UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session of 2007/2008

October/November 2007

EBS 417E – Geomechanics
[Geomekanik]

Duration: 3 hours
[Masa: 3 jam]

Please ensure that this paper consists of SEVENTEEN printed pages and TWO pages APPENDIX before you proceed with the examination.
[Sila pastikan bahawa kertas peperiksaan ini mengandungi TUJUH BELAS muka surat yang bercetak dan DUA muka surat LAMPIRAN sebelum anda memulakan peperiksaan.]

This paper contains TWO questions from PART A and FIVE questions from PART B.
[Kertas soalan ini mengandungi DUA soalan dari BAHAGIAN A dan LIMA soalan dari BAHAGIAN B.]

Instruction: Answer **ALL** questions from PART A and answer **THREE** (3) questions from PART B. If a candidate answers more than three questions, only the first three questions answered will be examined and awarded marks.
[Arahan: *Jawab **SEMUA** soalan dari BAHAGIAN A dan jawab **TIGA** (3) soalan dari BAHAGIAN B. Jika calon menjawab lebih daripada tiga soalan hanya tiga soalan pertama mengikut susunan dalam skrip jawapan akan diberi markah.]*

Answers to any question must start on a new page.
[Mulakan jawapan anda untuk setiap soalan pada muka surat yang baru.]

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

PART A
BAHAGIAN A

Answer all questions in this part.
Jawab semua soalan dalam bahagian ini.

1. [a] How is soil defined in engineering? What methods are used to classify a soil for engineering purposes?

Bagaimanakah tanah ditakrifkan dalam kejuruteraan? Kaedah-kaedah apakah yang digunakan untuk mengkelaskan tanah bagi kegunaan kejuruteraan?

(5 marks/*markah*)

[b] Define (i) liquid limit; (ii) plastic limit and (iii) plasticity index.

Takrifkan (i) had cecair; (ii) had plastik dan (iii) indeks keplastikan.

(3 marks/*markah*)

[c] A sample of a dry coarse-grained material of mass 500 g was shaken through a nest of seives and the following results were obtained:

Suatu sampel bahan kering berbutiran kasar dengan jisim 500 g telah digoncang melalui satu siri saringan dan keputusan berikut diperolehi:

Seive no. / *No. saringan*	Opening / *pembukaan* (mm)	Mass retained / *jisim tertinggal* (g)
4	4.750	0
10	2.000	14.8
20	0.850	98.0
40	0.425	90.1
100	0.150	181.9
200	0.075	108.8
pan		6.1

...3/-

(i) Plot the particle size distribution curve.

(ii) Determine the effective size, the average particle size and the uniformity coefficient.

(iii) Determine the textural composition of the soil (i.e. the amount of gravel, sand etc). Make use of the chart in Attachment 1.

(i) Plotkan lengkung taburan saiz zarah.

(ii) Tentukan saiz berkesan, saiz zarah purata dan pekali keseragaman.

(iii) Tentukan komposisi tekstur tanah (i.e. banyaknya kelikir, pasir dan sebagainya). Gunakan carta di Lampiran 1.

(12 marks/*markah*)

2. Answer all objective questions as the following by writing the appropriate alphabet corresponding to the correct answer in your answer script.
Jawab semua soalan objektif seperti berikut dengan hanya menulis huruf yang sesuai dengan jawapan yang betul di dalam skrip jawapan anda.

i Based on Figure 1, what is the average vertical stress component of the rock at a depth of 900 metres?
A. 25 kN/m^2
B. 24.3 MPa
C. 25 MPa
D. 238.38 MPa

i Berdasarkan kepada Rajah 1, apakah komponen tegasan menegak puratabatuan di kedalaman 900 meter?
A. 25 kN/m^2
B. 24.3 MPa
C. 25 MPa
D. 238.38 MPa

ii From question (i), what is the average density of the rock?
A. 2,700 kg/m^3
B. 2.7
C. 2,752 kg/m^3
D. 2.7 tonne/m^3

ii Daripada soalan (i), apakah ketumpatan purata batuan?
A. 2,700 kg/m^3
B. 2.7
C. 2,752 kg/m^3
D. 2.7 tonne/m^3

