UNIVERSITI SAINS MALAYSIA

Second Semester Examination
2011/2012 Academic Session

June 2012

EAG 245/3 – Soil Mechanics
[*Mekanik Tanah*]

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

Please check that this examination paper consists of **NINETEEN (19)** pages of printed material including 2 appendices before you begin the examination.
[*Sila pastikan bahawa kertas peperiksaan ini mengandungi **SEMBILAN BELAS (19)** muka surat yang bercetak termasuk 2 lampiran sebelum anda memulakan peperiksaan ini.*]

Instructions : This paper contains **SIX (6)** questions. Answer **FIVE (5)** questions.
[***Arahan** : Kertas ini mengandungi **ENAM (6)** soalan. Jawab **LIMA (5)** 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 saturated silty clay soil with a natural water content of 23.5 % has been found in a deep excavation of shaft for KL MRT tunnel. Determine its porosity and bulk unit weight. (Assume G_s=2.7)

[4 marks]

(b) Understanding relationship among the soil constituents is important to solve a variety of problems in soil mechanics. Based on your understanding on the soil constituents prove the following relationships:

(i) $S = \frac{wG_s}{e}$

(ii) $\gamma_d = \frac{\gamma}{1+w}$

[4 marks]

(c) A liquid limit test using the Casagrande cup device was carried out as one of the evaluation criteria for the foundation design in reclaimed land area over untreated marine clay soil in Penang. The test results are given in **Table 1**.

Table 1

Number of blows	*6*	*12*	*20*	*28*	*32*
Water content (%)	*51.5*	*46.1*	*42.2*	*37.6*	*36.0*

(i) Determine the liquid limit of the clay soil.

(ii) If the natural moisture content is 37% and the plastic limit is 24%, calculate the liquidity index of the clay

(iii) Explain whether a brittle type of failure to occur for this type of clay.

[6 marks]

(d) An embankment for a new West Coast Highway is to be constructed using soil from a borrow pit located 10 km from the construction site. The bulk unit weight of the soil in the borrow pit is 16.5 kN/m^3 and its natural water content is 4%. The soil is to be compacted to attain a dry unit weight of 17.5 kN/m^3 at water content of 7%. Determine the additional volume of water required per cubic meter of embankment, assuming no loss of water during soil transportation.

[6 marks]

2. (a) The result of a particle size analysis of a soil obtained from a new housing development site at Balik Pulau, Penang is given in **Table 2**.

Table 2

Sieve No.	3/8"	4	10	20	40	100	200
Opening (mm)	9.53	4.75	2	0.85	0.425	0.15	0.075
% finer	100	90.8	71.2	63.5	50.8	29.6	5.1

(i) Plot the particle size distribution curve from the results above.

(ii) Explain, whether an Atterberg limit test is necessary for this type of soil.

(iii) Classify the soil according to the USCS and AASHTO Soil Classification System (refer to **Appendix 1** and **2**).

[12 marks]

(b) The water contents of soil samples taken from the bed of a dry pond at different depths are given in **Table 3**.

Table 3

Depth (m)	1	2	3	4	5	6
Water content, w (%)	20.2	24.5	6.1	33.6	42.5	43.0

The groundwater table is at the surface of the bed. Assume Gs = 2.7

(i) Plot the depth versus water content and depth versus saturated unit weight on the same graph.

(ii) Identify any ambiguous water content value with depth from the graph plotted.

(iii) Assuming the water contents given in table above are correct, determine the type of soil that might be encountered from the answer given in ii.

[8 marks]

3. (a) Explain briefly why constant head test is not suitable for the determination of permeability coefficient of fine grained soils.

[2 marks]

(b) A falling head permeability test was carried out on a clay soil of diameter 10 cm and length 15 cm. In 1 hour the head in the 5 mm diameter standpipe dropped from 66 cm to 48.2 cm. Calculate the permeability coefficient of this clay soil.

[4 marks]

(c) A flownet is a graphical representation of a flow field that satisfies Laplace's equation and comprises a group of flow lines and equipotential lines. With the help of sketch, explain the practical uses of a flownet in geotechnical engineering applications.

[6 marks]

(d) An excavation is made for the canal that will receive water seeping from the stream in Ulu Langat, Selangor **(Figure 1)**. The measured flow into the canal is 0.3 x 10^{-4} m^3/s per unit area of flow. Two pore water pressure transducers, A and B, placed along a line parallel to the slope and approximately at the canal mid height gave readings of 4 kPa and 3.5 kPa. Assuming flow parallel to the slope, estimate the permeability coefficient of the soil.

