

---

UNIVERSITI SAINS MALAYSIA

2<sup>nd</sup>. Semester Examination  
2003/2004 Academic Session  
*Peperiksaan Semester Kedua  
Sidang Akademik 2003/2004*

Februari / Mac 2004

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

Duration: 3 hours  
*Masa : 3 jam*

---

**Instructions to candidates:**

1. Ensure that this paper contains **FOURTEEN (14)** printed pages including appendices before you start your examination.  
*Sila pastikan kertas peperiksaan ini mengandungi **EMPAT BELAS (14)** muka surat bercetak termasuk lampiran sebelum anda memulakan peperiksaan ini.*
2. This paper contains **SIX (6)** questions. Answer **FIVE (5)** questions only. Marks will be given to the **FIRST FIVE (5)** questions put in order on the answer script and **NOT** the **BEST FIVE (5)**.  
*Kertas ini mengandungi **ENAM (6)** 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 page.  
*Tiap-tiap soalan **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 does it meant by 3-phase and 2-phase in soil engineering aspect?  
(2.5 marks)

*Apakah yang dimaksudkan dengan 3-fasa dan 2-fasa dalam aspek kejuruteraan tanah?*

- (b) Indicate the difference between index properties of soil and classification tests.  
(2.5 marks)

*Tunjukkan perbezaan antara kandungan indeks dan pengelasan tanah*

- (c) Given the following data for an undisturbed soil sample;

$$G_s = 2.65, e = 0.55, w = 14\%$$

Determine wet unit weight, dry unit weight and degree of saturation.

(5 marks)

*Diberi data untuk sampel tanah tak terganggu seperti berikut;*

$$G_s = 2.65, e = 0.55, w = 14\%$$

*Tentukan berat unit basah, berat unit kering dan darjah ketepuan.*

- (d) A  $0.65\text{m}^3$  sample of soil weighs 15.5kg. When it is dried in an oven, it weighs 12.6kg. The specific gravity solids is found to be 2.65. Find the water content, void ratio, porosity, degree of saturation and wet and dry unit weights

(5 marks)

*$0.65\text{ m}^3$  sampel tanah mempunyai berat sebanyak 15.5kg. Apabila dikeringkan dalam ketuhar, beratnya menjadi 12.6kg. Graviti tentu tanah adalah 2.65, tentukan kandungan air, nisbah lompang, darjah ketepuan dan berat unit kering dan basah.*

1. (e) The following information is obtained from a sieve analysis to determine the range of particle sizes in a granular sample.

*Maklumat daripada analisis ayakan diberi untuk mengenalpasti julat saiz zarah untuk sampel berbutir.*

Sieve sizes (Saiz ayak)	Sieve opening (Bukaan ayak)	Percent filter by weight (Peratusan ketelusan dari jisim)
#4	4.76	96
#10	2.00	80
#20	0.84	52
#40	0.42	38
#60	0.25	25
#100	0.149	12
#200	0.074	5

Present the information as a grain-size curve on semilog graph. From the plot, determine the uniformity coefficient  $C_u$  and  $C_c$ .

*Tunjukkan maklumat tersebut dalam bentuk lengkung saiz zarah dengan menggunakan graf semilog. Daripada plot tersebut tentukan  $C_u$  dan  $C_c$ .*

(5 marks)

2. (a) Clay is a soil material that possesses plasticity in the presence of water. What does the term plastic mean in relation to clay soils?

(2.5 marks)

*Lempung adalah suatu bahan tanah yang mengandungi keplastikan apabila terdapat kehadiran air. Apakah terminologi plastik yang dimaksudkan dalam hubungan tanah lempung ini?*

- (b) Sketch the clay mineral in simple form and explain briefly the **THREE (3)** clay structure from the combination.

(2.5 marks)

*Lakarkan mineral lempung dalam bentuk mudah dan terangkan **TIGA (3)** jenis pembentukan mineral tersebut secara ringkas.*

2. (c) Cone penetrometer tests carried out on a sample of boulder clay gave the following results:

*Ujian penusukan kon telah dijalankan ke atas lempung dan keputusannya adalah seperti berikut;*

cone penetration (mm) <i>(penusukan kon [mm])</i>	15.8	18.1	18.3	21.9	22.3
moisture content (%) <i>kandungan lembapan (%)</i>	31.0	32.4	33.8	35.0	37.0

Determine the liquid limit of the soil.