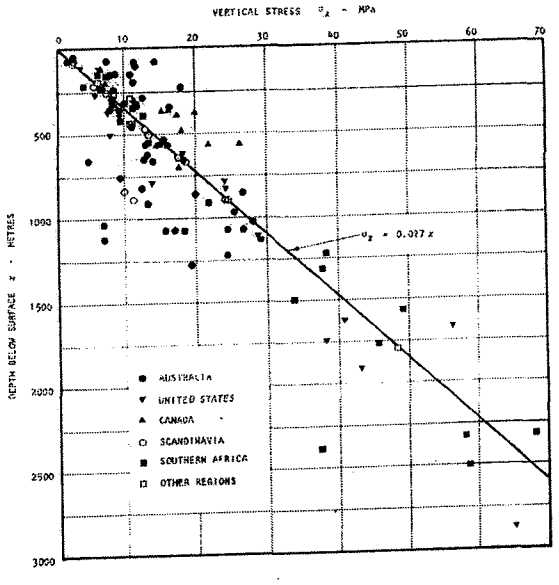

Figure 1
Rajah 1

iii Figure 2 shows the value of k with depth. What is k?

A. σ_v/σ_h
B. $1/\sigma_v$
C. $1/\sigma_h$
D. σ_h/σ_v

iii Rajah 2 menunjukkan nilai dengan kedalaman. Apakah k?

A. σ_v/σ_h
B. $1/\sigma_v$
C. $1/\sigma_h$
D. σ_h/σ_v

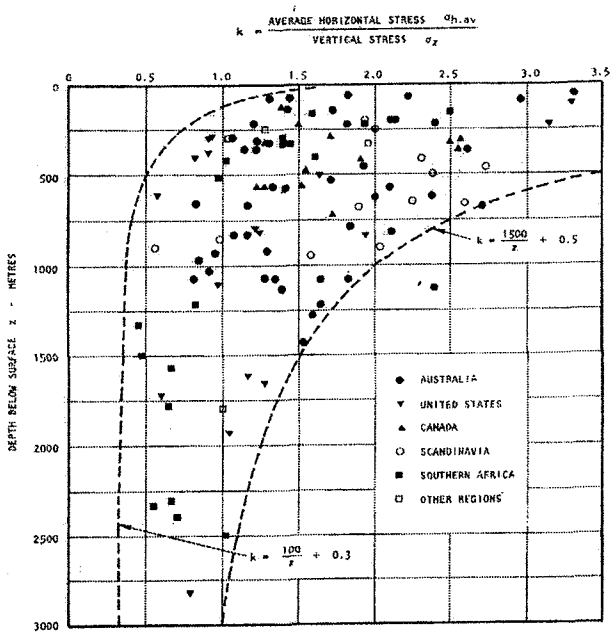

Figure 2
Rajah 2

iv Induced stresses in rock are .....

A. the result of stress changes due to manmade excavation.
B. the rock stresses as measured by an instrument.
C. the virgin stresses found in rock and the overburden.
D. stresses found in rock before excavation.

iv Tegasan aruhan di dalam batuan adalah .....

A. akibat pertukaran tegasan oleh pengorekan yang dibuat oleh manusia.
B. tegasan batuan yang diukur daripada satu peralatan.
C. tegasan dara yang didapati dalam batuan dan tanah beban.
D. tegasan yang didapati dalam batuan sebelum pengorekan.

v Figure 3 is one of the instrument used for the determination of ground stresses in rock. What method is this instrument being used for?
A. Hydraulic fracturing
B. Overcoring
C. Drill stem testing
D. Stresses compensation

v Rajah 3 ialah salah satu daripada peralatan yang digunakan untuk menentukan tegasan dalam batuan. Kaedah apakah peralatan ini digunakan?
A. Rekahan hidraulik
B. Peneras-lebihan
C. Ujian batang gerudi
D. Penebusgantian tegasan

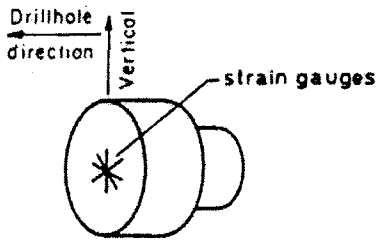

Figure 3 : the door stopper
Rajah 3: "door stopper"

vi Mohr's Coulomb formula is expressed as in Figure 4 that gives a relationship of .....
A. $\tau = c + \sigma_n \tan\phi$
B. $c = \tau + \sigma_n \tan\phi$
C. $\sigma_n = c + \tau \tan\phi$
D. $\phi = c + \sigma_n \tan\tau$

vi Formula Mohr Coulomb dinyatakan seperti di dalam Rajah 4 yang memberikan hubungan .....
A. $\tau = c + \sigma_n \tan\phi$
B. $c = \tau + \sigma_n \tan\phi$
C. $\sigma_n = c + \tau \tan\phi$
D. $\phi = c + \sigma_n \tan\tau$

