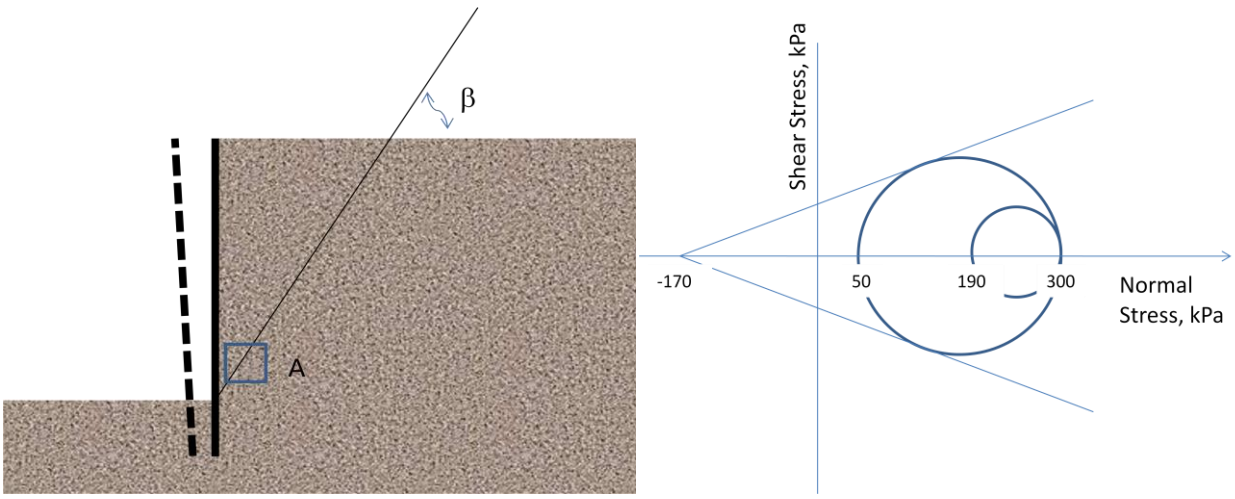
[3 markah]

(v) Persamaan kekuatan ricih tanah

[4 markah]

(vi) Sudut β, iaitu yang menerangkan kedudukan permukaan kegagalan

[4 markah]

