

---

UNIVERSITI SAINS MALAYSIA

2<sup>nd</sup> Semester Examination  
2005/2006 Academic Session  
*Peperiksaan Semester Kedua  
Sidang Akademik 2005/2006*

April / May 2006

**EAG 245E/3 – Soil Mechanics**  
*EAG 245E/3 – Mekanik Tanah*

*Duration: 3 hours  
Masa: 3 jam*

---

**Instructions To Candidates:**

**Arahan Kepada Calon:**

1. Ensure that this paper contains **TWELVE (12)** printed pages including appendices before you start your examination.  
*Sila pastikan kertas peperiksaan ini mengandungi **DUA BELAS (12)** muka surat bercetak termasuk lampiran sebelum anda memulakan peperiksaan ini.*
2. This paper contains **SEVEN (7)** questions. Answer **FIVE (5)** questions only. Marks will be given to the **FIVE (5)** questions put in order on the answer script and **NOT** the **BEST FIVE (5)**.  
*Kertas ini mengandungi **TUJUH (7)** soalan. Jawab **LIMA (5)** soalan sahaja. Markah hanya akan dikira bagi **LIMA (5)** jawapan **PERTAMA** yang dimasukkan di dalam buku mengikut susunan dan bukannya **LIMA (5)** jawapan terbaik.*
3. All questions **CAN BE** answered in English or Bahasa Malaysia or combination of both languages.  
*Semua soalan boleh dijawab dalam Bahasa Inggeris atau Bahasa Malaysia ataupun kombinasi kedua-dua bahasa.*
4. Each question **MUST BE** answered on a new sheet.  
*Tiap-tiap jawapan **MESTILAH** dimulakan pada muka surat yang baru.*
5. Write the answered question numbers on the cover sheet of the answer script.  
*Tuliskan nombor soalan yang dijawab di luar kulit buku jawapan anda.*

1. (a) What is the purpose to do soil classification and how many classification are there in the world, name them?

(6 marks)

*Apakah tujuan klasifikasi tanah dan berapa banyakkah klasifikasi yang ada di dunia, dan namakan?*

- (b) A sample of soil has a water content of 25% and a bulk density of  $1.8\text{Mg/m}^3$ . Determine the dry density, void ratio of the soil and the specific gravity of the particles.

What would be the bulk density of a sample of this soil with the same void ratio, if the soil is 90% saturated?

(14 marks)

*Suatu sampel tanah mengandungi kandungan air sebanyak 25% dan ketumpatan pukal adalah  $1.8\text{Mg/m}^3$ . Tentukan ketumpatan kering, nisbah lompong untuk tanah dan graviti tentu untuk zarah tanah tersebut.*

*Apakah ketumpatan pukal bagi sampel tanah bagi nisbah lompong yang sama sekiranya tanah mempunyai ketepuan sebanyak 90%?*

2. (a) What type of soil is usually produced by weathering and transportation process?

*Apakah jenis tanah yang kebiasaannya terdapat dari proses luluhawa dan pengangkutan?*

- (b) Variation of particles sizes depending on what factors?

*Perbezaan saiz zarah bergantung ke atas faktor apa?*

(8 marks)

- (c) To determine particles size distribution of a soil sample was placed in the top tower of the sieves which consisted of 19mm, 9.5mm, 4.75mm, 2.36mm, 1.18mm sieves and a pan. After shaking the sieves for 15 minutes the amount retained on the each sieve were measured and recorded. From these result which are shown in Table 1 below, determine the Particles Sizes Distribution, its type and their factors of  $C_u$  and  $C_v$ . Comment your result.

(12 marks)

*Untuk menentukan taburan saiz zarah suatu sampel tanah diletakkan di atas suatu susunan siri ayak yang terdiri dari 19mm, 9.5mm, 4.75mm, 2.36mm, 1.18mm dan pelapik pan. Selepas getaran selama 15 min tanah yang tertahan ditimbang dan direkodkan. Daripada keputusan yang berikan dalam Jadual 1 di bawah, tentukan taburan saiz zarah, jenis tanah dan factor  $C_u$  dan  $C_v$ . Komen keputusan anda.*

Table 1

Sieve size <i>Saiz Ayak</i> (mm)	Mass Retained <i>Jisim Tertahan</i> (g)
19	89.9
9.5	209.5
4.75	290.7
2.36	331.5
1.18	247.2
pan	79.8

3. (a) Define the term total normal stress, pore water pressure and effective normal stress in soils.