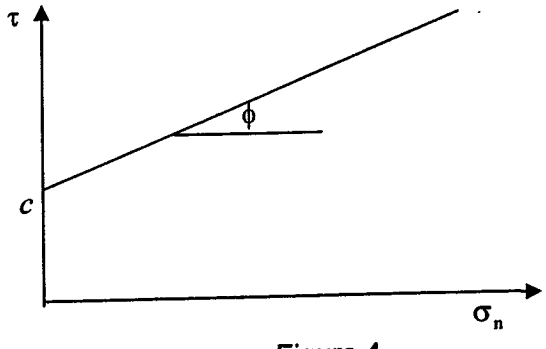

Figure 4
Rajah 4

vii The roof of a tunnel is subjected to stresses in .....
A. tangent to the tunnel face.
B. compression
C. virgin ground
D. tension

vii Bumbung terowong mengalami tegasan dalam .....
A. keadaan tangen kepada muka terowong
B. mampatan
C. kawasan dara
D. tegangan

viii The wall of a tunnel is subjected to stresses in .....
A. tension
B. compression
C. virgin ground
D. tangent to the tunnel face.

viii Dinding terowong mengalami tegasan dalam .....
A. tegangan
B. mampatan
C. kawasan dara
D. mentangen kepada muka terowong

ix Rocks are weak in .....
A. tension
B. compression
C. virgin ground
D. tension and compression

ix Batuan lemah dalam keadaan .....
A. tegangan
B. mampatan
C. kawasan dara
D. tegangan dan mampatan

x What is the purpose of rock mass classification system?
A. To classify rock according to its particle size.
B. To classify rock according to tunnel sizes.
C. To classify rock according to its strength.
D. To guide judgement through standardized procedures and description in support of engineering decision involving rock.

x Apakah tujuan sistem pengelasan jisim batuan?
A. Untuk mengkelaskan batuan menurut size zarahnya.
B. Untuk mengkelaskan batuan menurut saiz terowong.
C. Untuk mengkelaskan batuan menurut kekuatannya.
D. Untuk memberi panduan kepada pertimbangan dan kesimpulan melalui aturcara dan penerangan yang piawai dalam memberi sokongan kepada keputusan kejuruteraan yang melibatkan batuan.

xi Hoek Brown Criterion for rock failures is expressed as:

$\sigma_1 = \sigma_3 + \sqrt{m\sigma_c\sigma_3 + s\sigma_c^2}$.

What is "s" stands for in the formula?

A. Minimum stress applied to specimen.
B. Maximum stress applied to specimen.
C. Uniaxial compressive strength.
D. Degree of fracturization of sample and tensile strength.

xi Kriteria Hoek Brown untuk kegagalan batuan dinyatakan seperti:

$\sigma_1 = \sigma_3 + \sqrt{m\sigma_c\sigma_3 + s\sigma_c^2}$.

Apakah "s" di dalam formula tersebut?

A. Tegasan minimum yang dikenakan ke atas sampel.
B. Tegasan maksimum yang dikenakan ke atas sampel.
C. Kekuatan mampatan unipaksi.
D. Tahap keretakan dalam sampel dan kekuatan tegangan.

xii What is the Hoek Brown Criterion trying to achieve?

A. To obtain a correct relation-ship of stresses involve in the rock.
B. To obtain a stable span of the tunnel.
C. To extend the uniaxial compressive strength obtained from intact sample to the strength of the rock mass.
D. To calculate the minimum and maximum stress in the rock.

xii Apakah Kriteria Hoek Brown cuba mencapai?

A. Untuk memperolehi hubungan yang betul mengenai tegasan yang terlibat di dalam batuan.
B. Untuk memperolehi bukaan terowong yang stabil.
C. Untuk memanjangkan kekuatan mampatan unipaksi yang diperolehi daripada sampel tak terjejas kepada kekuatan jisim batuan.
D. Untuk mengira tegasan minimum dan maksimum dalam batuan.

xiii How do rock bolts act in the support of the roof of a tunnel?

A. The rock bolts are made of steel and they will reinforce the roof.
B. The series of rocks bolts on the roof will tie in all discontinuities or cracks and a beam of rock is created across the roof of the tunnel.
C. The rock bolts will increase the tensile strength of the rock.
D. The rock bolts will increase the compressive strength of the rock.

xiii Bagaimanakah bolt batuan bertindak dalam sokongan di bumbung terowong?