[8 marks]

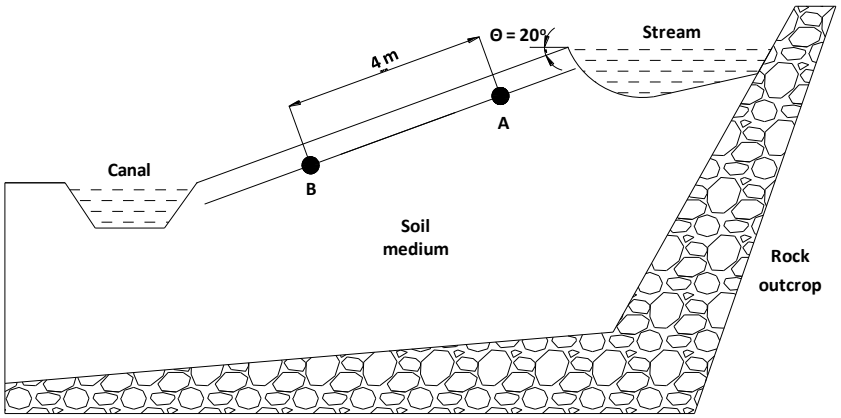


Figure 1

4. Given in **Figure 2** is the result of a modified proctor compaction test on a soil. The volume of mould used was 943.3 cm³. The hammer weigh 44.5 N and height of drop was 457.2 mm. For each layer of soil, 25 blows were applied, and 5 layers were required to fill the mould.

(a) From **Figure 2**, determine the maximum dry unit weight of soil and the optimum moisture content.

[4 marks]

(b) What would be the mass (in kg) of soil in the mould if it was having maximum dry unit weight and optimum moisture content as in Question (a).

[4 marks]

(c) A mould of compacted soil having optimum moisture content was put in water until saturated, and then weighed, and the mass of the saturated soil turned out to be 2.00 kg. What would be the specific gravity of the solid mass of soil?

[4 marks]

(d) Determine the energy required for the compaction of a mould of soil by Modified Proctor method.

[4 marks]

(e) Based on the information available from the test, what would be the best degree of saturation required for the soil, if it was to receive the best compaction result in the field?

[4 marks]

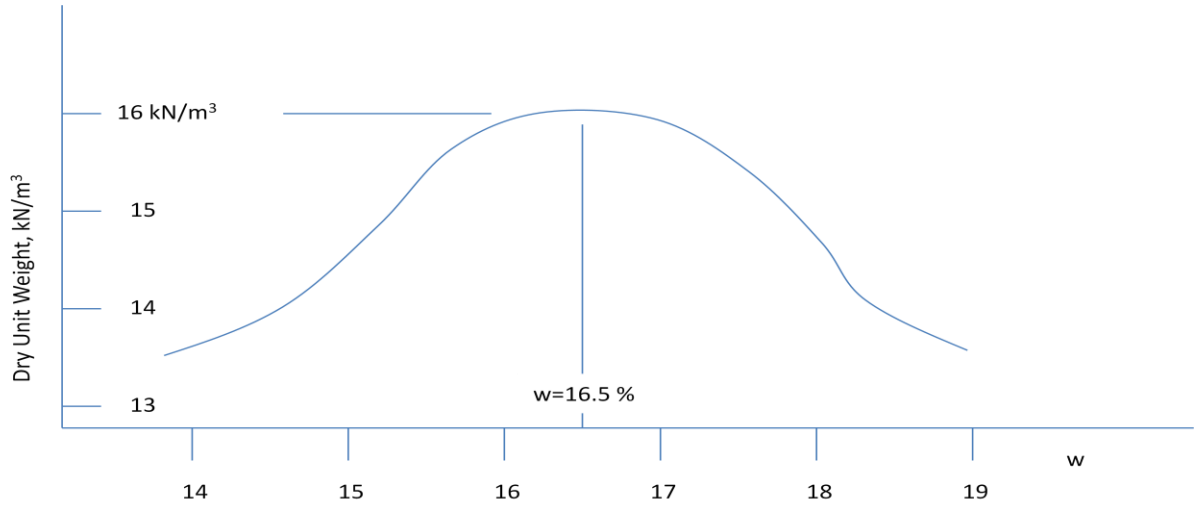


Figure 2

5. The profile of **Figure 3** shows a new 14 m wide embankment located over layers of sand and clay. The water level is as shown at ground surface.

Before placing the embankment:

(a) Determine vertical total stresses at Point 1 (3 m below surface), Point 2 (5 m below surface), and Point 3 (7 m below surface).

[4 marks]

(b) Determine pore water pressure at Point 1 (3 m below surface), Point 2 (5 m below surface), and Point 3 (7 m below surface).

[4 marks]

(c) Determine vertical effective stresses at Point 1 (3 m below surface), Point 2 (5 m below surface), and Point 3 (7 m below surface).

[4 marks]

After placing the embankment:
(**Figure 4** may be used to determine change in stress under the embankment)

(d) Determine vertical total stresses at Point 1 (3 m below surface), Point 2 (5 m below surface), and Point 3 (7 m below embankment).

[4 marks]

(e) Determine vertical effective stresses at Point 1 (3 m below surface), Point 2 (5 m below surface), and Point 3 (7 m below embankment).