(3 marks)

*Berikan definisi tegasan jumlah, tekanan air liang dan tekanan berkesan dalam tanah.*

- (b) A layer of sand with 5.0 m thick overlies a layer of clay with 3.5 m thick. The water table is 3.0 m below the surface of sand layer. The saturated unit weights of sand and clay are  $17.5 \text{ kN/m}^3$  and  $19 \text{ kN/m}^3$  respectively. And above the water table, the unit weight of sand is  $16.5 \text{ kN/m}^3$ . Draw the pressure distribution diagrams for total vertical stress, pore water pressure and effective vertical stress if sand is filled with capillary water up to 65% degree of saturation to a height of 1.0 m above the water table.

(7 marks)

*Satu lapisan pasir dengan ketebalan 5.0 m terletak di atas satu lapisan tanah liat dengan ketebalan 3.5 m. Aras air bumi berada 3.0 m di bawah permukaan lapisan pasir. Berat unit tepu pasir dan tanah liat masing-masing adalah  $17.5 \text{ kN/m}^3$  dan  $19 \text{ kN/m}^3$ . Di atas aras air bumi, berat unit pasir adalah  $16.5 \text{ kN/m}^3$ . Lakarkan agihan tekanan untuk jumlah tekanan, tekanan air liang dan tegasan berkesan sekiranya pasir dipenuhi dengan air kapilari dengan darjah ketepuan 65% setinggi 1.0 m ke atas dari aras air bumi. (Abaikan tekanan udara dalam kawasan yang dipenuhi dengan air kapilari).*

3. (c) A rectangular loaded area as shown in Figure 1.0 is to be loaded with a uniformly distributed load of  $q$ ,  $80 \text{ kN/m}^2$ . Determine the vertical stress increase  $\Delta\sigma_v$  at a depth of  $z = 3 \text{ m}$  below points A and B using the equations given below. Determine also the vertical stress increase  $\Delta\sigma_v$  at a depth of  $z = 3 \text{ m}$  below points C and D using the Newmark's influence chart (sketch the diagrams on the attached chart and enclosed with your answer script).

(10 marks)

*Suatu kawasan berbentuk segiempat tepat seperti yang ditunjukkan dalam Rajah 1.0 akan dikenakan dengan beban agihan seragam,  $q$  sebanyak  $80 \text{ kN/m}^2$ . Kirakan pertambahan tegasan menegak,  $\Delta\sigma_v$  pada kedalaman,  $z = 3 \text{ m}$  di bawah titik-titik A dan B dengan menggunakan persamaan-persamaan yang diberikan di bawah. Tentukan juga pertambahan tegasan menegak,  $\Delta\sigma_v$  pada kedalaman,  $z = 3 \text{ m}$  di bawah titik-titik C dan D dengan menggunakan Newmark's influence chart (tunjukkan lakaran pada carta yang diberikan dan dikepilkan bersama dengan buku jawapan anda).*

$$\Delta\sigma_v = qI_R$$

di mana

$$I_R = \frac{1}{4\pi} \left[ \frac{2mn\sqrt{m^2 + n^2 + 1}}{m^2 + n^2 + m^2n^2 + 1} \left( \frac{m^2 + n^2 + 2}{m^2 + n^2 + 1} \right) + \tan^{-1} \left( \frac{2mn\sqrt{m^2 + n^2 + 1}}{m^2 + n^2 - m^2n^2 + 1} \right) \right]$$