A. Bolt batuan diperbuat daripada keluli dan ia akan memperkuat-kan bumbung.
B. Siri bolt batuan yang dipasang di bumbung akan mengikat semua ketakselanjaran atau retakan dan satu gelegar batuan terbentuk di bumbung terowong.
C. Bolt batuan akan menambahkan kekuatan tegangan batuan.
D. Bolt batuan akan menambahkan kekuatan mampatan batuan.

xiv Parameters involve in assessing the slope stability.

I. slope materials unit weight
II. cohesion
III. angle of friction
IV. drainage

A. All of the above
B. None of the above
C. I, II and III
D. II and III

xv Why is it important to familiarise oneself with streographic projection in rock mechanics?

A. It is not that important since it is just one of the many methods used in assessing rock stability.
B. It gives very accurate results and cheap.
C. It simplifies graphical solution to problems involving assessment of stability in excavations.
D. Its importance only lies in the study of stability in slope stability only.

xiv Parameter-parameter yang terlibat dalam menilai kestabilan cerun.

I. berat unit bahan-bahan dalam cerun
II. kejeleketan
III. sudut geseran
IV. saliran

A. Semua di atas
B. Tiada jawapan di atas
C. I, II dan III
D. II dan III

xv Kenapakah ia penting untuk seseorang memfasihkan diri dalan unjuran streografik dalam mekanik batuan?

A. Ia tidak begitu penting kerana ia hanyalah salah satu daripada banyak kaedah yang digunakan untuk menilai kestabilan batuan.
B. ia memberi keputusan yang begitu tepat dan murah.
C. Ia mempermudahkan penyelesaian grafik kepada masalah-masalah yang melibatkan penilaian kestabilan dalam pengorekan.
D. Kepentingannya hanya terdapat dalam pengajian kestabilan cerun sahaja.

(20 marks/*markah*)

PART B
BAHAGIAN B

There are five (5) questions and attempt any three of them.
Terdapat lima (5) soalan dan jawab tiga daripadanya.

3. [a] Discuss the principle and merits in the application of shotcrete as one of the supporting methods in mines.

Bincangkan prinsip dan kebaikan dalam penggunaan syotkrit sebagai salah satu daripada kaedah sokongan di dalam lombong.

(10 marks/*markah*)

[b] Give an account, with examples and sketches, of the following aspects of stress analysis for underground excavations:

Berikan penerangan, dengan contoh dan lakaran, bagi beberapa aspek analisa tegasan untuk pengorekan bawah tanah:

(i) the streamflow analogy as applied to underground excavation.

analogi aliran sungai seperti digunakan untuk pengorekan bawah tanah.

(4 marks/*markah*)

(ii) radius of influence of excavation based on Kirsch equations.

jejari pengaruh pengorekan berdasarkan kepada persamaan Kirsch.

$$\sigma_\theta = \frac{1}{2}(\sigma_x + \sigma_y)\left(1+\frac{a^2}{r^2}\right) - \frac{1}{2}(\sigma_x - \sigma_y)\left(1+3\frac{a^4}{r^4}\right)\cos 2\theta$$

$$\sigma_r = \frac{1}{2}(\sigma_x + \sigma_y)\left(1-\frac{a^2}{r^2}\right) + \frac{1}{2}(\sigma_x - \sigma_y)\left(1+3\frac{a^4}{r^4}-4\frac{a^2}{r^2}\right)\cos 2\theta$$

(6 marks/*markah*)

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4. [a] Define (i) total stress (ii) effective stress.

Takrifkan (i) tegasan jumlah (ii) tegasan berkesan.

(6 marks/*markah*)

[b] A dam (Figure 5) of breadth 30 m rests on the horizontal upper surface of a uniform soil deposit of depth of 30 m underlain by an impermeable stratum. It is provided with an impermeable cut-off at the mid point which extends to a depth of 15 m below the dam base. The net head of water effective in producing flow is 18 m and the coefficient of permeability of the soil is 0.00169 mm/s. Sketch the flow net and the uplift pressure and determine:

(i) the seepage quantity per metre length of dam,

(ii) the drop in pressure at the downstream side of the cut-off.