[4 marks]

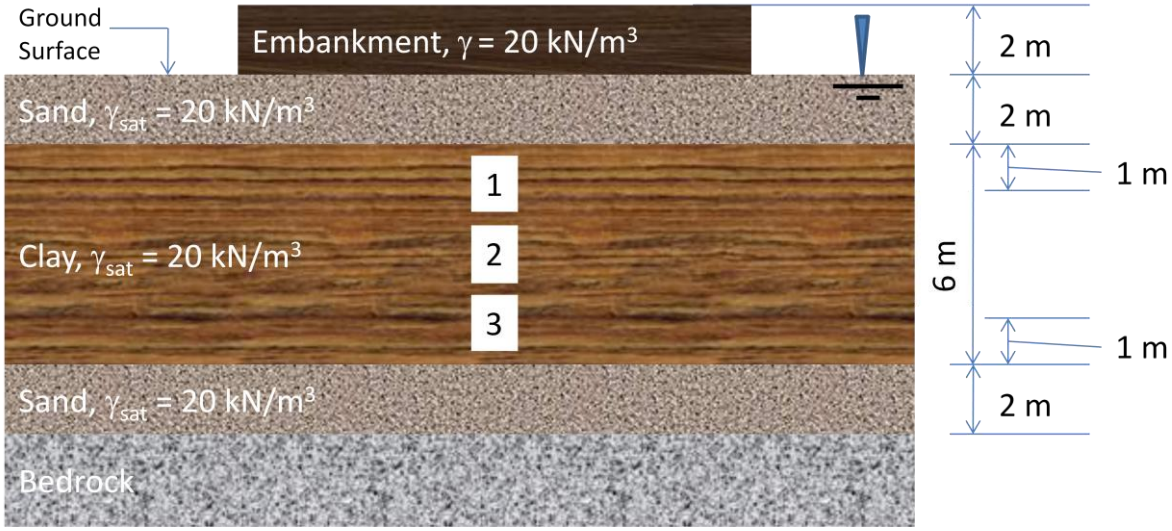
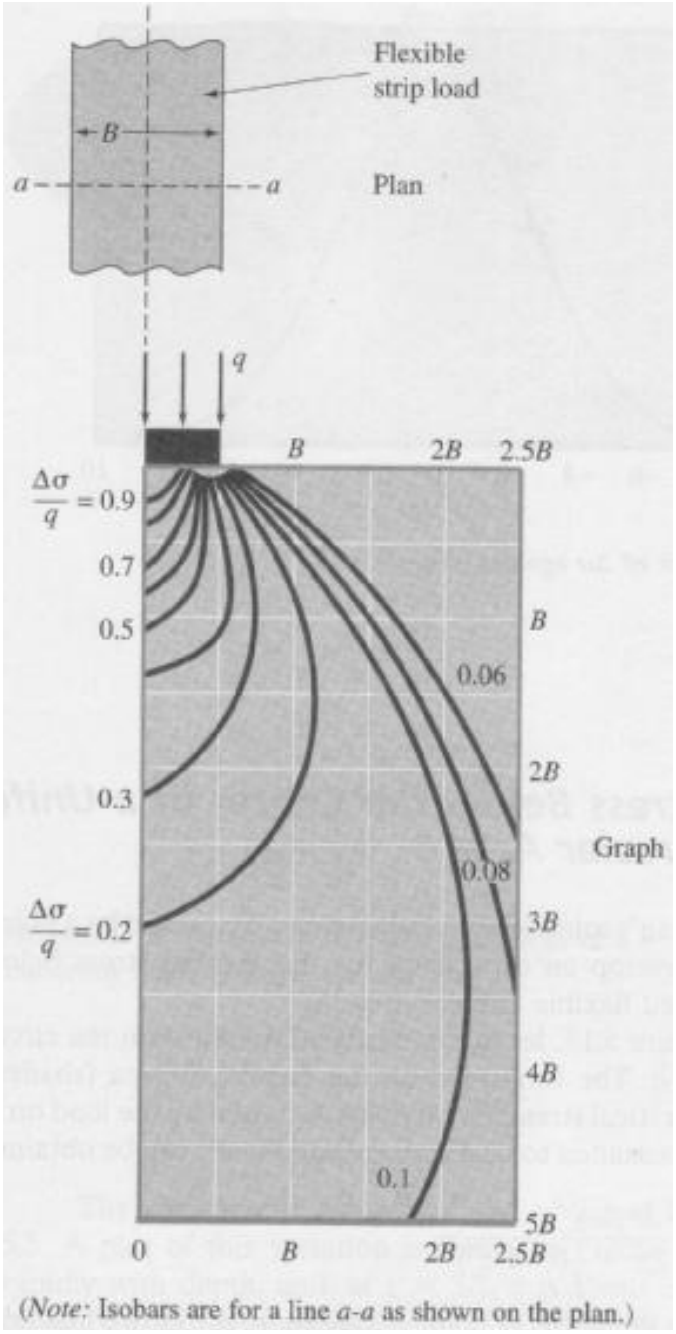


Figure 3



Courtesy of Das B M, Fundamentals of Geotechnical Engineering (2000), Brooks/Cole Thomson Learning, Pacific Groove, CA 93950, page 131

Figure 4

6. (a) Describe the relationship between consolidation settlement and other basic geotechnical parameters, by starting with a phase diagram and followed by other theories of consolidation.

[4 marks]

(b) Explain briefly the principles of pre-compression that is used to eliminate post construction settlement problem.