$$m = \frac{B}{z} \text{ dan } n = \frac{L}{z}$$

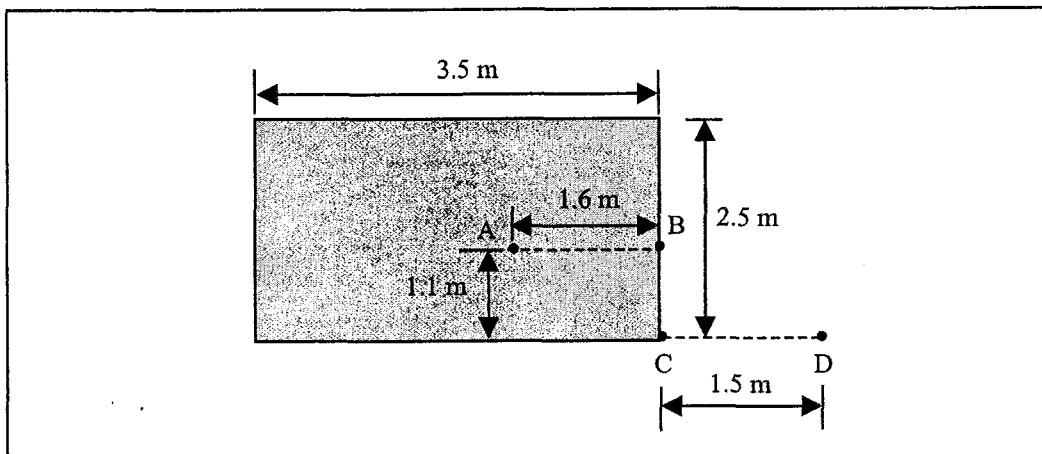


Figure 1.0

4. (a) Explain briefly as to how the constant head test conducted in laboratory can be used to determine the permeability of soil.

(4 marks)

*Terangkan dengan ringkas bagaimana ujian meter telap turus malar yang dijalankan di makmal dapat digunakan menentukan kebolehtelapan tanah.*

4. (b) A pumping test was carried out in the sand stratum to a depth of 15 m overlaying a clay layer with very low permeability. The initial ground water level is 1.9 m below ground level. Two observation wells were constructed with a distance of 15 m and 30 m from the well. Water was pumped out from the well with a constant rate of  $10.6 \times 10^{-3} \text{ m}^3/\text{s}$ . Water level in the first observation well (15 m from well) were reduced by 1.85 m and water level in the second observation well (30 m from well) were reduced by 1.25 m. Sketch the diagram of the pump well test. Derive the equation used to determine the coefficient of permeability and determine the coefficient of permeability.

(8 marks)

*Sebuah telaga dibina melalui stratum pasir sedalam 15 m sehingga kepada lapisan tanah liat yang mempunyai kebolehtelapan yang sangat rendah. Aras air bumi pada asalnya adalah 1.9 m di bawah paras bumi. Dua buah telaga cerapan dikorek dengan jarak 15 m dan 30 m dari telaga. Air dipam dari telaga sehingga mantap pada kadar aliran  $10.6 \times 10^{-3} \text{ m}^3/\text{s}$ . Aras air di dalam telaga cerapan pertama (15 m dari telaga) turun sebanyak 1.85 m manakala telaga cerapan kedua (60 m dari telaga) turun sebanyak 1.25 m. Lakarkan keadaan ujian telaga berkenaan. Terbitkan persamaan yang digunakan untuk menentukan pekali kebolehtelapan dan tentukan pekali kebolehtelapan stratum pasir.*

- (c) Define the term flow line and equipotential line. The section through a dam is shown in Figure 2.0. Draw the flow net under the dam. If the coefficient of permeability of the soil is  $4 \times 10^{-4} \text{ cm/s}$ , determine the quantity of seepage per meter of dam. Also, plot the pore air pressure distributions at the base of the dam.

(8 marks)

*Berikan definisi garisan aliran dan garisan sama upaya. Satu keratan merentasi empangan ditunjukkan dalam Rajah 2. Lukiskan jaringan aliran untuk empangan tersebut. Sekiranya pekali kebolehtelapan tanah ialah  $4 \times 10^{-4} \text{ cm/s}$ , tentukan kuantiti resipan air di bawah empangan per m panjang empangan. Plotkan agihan tekanan air liang yang bertindak sepanjang dasar empangan.*

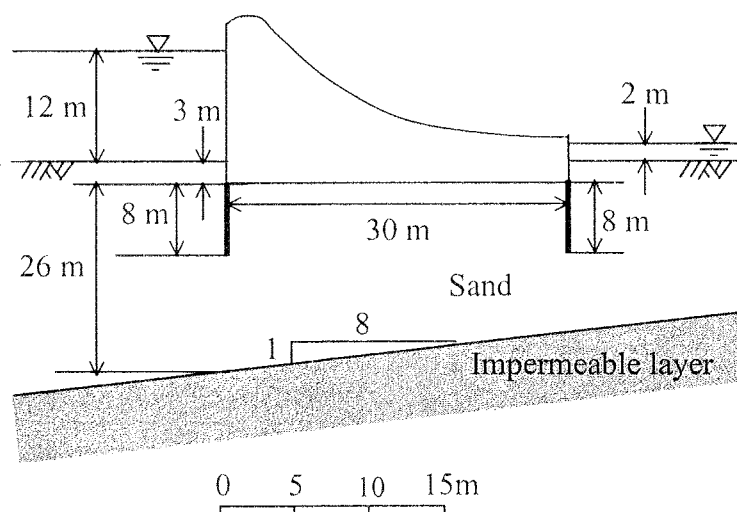


Figure 2.0

5. (a) Describe the standard compaction test normally carried out in the laboratory to determine the maximum dry density and optimum moisture content of the soil and define the compaction processes that you understand.