Sebuah empangan (Rajah 5) dengan kelebaran 30 m terletak di atas permukaan mendatar satu mendapan tanah dengan kedalaman 30 m di atas satu lapisan yang tidak telap. Empangan ini dipasang satu halangan di tengah-tengahnya yang menjurus di kedalaman sehingga15 m di bahagian bawah empangan. Turus berkesan yang menghasil aliran ialah 18 m dan pekali kebolehtelapan tanah ialah 0.00169 mm/s. Lakarkan jaringan aliran, rajah tekanan mengangkat dan tentukan:

(i) kuantiti resapan per meter panjang empangan,

(ii) kejatuhan tekanan di bahagian hilir daripada halangan.

(14 marks/*markah*)

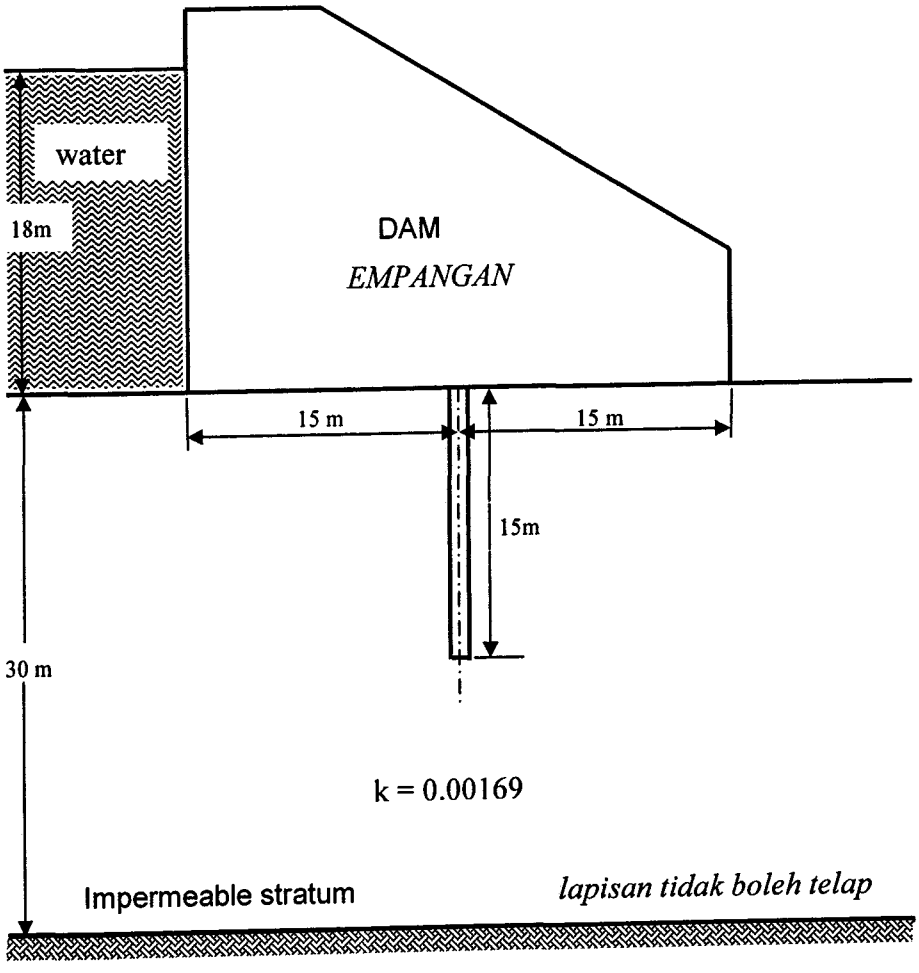

Figure 5
Rajah 5

5. [a] Figure 6 shows the concentration of the pole plot of discontinuities in an open pit copper mine. The shape of the pit is almost circular. Which part of the pit is having some problems in slope stability? If the dip of fracture set A is 50^0 towards 307^0 and the dip of fracture set B is 61^0 towards 353^0, what is the steepest safe slope angle of that part of the pit? Assume that the angle of friction of the rock is 36^0. Give reasons for your answers.

Rajah 6 menunjukkan penumpuan plot kutub bagi ketakselanjaran di dalam sebuah lombong tembaga. Lubang lombong lebih kurang berbentuk bulat. Bahagian manakah daripada lombong ini yang mengalami masalah kesetabilan cerun? Jika kemiringan set keretakan A ialah 50^0 menghala 307^0 dan kemiringan set keretakan B ialah 61^0 menghala 353^0, apakah sudut cerun selamat yang paling curam bagi bahagian lubang lombong ini? Andaikan sudut geseran batuan sebagai 36^0. Beri sebab bagi jawapan anda.