[4 marks]

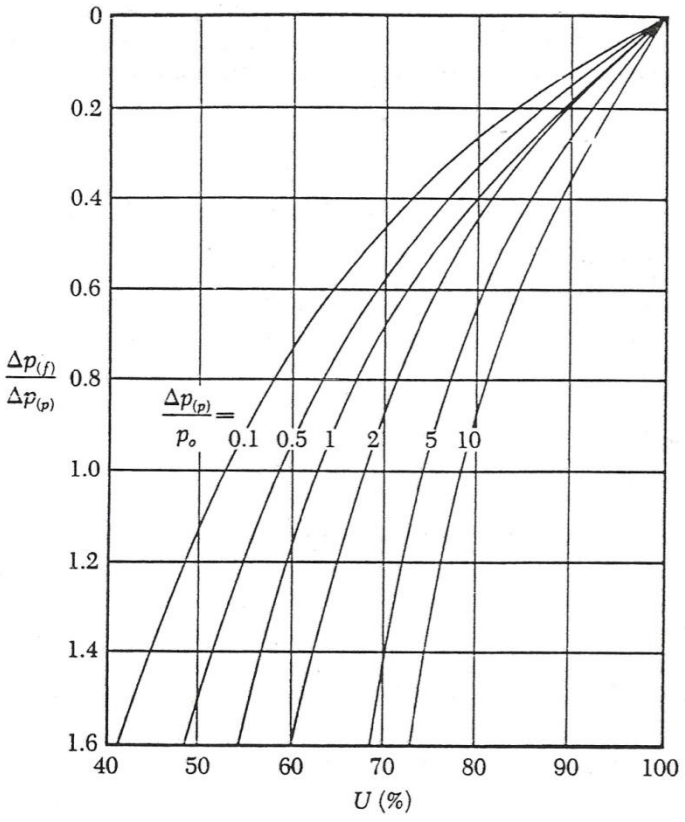
(c) During the construction of a highway bridge, it is expected that the average permanent load on a clay layer will increase by about 115kPa. The average effective overburden pressure at the middle of the clay is 210kPa. Given H_c = 6m, c_v = 0.36 m^2/month, and the clay is normally consolidate.

(i) Determine the surcharge load needed to eliminate the entire primary consolidation in 9 months. Use **Figure 5 (a)**, **(b)** and **(c)** below to solve the problem.

[8 marks]

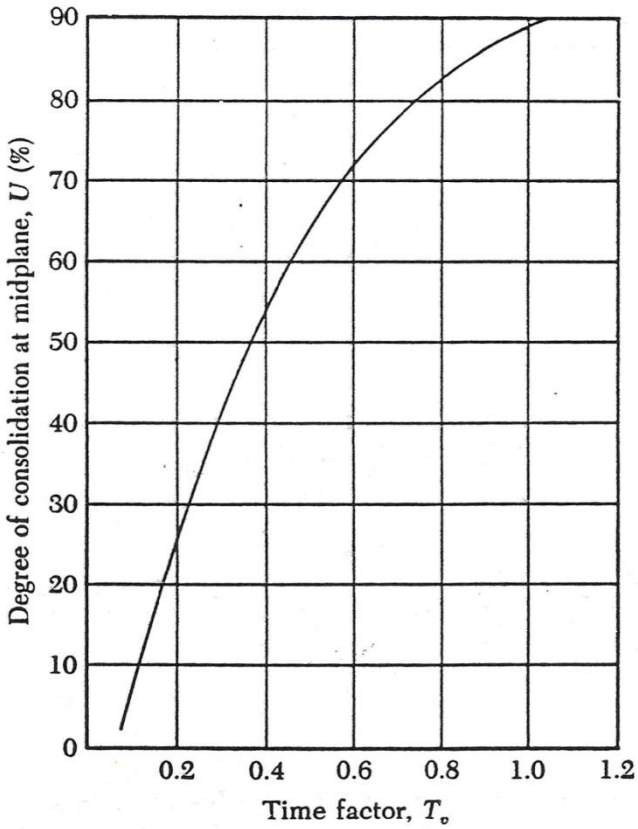
(ii) Suggest a suitable method in reducing the amount of surcharge load and the application time required in order to eliminate the entire primary consolidation.

[4 marks]



Plot of $\Delta p_{(f)}/\Delta p_{(p)}$ against U for various values of $\Delta p_{(p)}/p_o$

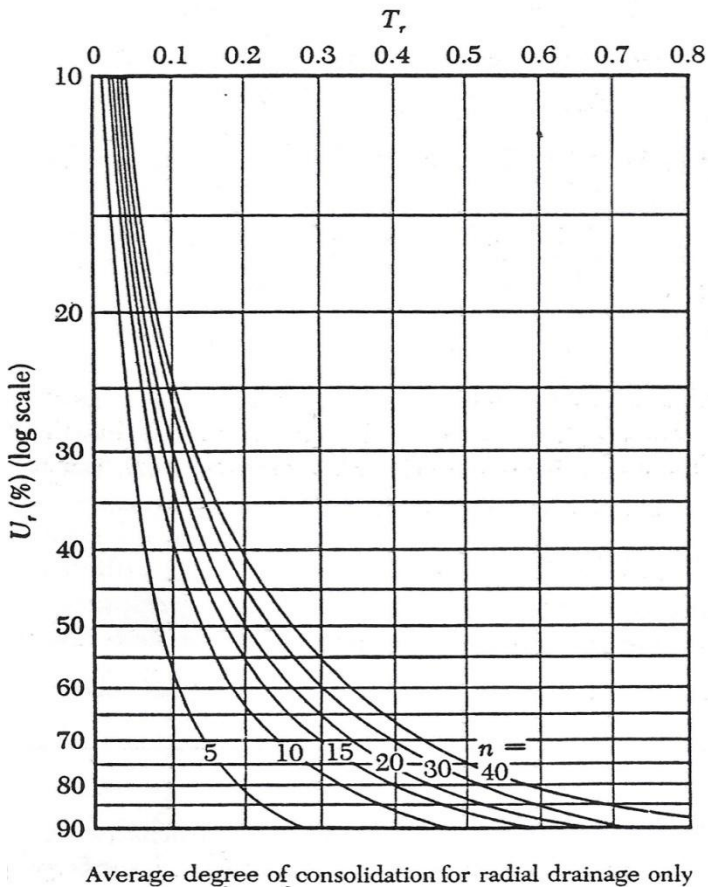
(a)