(5 marks)

*Huraikan kaedah pemadatan piawai yang selalunya dijalankan di makmal untuk menentukan nilai ketumpatan kering maksima dan kandungan air optima untuk sesuatu jenis tanah dan berikan definisi proses pemadatan yang dimaksudkan.*

- (b) Describe **FOUR (4)** of the techniques used on site to determine the relative density of the compacted soil and **FOUR (4)** type of machinery normally used on site to carry out compaction process.

(5 marks)

*Huraikan EMPAT (4) kaedah kawalan pemadatan yang digunakan di tapak bina untuk menentukan katumpatan relatif tanah yang dipadat dan EMPAT (4) jenis jentera pemadat yang selalunya digunakan.*

- (c) The results below were obtained from a series of standard compaction test in a laboratory to a specimen of soil sample to determine the suitability of the soil sources for an embankment to a housing project.

Draw a compaction curve and air void lines of 0% and 10% and determine the value of maximum dry density, optimum moisture content and the optimum air void content of the compacted sample if the relative density of the sample is 2.65.

(10 marks)

*Keputusan di bawah dicapai daripada suatu ujian pemadatan di makmal ke atas suatu sampel tanah yang diperlukan untuk kerja-kerja tambakan suatu projek perumahan.*

*Lukiskan lengkung pemadatan tanah dan garisan lompong udara 0% dan 10% seterusnya tentukan nilai ketumpatan kering maksimum, nilai kandungan air optima dan kandungan udara optimum sekiranya nilai ketumpatan bandingan tanah bersamaan dengan 2.65.*

**Table 2**

Water Content (%)	7.4	8.8	10.0	12.2	15.2	17.2
<i>Kandungan Air Tanah (%)</i>						
Bulk Density (Mg/m <sup>3</sup> )	1.89	2.04	2.13	2.16	2.10	2.06
<i>Ketumpatan Pukul Tanah (Mg/m<sup>3</sup>)</i>						

6. A consolidation test conducted on a sample has resulted in data shown in Table 3.

*Ujian pengukuhan keatas suatu sample menghasilkan data di Jadual 3.*

**Table 3**

e	Pressure, $\sigma'$ (kPa)
1.03	25
1.02	50
0.98	100
0.91	200
0.79	400
0.71	800
0.62	1600

- a. Determine the pre-consolidation pressure. (4 marks)

*Tentukan tegasan pra-pengukuhan.*

- b. Determine Compression Index,  $C_c$ . (4 marks)

*Tentukan Indeks Pengukuhan,  $C_c$ .*

- c. Say the sample taken from the middle of clay layer of Figure 3.0, find the over consolidation ratio, OCR, of the clay where sample was taken. If the agreed pre-consolidation pressure is 130 kPa, is the clay over-consolidated, normally-consolidated, or under-consolidated. (4 marks)

*Katakan sampel diambil dari pertengahan lapisan lempung di Rajah 3.0, tentukan nisbah pengukuhan terlebih, OCR, lempung tempat sampel diambil. Katakan teasan pra-pengukuhan 130 kPa, adakah lempung terkukuh-lebih, terkukuh-biasa, atau kurang terkukuh.*

- d. Say a fill of 5.0 m thick with a unit weight of 20 kN/m<sup>3</sup> was placed on the land surface of Figure 1, determine the total settlement which would occur due to the consolidation of the clay layer. (4 marks)

*Katakan selapisan tanah isi, 5.0 m, dengan berat unit 20 kN/m<sup>3</sup>, diletakkan di permukaan tanah, tentukan enapan pengukuhan yang bakal berlaku.*

6. e. Say a fill of 10.0 m thick with a unit weight of  $20 \text{ kN/m}^3$  was placed on the land surface of Figure 3.0, determine the total settlement which would occur due to the consolidation of the clay layer.