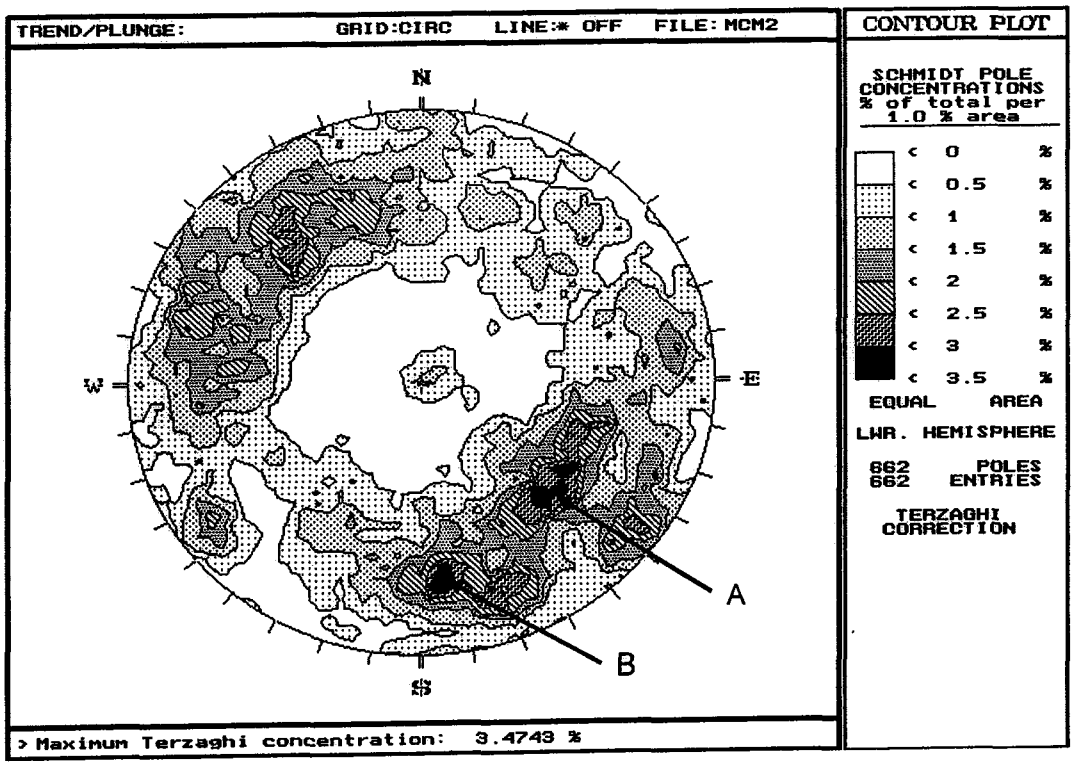

Figure 6
Rajah 6

(10 marks/*markah*)

[b] Write short notes about the methods of measuring stress in underground excavation.

Tuliskan nota ringkas mengenai pengukuran tegasan di dalam pengorekan bawah tanah.

(10 marks/*markah*)

6. [a] What is meant by shear strength of soils?

Apakah yang dimaksudkan dengan kekuatan ricih tanah?

(5 marks/*markah*)

[b] Describe briefly one of the methods to determine the shear strength of soils?

Terangkan dengan ringkas salah satu kaedah untuk menentukan kekuatan ricih tanah?

(5 marks/*markah*)

[c] An unconfined compression test was carried out on a saturated clay sample. The maximum load the clay sustained was 127 N and the vertical displacement was 0.8 mm. The size of the sample was 38 mm diameter by 76 mm long. Determine the undrained shear strength. Draw Mohr's circle of stress for the test and locate the undrained shear strength.

Satu ujian mampatan tidak terkurung telah dijalankan ke atas sampel tanah liat tepu. Beban maksimum tanah liat ini boeh menahan ialah 127 N dan anjakan menegak ialah 0.8 mm. Saiz sampel ialah 38 mm garispusat dan 76 mm panjang. Tentukan kekuatan ricih tidak tersalir. Lukiskan bulatan tegasan Mohr untuk ujian ini dan tunjukkan di manakah nilai kekuatan ricih tidak tersalir.

(10 marks/*markah*)

7. [a] Define active and passive earth pressures.

Takrifkan tekanan bumi aktif dan pasif.