Plot of midplane degree of consolidation against T_v

(b)

Figure 5


T_r
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
10
20
30
40
50
60
70
80
90
U_r (%) (log scale)
5
10
15
20
30
40
n =
Average degree of consolidation for radial drainage only

(c)

Figure 5

1. (a) *Tanah lempung berkelodak yang mempunyai kandungan air semulajadi sebanyak 35% telah ditemui semasa korekan dalam syaf untuk terowong KL MRT. Tentukan keliangan dan berat unit pukal tanah tersebut. (Andaikan G_s=2.7)*

[4 markah]

(b) *Pemahaman hubungkait antara juzuk-juzuk tanah penting dalam menyelesaikan pelbagai masalah mekanik tanah. Berdasarkan kepada pemahaman anda terhadap juzuk-juzuk tanah, buktikan hubungkait berikut:*

(i) $S = \frac{wG_s}{e}$

(ii) $\gamma_d = \frac{\gamma}{1+w}$

[4 markah]

(c) *Ujian had cecair menggunakan 'Casagrande Cup device' telah dijalankan sebagai salah satu kriteria penilaian rekabentuk asas di atas tanah lempung laut tak dirawat di kawasan tebus guna tanah di Pulau Pinang. Hasil ujikaji tersebut diberikan di* ***Jadual 1.***

Jadual 1

Jumlah hentaman	*6*	*12*	*20*	*28*	*32*
Kandungan air (%)	*51.5*	*46.1*	*42.2*	*37.6*	*36.0*

(i) Tentukan had cecair tanah lempung tersebut

(ii) Jika kandungan air semulajadi, 37% dan had plastik, 24%, kira indeks kecairan lempung tersebut.

(ii) Jelaskan samaada kegagalan rapuh akan berlaku terhadap jenis lempung tersebut.

[6 markah]

(d) *Benteng untuk lebuhraya baru pantai barat akan dibina menggunakan tanah dari lubang tanah pinjam yang terletak 10 km dari tapak binaan. Berat unit pukal tanah di dalam lubang tanah pinjam tersebut; 16.5 kN/m^3, dan kandungan air semulajadi, 4 %. Tanah tersebut perlu dimampatkan untuk mendapatkan berat unit kering, 17.5 kN/m^3 dan kandungan air, 7 %. Tentukan penambahan isipadu air yang diperlukan untuk benteng tersebut dengan mengandaikan tiada kehilangan air semasa pemindahan tanah tersebut.*

[6 markah]

2. (a) *Keputusan analisis saiz zarah tanah yang diperolehi dari pembangunan perumahan baru di Balik Pulau, Pulau Pinang diberikan di* ***Jadual 2****.*

Jadual 2

No. Ayak	*3/8"*	*4*	*10*	*20*	*40*	*100*	*200*
Bukaan (mm)	*9.53*	*4.75*	*2*	*0.85*	*0.425*	*0.15*	*0.075*
% halus	*100*	*90.8*	*71.2*	*63.5*	*50.8*	*29.6*	*5.1*

(i) Plot lenkungan taburan saiz zarah dari keputusan di atas.

(ii) Jelaskan, samaada ujikaji had atterberg diperlukan untuk jenis tanah tersebut.

(iii) Kelaskan tanah tersebut berdasarkan sistem pengelasan tanah USCS dan AASHTO (rujuk kepada ***Appendik 1*** *dan* ***2****).*

[12 markah]

(b) *Kandungan air dari sampel tanah yang diambil dari dasar tasik yang kering pada kedalaman yang berbeza diberikan di* ***Jadual 3****.*

Jadual 3

Kedalaman (m)	*1*	*2*	*3*	*4*	*5*	*6*
Kandungan air; w (%)	*20.2*	*24.5*	*6.1*	*33.6*	*42.5*	*43.0*

Paras air bumi adalah pada permukaan dasar tasik. Andaikan Gs = 2.7.

(i) Plot kedalaman lawan kandungan air dan kedalaman lawan berat unit tepu pada graf yang sama.

(ii) Kenalpasti nilai kandungan air dengan kedalam yang meragukan dari graf yang diplot.

(iii) Andaikan kandungan air yang diberikan betul, tentukan jenis tanah yang mungkin ditemui dari jawapan yang diperolehi pada ii.