*Tentukan had kecairan tanah tersebut.*

(5 marks)

- (d) The Atterberg's limits of soil are  $LL = 60\%$  ,  $PL = 25\%$  and the soil contains 44% by mass of solids in clay range of the particles size. If the natural water content of the soil is 62.5%, calculate its Plasticity Index, Activity and Liquidity Index. Comment your result.

(10 marks)

*Had Atterberg's tanah adalah  $LL = 60\%$ ,  $PL = 25\%$  dan kandungan tanah lempung adalah 44%. Sekiranya kandung air semulajadi adalah 62.5%, kira Indeks Keplastikan, Aktiviti dan Indeks Kecaiban. Komen keputusan anda.*

3. A consolidation test was conducted on a sample and resulted in data shown in Table 1.

*Suatu ujian pengukuhan dijalankan di makmal ke atas suatu sampel tanah lempung dan keputusan yang didapati dinyatakan di Jadual 1.*

**Table 1**

e	Pressure, $\sigma'$ (kPa)
1.1	25
1.085	50
1.055	100
1.01	200
0.94	400
0.79	800
0.63	1600

- a. Determine the preconsolidation pressure.

(5 marks)

*Tentukan tekanan pra-pengukuhan.*

- b. Determine Compression Index,  $C_c$ , and Swell Index,  $C_s$ , if any.

(5 marks)

*Tentukan nilai Indeks Pemampatan (Compression Index),  $C_c$ , dan Indeks Pengembangan (Swell Index),  $C_s$ , jika ada.*

- c. Say the sample was taken from the middle of clay layer in Figure 1, determine its over consolidation ratio, OCR. Was the sample overconsolidated, normally consolidated, or underconsolidated. Use:  $\gamma_1 = 16 \text{ kN/m}^3$ ,  $\gamma_2 = 20 \text{ kN/m}^3$ , and  $\gamma_3 = 20 \text{ kN/m}^3$ .

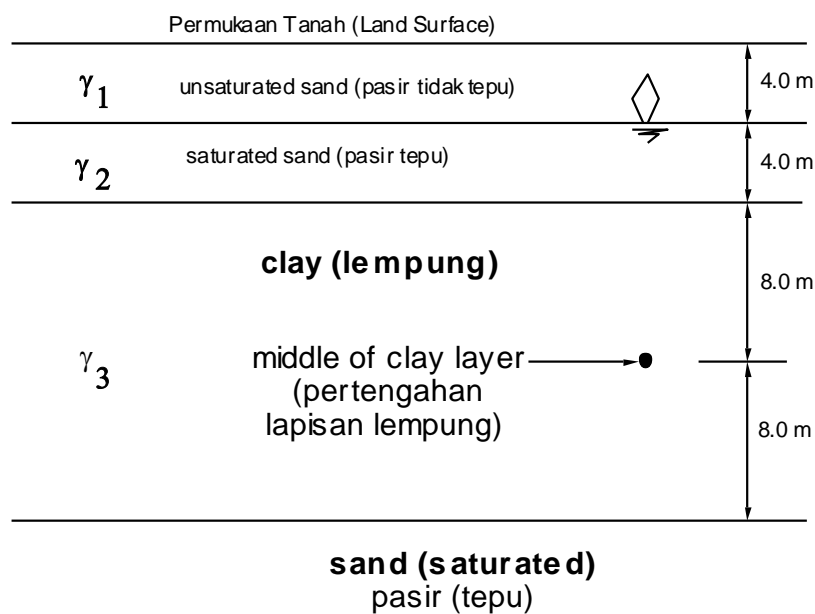
(5 marks)

*Jika sampel tanah diambil dari kedudukan yang dinyatakan di Rajah 1, tentukan nilai Nisbah Pengukuhan Lebih (Over Consolidation Ratio), OCR. Adakah tanah terkukuh lebih (overconsolidated), terkukuh normal (normally consolidated), atau terkukuh kurang (underconsolidated). Gunakan nilai  $\gamma_1 = 16 \text{ kN/m}^3$ ,  $\gamma_2 = 20 \text{ kN/m}^3$ , dan  $\gamma_3 = 20 \text{ kN/m}^3$ .*

- d. Say a fill of 5.0 m thick with a unit weight of  $16 \text{ kN/m}^3$  was placed on the land surface in Figure 1, determine the total settlement which would occur due to the consolidation of the clay layer.