(5 marks/*markah*)

(b) A smooth back vertical wall of 6 m retains the upper soil level with the top of the wall as shown in Figure 7, determine the following:

(i) the active lateral earth pressure distribution with depth;

(ii) the passive lateral earth pressure distribution with depth;

(iii) the magnitudes and locations of the active and passive forces;

(iv) the resultant force and its location;

(v) will the wall rotate?

Suatu dinding licin ketinggian 6 m menahan bahagian atas tanah dengan bahagian atas dinding seperti Rajah 7, tentukan perkara berikut:

(i) taburan tekanan bumi mendatar aktif dengan kedalaman;

(ii) teburan tekanan bumi pasif dengan kedalaman;

(iii) magnitud dan kedudukan daya-daya aktif dan pasif;

(iv) daya resultan dan kedudukannya;

(v) adakah dinding ini akan berputar?

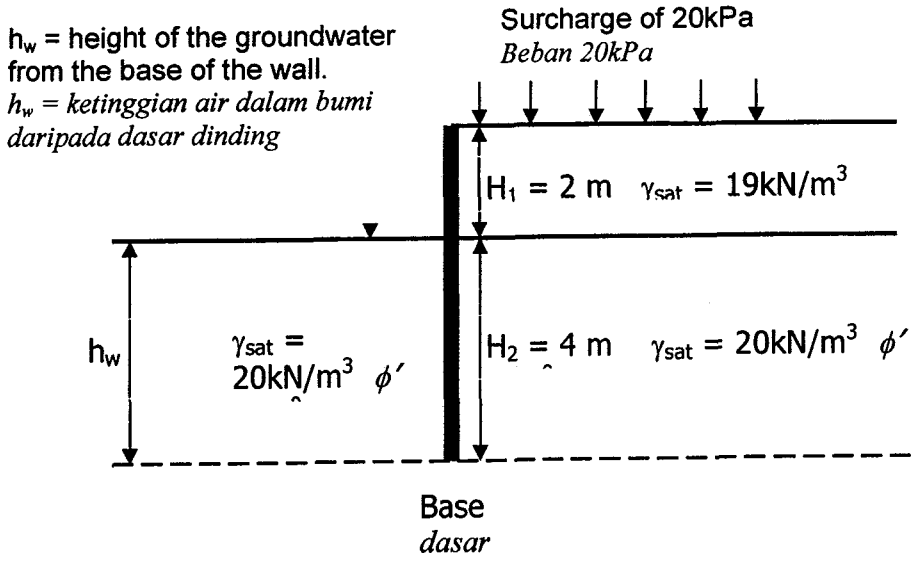

Figure 7
Rajah 7

(15 marks/*markah*)