[8 markah]

3. (a) *Jelaskan secara ringkas kenapa ujikaji turus malar tidak sesuai digunakan untuk menentukan pekali kebolehtelapan bagi tanah berbutir halus.*

[2 markah]

(b) *Ujikaji turus menurun telah dijalankan pada tanah lempung berdiamter 10 cm dan panjang 15 cm. Dalam masa satu jam, turus di dalam paip tegak berdiameter 5 mm telah menurun daripada 68 cm kepada 50.2 cm. Kira pekali kebolehtelapan bagi tanah lempung tersebut.*

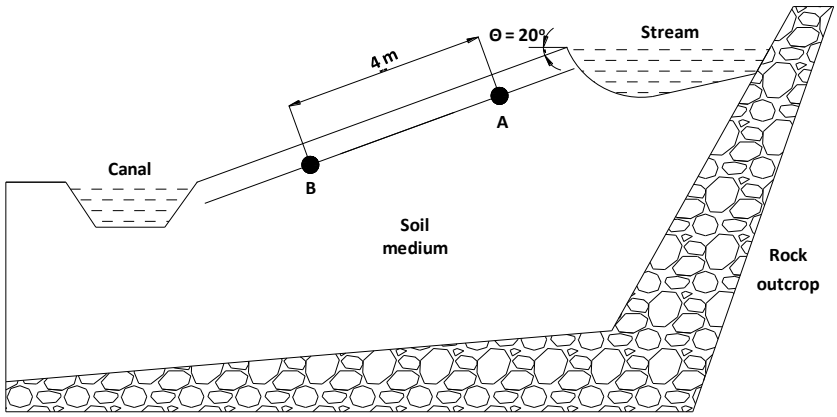
[4 markah]

(c) *Jaringan aliran merupakan gambaran medan aliran yang memenuhi persamaan Laplace dan meliputi sekumpulan garis aliran dan garis sama upaya. Dengan bantuan lakaran, jelaskan kegunaan praktikal jaringan aliran di dalam aplikasi kejuruteraan geoteknik.*

[6 markah]

(d) *Pengorekan telah dibuat untuk saluran yang akan menerima air resapan dari sungai di Ulu Langat, Selangor (**Rajah 1**). Aliran kedalam saluran yang diukur, 0.3 x 10^{-4} m^3/s per unit luas aliran. Dua transducer tekanan air liang, A dan B yang diletakkan sepanjang garisan selari kepada cerun dan lebih kurang tinggi tengah saluran memberikan bacaan, 4 kPa dan 3.5 kPa. Dengan mengandaikan aliran selari terhadap cerun, anggarkan pekali kebolehtelapan tanah tersebut.*

[8 markah]



Rajah 1

4. ***Rajah 2*** *menunjukkan keputusan ujian pemadatan praktor-ubahsuai keatas suatu sampel tanah yang baik. Isipadu acuan 943.3 cm³. Berat tukul pemadat 44.5 N dan ketinggian angkatan tukul bagi setiap hentakan 457.2 mm. Bagi setiap lapisan ujian, 25 hentakan dikenakan, dan 5 lapisan diperlukan bagi mengisi acuan.*

(a) *Dari **Rajah 2**, tentukan berat unit kering maksimum tanah dan kandungan air optimum tanah.*

[4 markah]

(b) *Tentukan jisim (dalam unit kg) tanah dalam acuan sekiranya tanah tersebut mempunyai berat unit kering maksimum dan kandungan air optimum tanah seperti dalam Soalan (a).*

[4 markah]

(c) *Katakan, acuan yang mengandungi tanah terpadat dengan berat kering maksimum dan kandungan air optimum direndam dalam air sehingga tepu, kemudian ditimbang. Jika jisim tanah tersebut didapati 2.00 kg, tentukan nilai graviti tentu bagi bahan pepejalnya.*

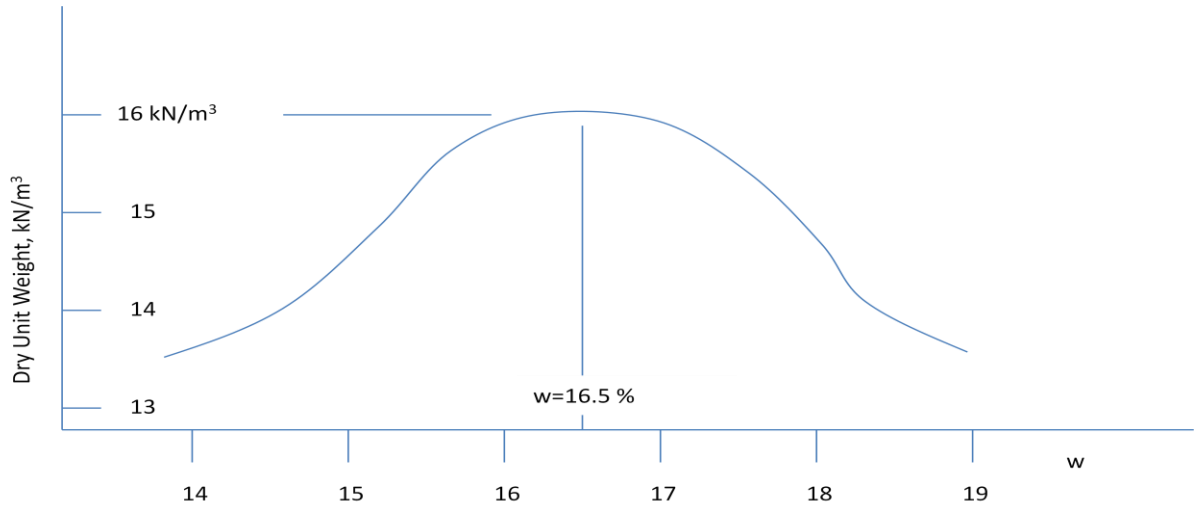
[4 markah]