(5 marks)

*Sekiranya suatu lapisan tanah isian setebal 5.0 m dan berat unitnya  $16 \text{ kN/m}^3$  diletakkan di atas permukaan tanah di Rajah 1, tentukan jumlah enapan yang akan berlaku disebabkan pengukuhan lapisan tanah lempung.*



**Figure 1**

4. A consolidation test was conducted on a clay sample and produced a result as shown in Table 2. The incremental pressure was 180 kPa while the original pressure was also 180 kPa. The sample was 22.00 mm thick when  $t=0$  and it was doubly drained.

*Suatu ujian pengukuhan dijalankan di makmal ke atas suatu sampel tanah lempung dan keputusan yang didapati dinyatakan di Jadual 2. Tekanan tambahan yang dikenakan 180 kPa sementara tekanan asal juga 180 kPa. Ketebalan sampel 22.00 mm pada masa  $t = 0$  dan sampel tersalir dua hala.*

**Table 2**

Time, t (minit)	Settlement (mm)
0	0
0.1	0.10
0.25	0.15
0.5	0.21
1	0.29
2	0.41
8	0.82
30	1.52
120	2.10
240	2.27
480	2.42
1440	2.59

- a. Determine the thickness of the sample when the average degree of consolidation,  $U_{avg} = 100\%$  and when the average degree of consolidation,  $U_{avg} = 50\%$ .

(5 marks)

*Apakah tebal sampel ketika darjah pengukuhan purata,  $U_{avg} = 100\%$  dan ketika darjah pengukuhan purata,  $U_{avg} = 50\%$ .*

- b. Determine the Coefficient of Consolidation,  $C_v$ . Any value from Table 3 may be used for the calculation. Help:  $C_v = \frac{TH}{t}$  .

(5 marks)

*Tentukan nilai Pekali Pengukuhan,  $C_v$ . Sebarang nilai dari Jadual 3 boleh digunakan dalam pengiraan anda. Bantuan:  $C_v = \frac{TH}{t}$  .*

**Table 3**

$U_{avg}$	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 in Figure 1, determine the time required for the whole clay layer to consolidate 90%.

(5 marks)

*Katakan sampel tanah diambil dari kedudukan di lapisan lempung seperti dinyatakan di Rajah 1, tentukan masa yang diperlukan bagi lapisan lempung mengukuh 90%.*

- d. Say the sample was taken from clay layer in Figure 1, determine the time required for the clay in the middle of the layer to consolidate 90%. Use Figure 2 for your calculation.

(5 marks)