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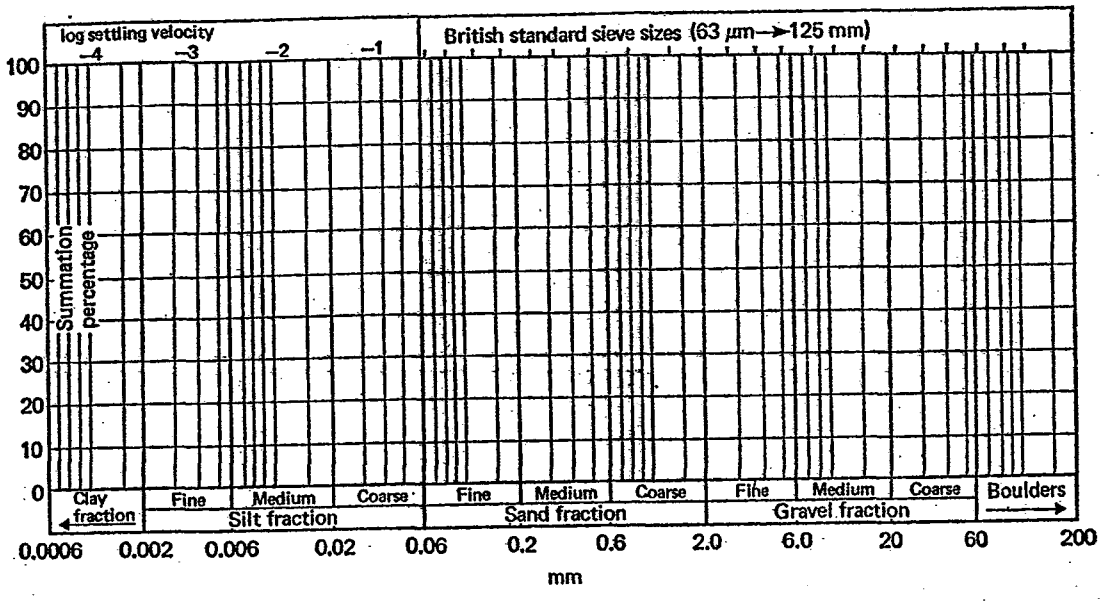
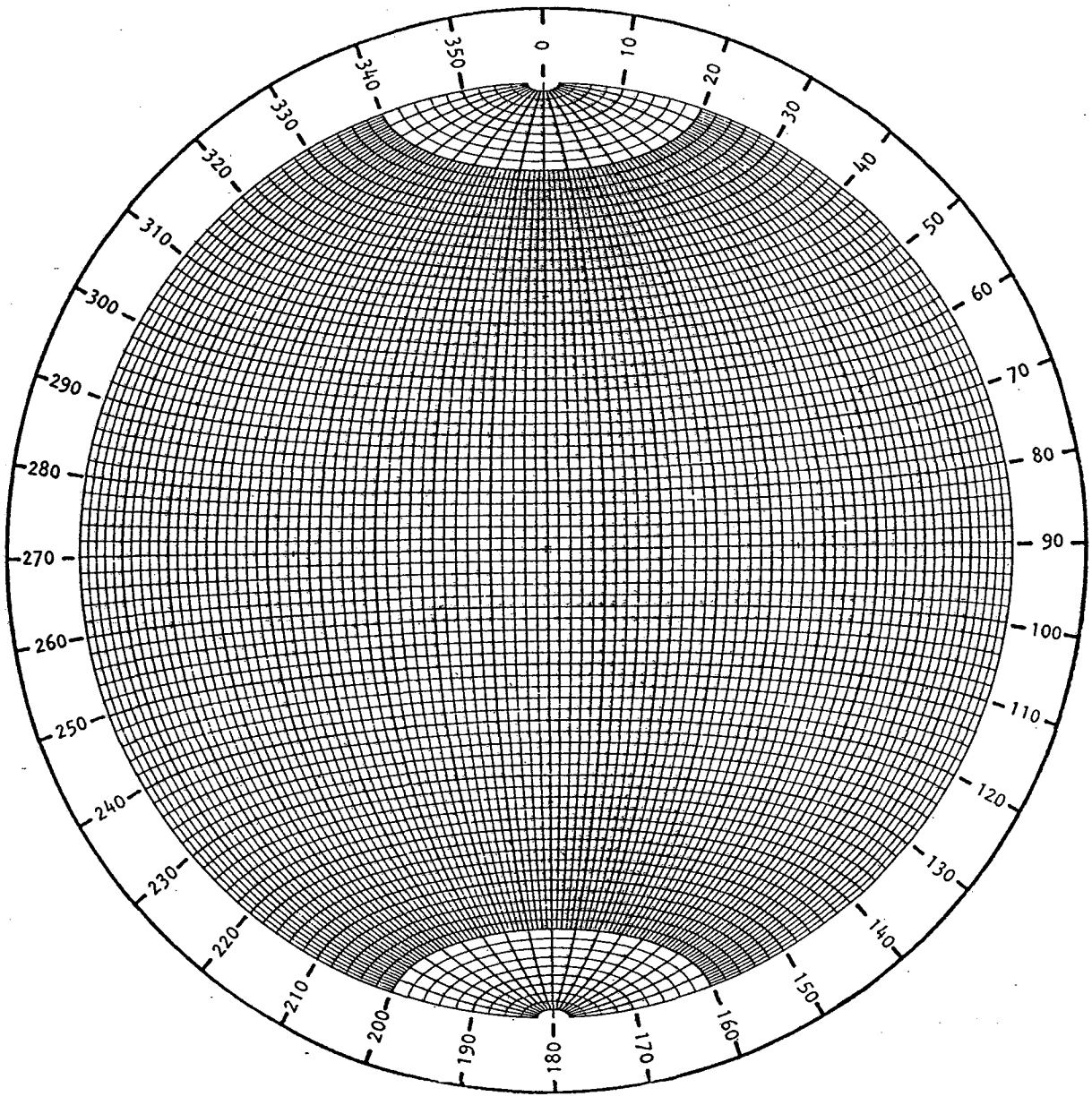
APPENDIX 1
LAMPIRAN 1



Particle-size distribution chart

APPENDIX 2
LAMPIRAN 2



Equatorial equal-area stereonet marked in 2^{o} intervals.

Computer drawn by Dr. C.M. St John of the Royal School of Mines, Imperial College, London.