(d) *Tentukan tenaga diperlukan bagi kerja pemadatan tanah sebuah acuan menurut kaedah praktor-ubahsuai.*

[4 markah]

(e) *Berdasarkan maklumat ujian, tentukan darjah ketepuan paling sesuai bagi tanah dilapangan, sekiranya ia dalam keadaan untuk menerima pemadatan terbaik.*

[4 markah]



Rajah 2

5. *Keratan rentas **Rajah 3** menunjukkan suatu tambakan 14 m lebar yang terletak diatas lapisan pasir dan tanah liat. Paras air seperti dinyatakan , iaitu pada paras tanah.*

Sebelum ada tambakan:

(a) *Tentukan tegasan jumlah menegak pada Titik 1 (3 m di bawah permukaan), Titik 2 (5m di bawah permukaan), dan Titik 3 (7 m di bawah permukaan).*

[4 markah]

(b) *Tentukan tekanan air liang pada Titik 1 (3 m di bawah permukaan), Titik 2 (5 m di bawah permukaan), dan Titik 3 (7 m di bawah permukaan).*

[4 markah]

(c) *Tentukan tegasan berkesan menegak pada Titik 1 (3 m di bawah permukaan), Titik 2 (5 m di bawah permukaan), dan Titik 3 (7 m di bawah permukaan).*

[4 markah]

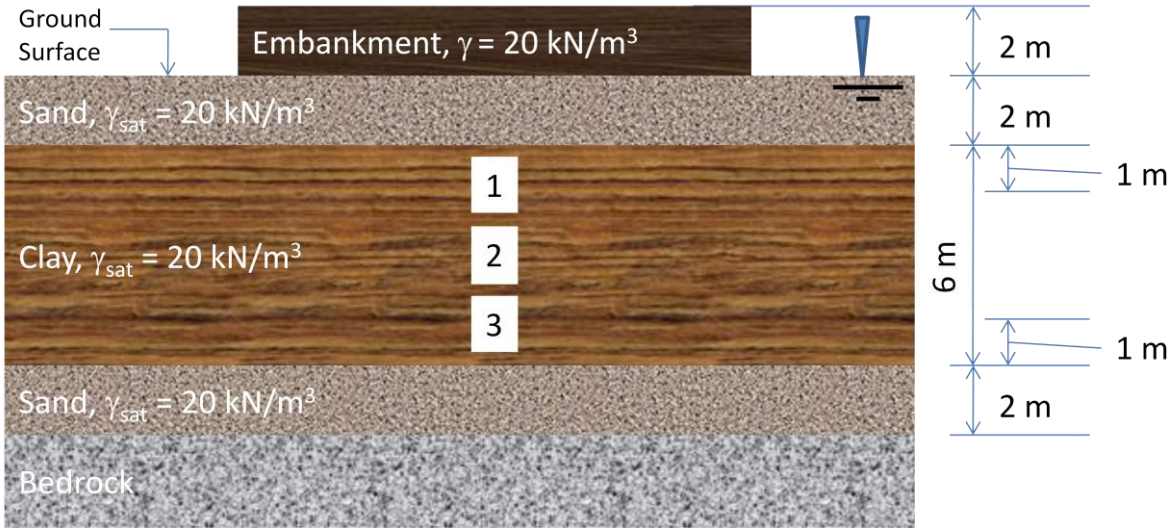
*Setelah ada tambakan (**Rajah 4)** boleh digunakan bagi menetukan perubahan tegasan di bawah tambakan):*

(d) *Tentukan tegasan jumlah menegak pada Titik 1 (3 m di bawah permukaan), Titik 2 (5m di bawah permukaan), dan Titik 3 (7 m di bawah permukaan).*