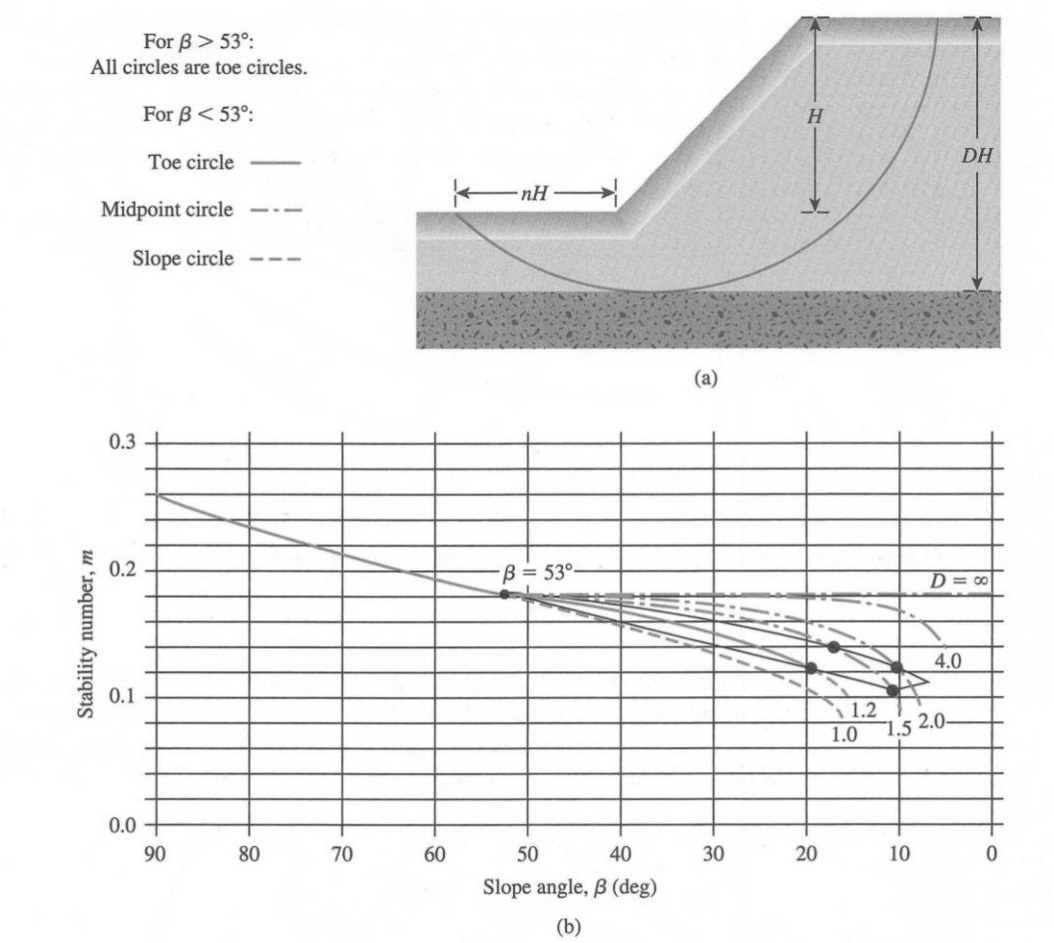


(a) (b)

Rajah 3

Appendix 1

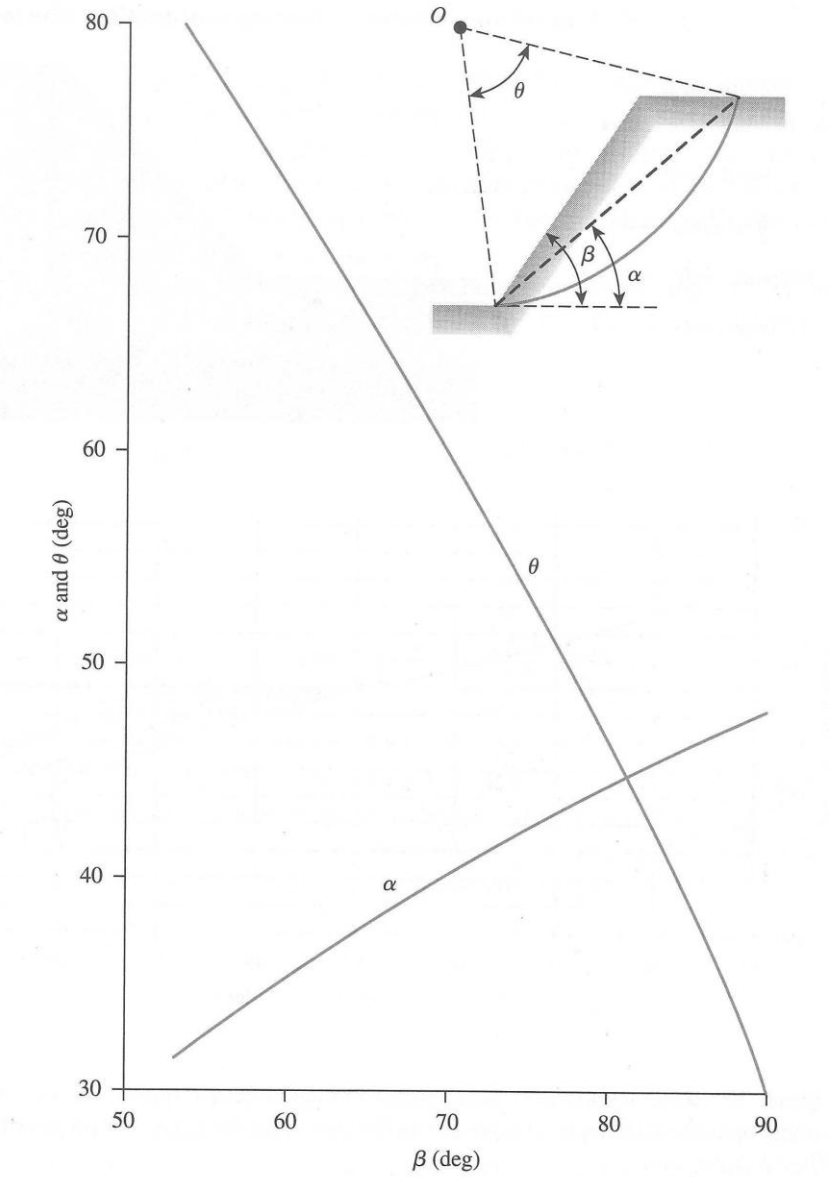
Lampiran 1



Definition of parameters for midpoint circle type of failure and plot of stability number against slope angle

Appendix 2

Lampiran 2



Location of the center of critical circles for $\beta > 53^o$

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