(4 marks)

*Katakan selapisan tanah isi, 10.0 m, dengan berat unit  $20 \text{ kN/m}^3$ , diletakkan di permukaan tanah, tentukan enapan pengukuhan yang bakal berlaku.*

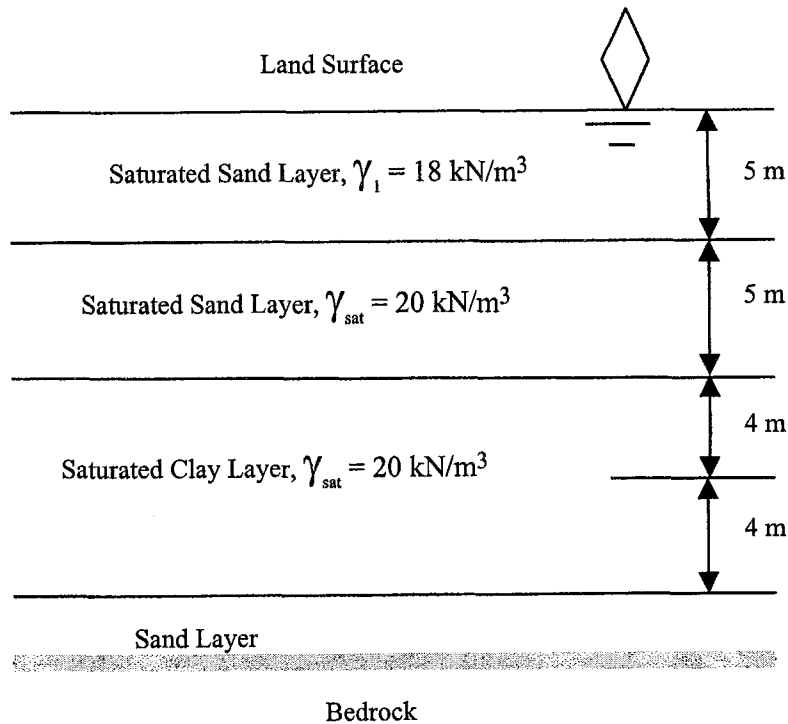


Figure 3.0



7. A consolidation test conducted on a clay sample has produced a result shown in Table 4. The incremental pressure was 100 kPa while the original pressure was also 100 kPa. The sample was 20 mm thick when  $t = 0$  and it was doubly drained.

*Ujian pengukuhan keatas sampel lempung menghasilkan data seperti di Jadual 4. Tegasan ditambah dari 100 kPa kepada 200 kPa. Sampel mempunyai ketebalan 20 mm semasa  $t = 0$ , dan sampel tersalir di kedua-dua arah.*

**Table 4**

Time, $t$ (minute)	Settlement (mm)
0	0
0.1	0.1
0.25	0.2
0.5	0.3
1	0.4
2	0.5
8	0.8
30	1.5
120	2.1
240	2.3
480	2.4
1440	2.6

- a. Determine the thickness of the sample when the average degree of consolidation,  $U = 50\%$

(4 marks)

*Tentukan ketebalan sampel apabila darjah pengukuhan purata,  $U = 50\%$ .*

- b. Determine the Coefficient of Consolidation,  $C_v$ . Use Table 5. Help:  $C_v =$

$$\frac{TH^2}{t}$$

(4 marks)

*Tentukan pekali pengukuhan,  $C_v$ . Gunakan Jadual 5. bantuan:  $C_v =$*

$$\frac{TH^2}{t}$$

**Table 5**

$U_{avg}$	Time Factor, T
0.1	0.008
0.2	0.031
0.3	0.071
0.4	0.126
0.5	0.197
0.6	0.287
0.7	0.403
0.8	0.567
0.9	0.848
0.95	1.163

- c. Say the sample was taken from the middle of the clay layer of Figure 3, determine the time required for the whole clay layer of Figure 1 to consolidate 95%. (4 marks)

*Katakan sampel diambil daripada pertengahan lapisan lempung di Rajah 3, tentukan masa diperlukan bagi lempung mengukuh 95%.*