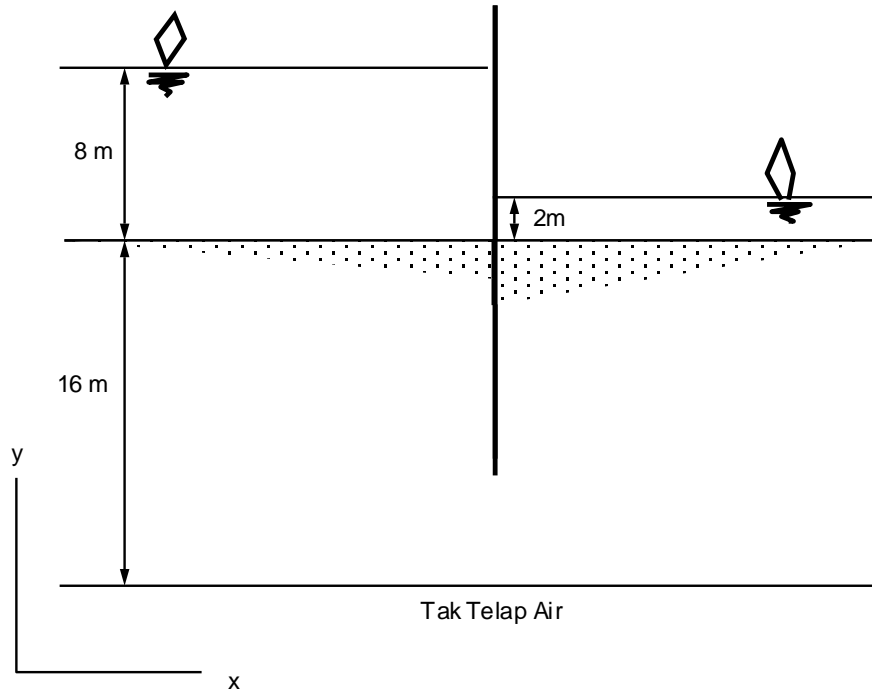
*Katakan sampel tanah diambil dari kedudukan di lapisan lempung seperti dinyatakan di Rajah 1, tentukan masa yang diperlukan bagi lempung di tengah lapisan tersebut mengukuh 90%. Gunakan Rajah 2 sebagai bantuan anda.*

Figure 2



5. Figure 3 shows the cross section of a sheet pile dam (a cofferdam), drawn to scale. The width of the channel (width of dam in z-direction) is 50 m.

*Rajah 3 yang dilukis menurut skel, menunjukkan keratan rentas suatu empangan daripada cerucuk keping. Lebar empangan (ketebalan pada arah z) 50 m.*



**Figure 3**

- a. Draw the flow net for seepage of water through the permeable soil. Use 3 flow channels ( $N_f = 3$ ). Examine the correctness of the net. Mark with a ✓ for every correct net unit and a ✗ for every incorrect one.

(5 marks)

*Lukiskan jaring aliran bagi resapan air melalui bawah empangan tersebut. Gunakan 3 laluan air ( $N_f = 3$ ). Periksa ketepatan lukisannya, pastikan setiap garis aliran memotong setiap garisan seturus pada sudut tepat. Tandakan setiap kotak yang betul lukisannya dengan tanda ✓ dan setiap kotak yang tidak betul lukisannya dengan tanda ✗.*

- b. Determine the flow rate across the dam in m cu. per day. Say  $k = 10^{-2}$  cm/s.  
(5 marks)

*Tentukan kadar resapan air merentasi empangan tersebut dalam kiraan m padu sehari. Anggap nilai  $k = 10^{-2}$  cm/s.*

- c. For the last downstream net unit next to the wall of dam, conduct a stability analysis. First, determine total stress at the base of net unit. Next, determine the water pressure,  $u$ . Finally, determine the Safety factor against quick condition, which is given by  $\frac{\sigma}{u}$ . Say  $\gamma_{sat} = 20$  kN/m<sup>3</sup>.

(5 marks)

*Bagi kotak aliran paling kritikal iaitu kotak terakhir bagi laluan aliran paling hampir dengan empangan, jalankan analisa kestabilannya. Mula-mula tentukan jumlah tegasan pada dasar kotak tersebut,  $\sigma$ . Tentukan pula tekanan air pada dasar kotak,  $u$ . Tentukan Faktor Keselamatan daripada keadaan jerlus iaitu  $\frac{\sigma}{u}$ . Anggap  $\gamma_{sat} = 20$  kN/m<sup>3</sup>.*