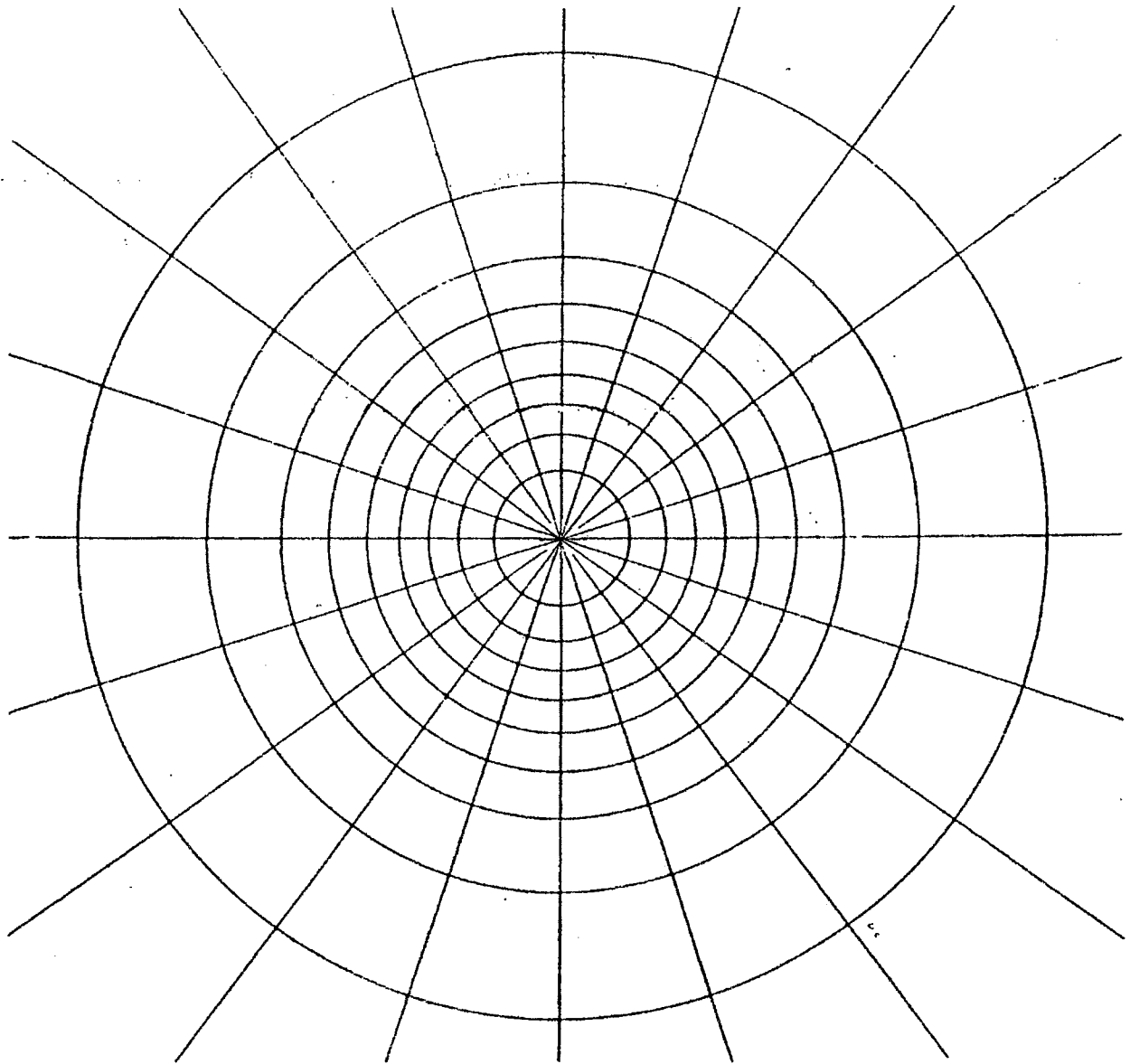
- d. Say the sample was taken from the middle of the clay layer of Figure 3, and the clay layer somehow is singly drained instead of doubly drained, determine the time required for the whole clay layer to consolidate 95%. (4 marks)

*Katakan sampel diambil daripada pertengahan lapisan lempung di Rajah 3, dan saliran hanya disatu arah saja dan bukan di kedua-dua arah, tentukan masa diperlukan bagi lempung mengukuh 95%.*

- e. Say for the clay layer of Figure 3, the total settlement due to a certain loading is 1.0 m, what would be the settlement when the whole clay layer achieved a degree of consolidation of 95%. (4 marks)

*Bagi tanah lempung di Rajah 3, katakan jumlah enapan kerana suatu bebanan ialah 1.0 m, tentukan enapan apabila keseluruhan lempung mengukuh 95%.*

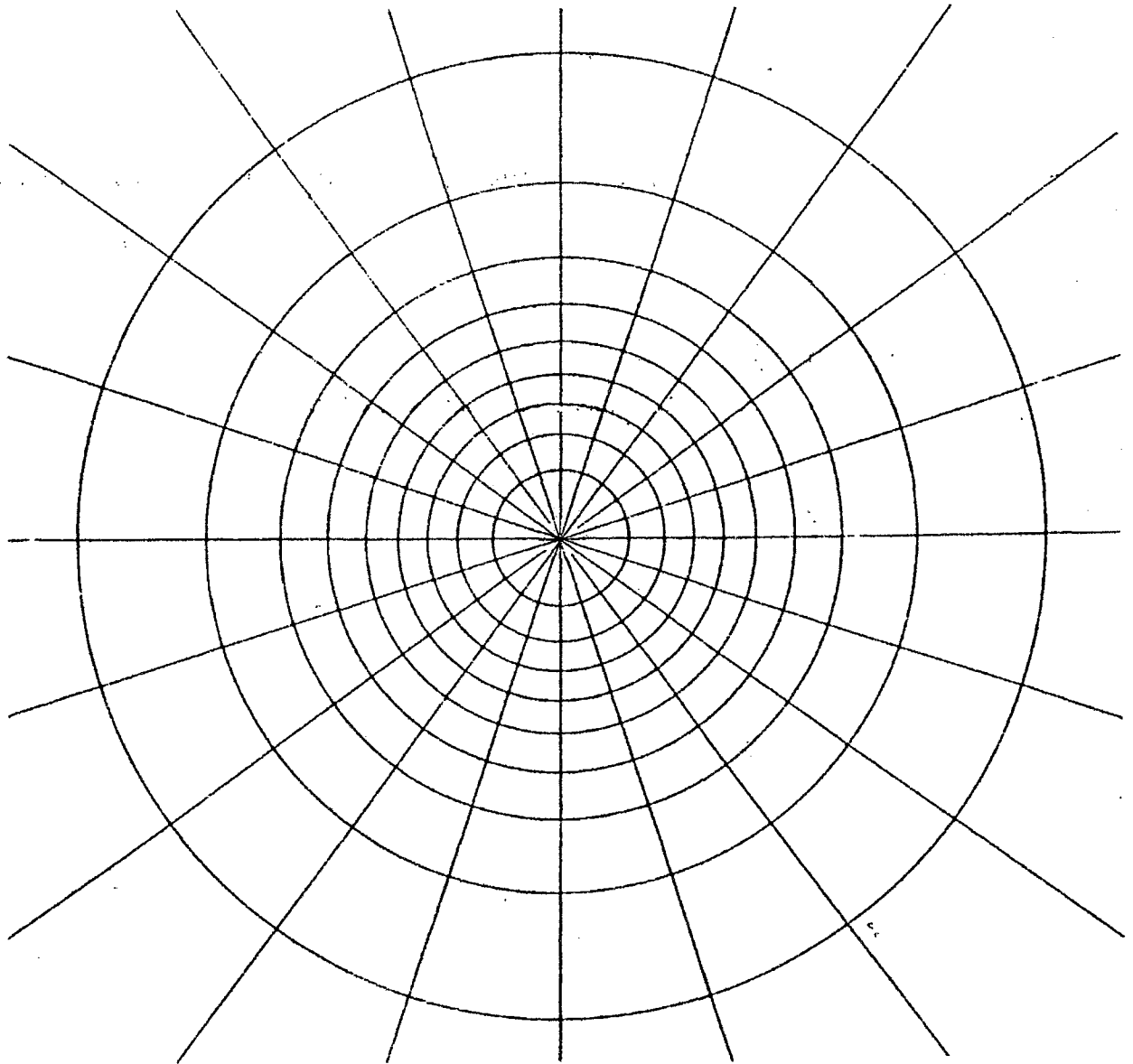
*Stresses and Displacements*



Scale line

Newmark's influence chart for vertical stress. Influence value per unit pressure = 0.005. (Reproduced from N.M. Newmark (1942) *Influence Charts for Computation of Stresses in Elastic Foundations*, University of Illinois Bulletin No. 338, by permission of Professor Newmark.)

*Stresses and Displacements*



Scale line

Newmark's influence chart for vertical stress. Influence value per unit pressure = 0.005. (Reproduced from N.M. Newmark (1942) *Influence Charts for Computation of Stresses in Elastic Foundations*, University of Illinois Bulletin No. 338, by permission of Professor Newmark.)