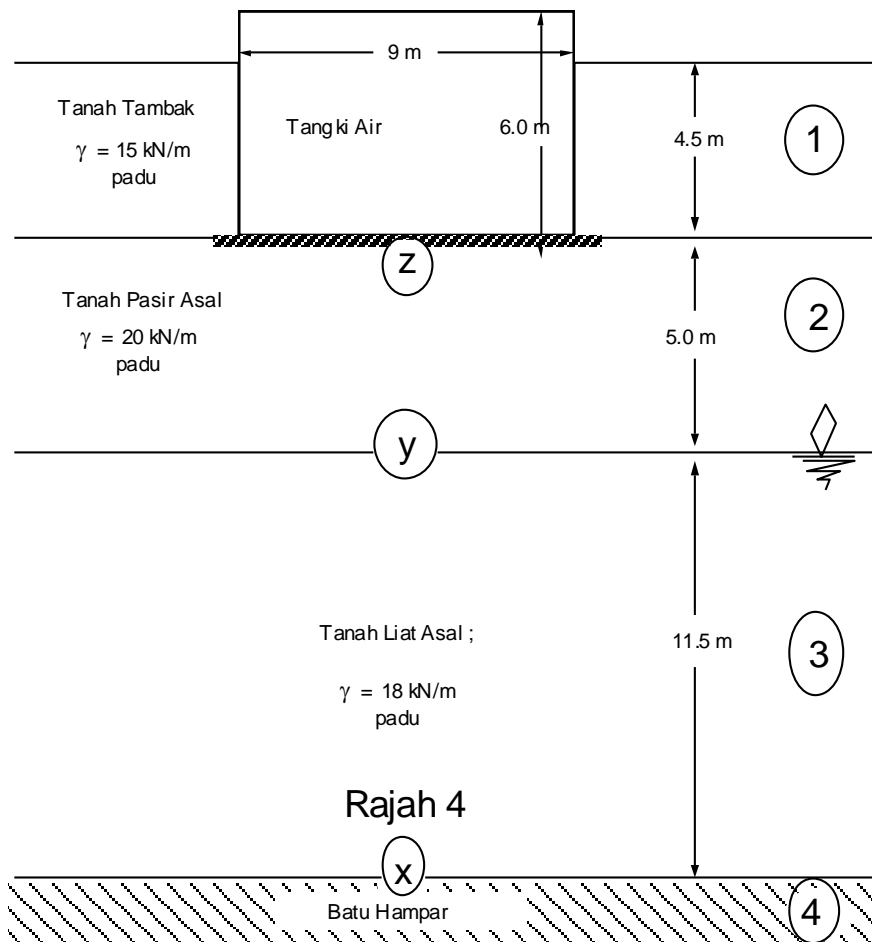
- d. Determine if there is a liquefaction occurring at the base of dam where the flow distance along a net unit is least. Help:  $i_{cr} = \frac{\gamma'}{\gamma_w}$ .

(5 marks)

*Tentukan sama ada keadaan kececairan (liquefaction) berlaku di dasar empangan. Bantuan:  $i_{cr} = \frac{\gamma'}{\gamma_w}$ .*

6. Figure 4 shows a 9.0 m diameter water tank with a flexible base. Soil layer 1 is a transported fill material placed uniformly around the water tank. Soil layers 2, 3, and 4 are originally existing at site.

Rajah 4 menunjukkan sebuah tangki air bular berdiameter 9.0 m yang dibina di atas suatu tapak boleh lentur (flexible). Lapisan Tanah 1 ditambak selepas tangki air dibina. Lapisan Tanah 2, Lapisan Tanah 3, dan Batu Hampar 4 semuanya berasal di situ.



- a. Determine the effective stresses at x, y, and z before construction of the water tank.

(10 marks)

Tentukan tegasan berkesan di x, y, dan z sebelum pembinaan tangki air dilakukan,

- b. Determine the effective stresses at  $x$ ,  $y$ , and  $z$  after completion of the construction, i.e., after placement of the uniform fill material and filling the tank with water. Say weight of the tank itself is very light compared to the weight of the water it contains.

(10 marks)

*Tentukan tegasan berkesan di  $x$ ,  $y$ , dan  $z$  selepas semua kerja selesai iaitu tanah di sekeliling tangki sudah ditambak, dan tangki sudah dipenuhi air. Anggap berat tangki sangat kecil jika dibandingkan dengan berat air di dalamnya.*

Help: for a location centrally located  
underneath a circular load

$$\Delta\sigma = q \left\{ 1 - \frac{1}{\left[ \left( \frac{R}{z} \right)^2 + 1 \right]^{3/2}} \right\}$$

Bantuan: bagi suatu kedudukan di  
bawah tengah bebanan bulat.