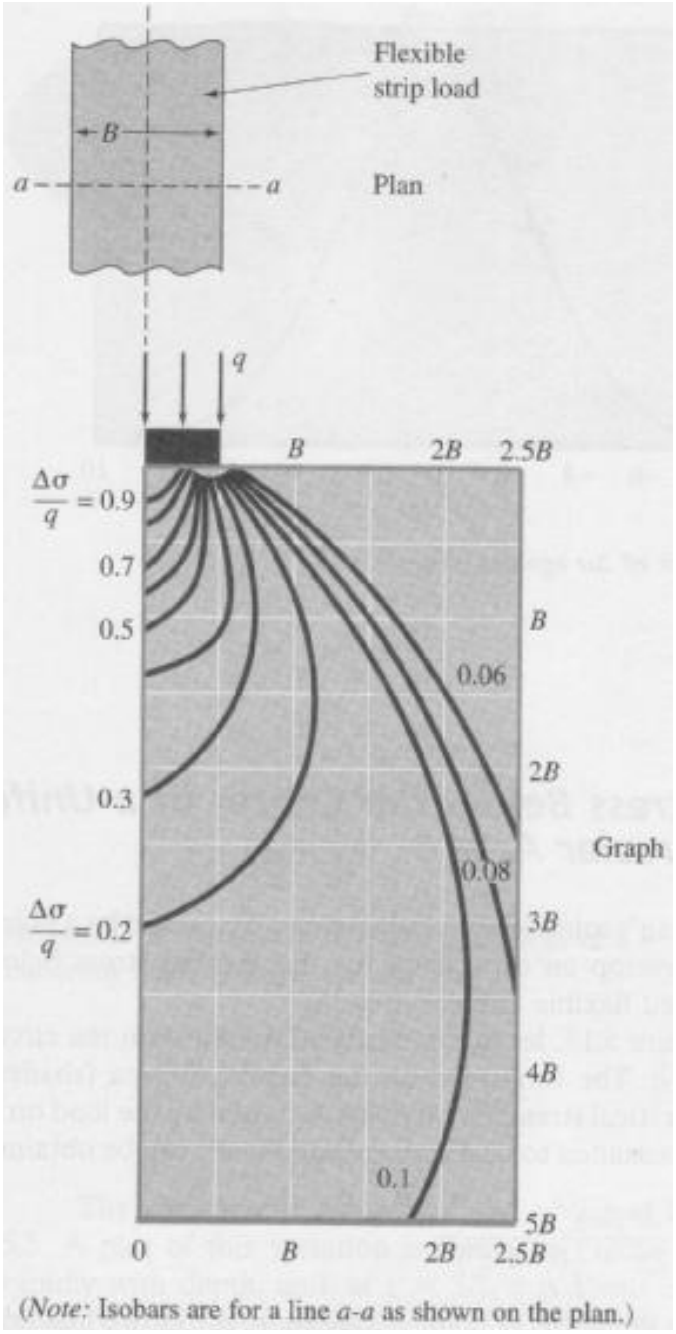
[4 markah]

(e) *Tentukan tegasan berkesan menegak pada Titik 1 (3 m di bawah permukaan), Titik 2 (5 m di bawah permukaan), dan Titik 3 (7 m di bawah permukaan).*

[4 markah]



Rajah 3



Courtesy of Das B M, Fundamentals of Geotechnical Engineering (2000), Brooks/Cole Thomson Learning, Pacific Groove, CA 93950, page 131

Figure 4

6. (a) *Terangkan hubungkait antara pengukuhan enapan dan parameter asas geoteknik yang lain, bermula dari gambarajah Fasa tanah yang diikuti oleh teori pengukuhan.*

[4 markah]

(b) *Terangkan secara ringkas prinsip pra-pengukuhan yang digunakan untuk menghapuskan masalah pengenapan selepas pembinaan*

[4 markah]

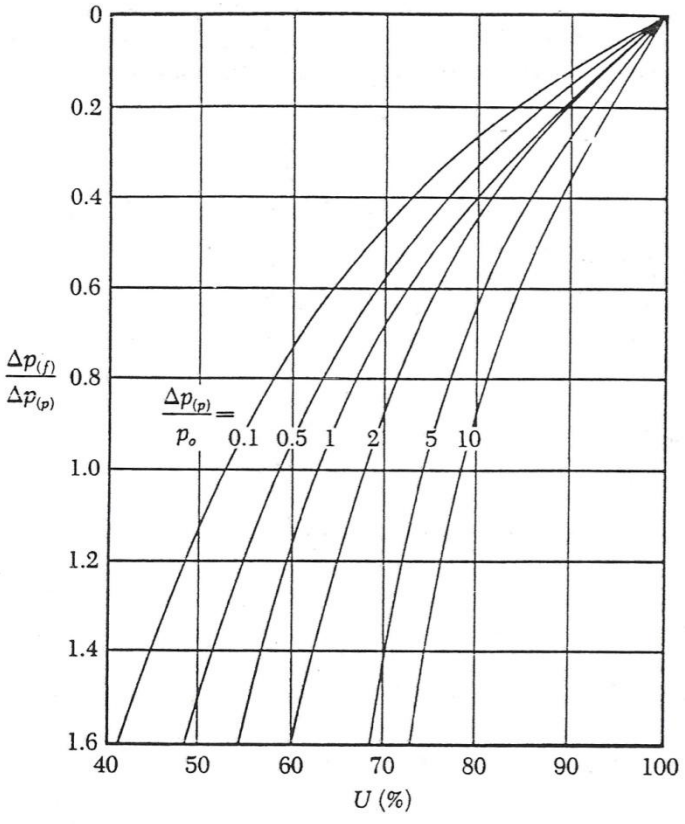
(c) *Semasa pembinaan sebuah jambatan lebuhraya, dianggarkan purata beban kekal ke atas lapisan tanah lempung akan meningkat sebesar 115 kPa. Purata tekanan tanggungan atas di pertengahan lapisan tanah lempung adalah 210 kPa. Diberikan Hc = 6m, cv = 0.36 m^2/bulan dan tanah lempung adalah dalam keadaan terkukuh biasa.*

(i) *Tentukan jumlah bebanan surcaj diperlukan untuk menghapuskan keseluruhan pengukuhan peringkat pertama dalam masa 9 bulan. Gunakan* ***Rajah 5*** **(a)**, **(b)** dan **(c)** *dibawah untuk menyelesaikan masalah.*

[8 markah]

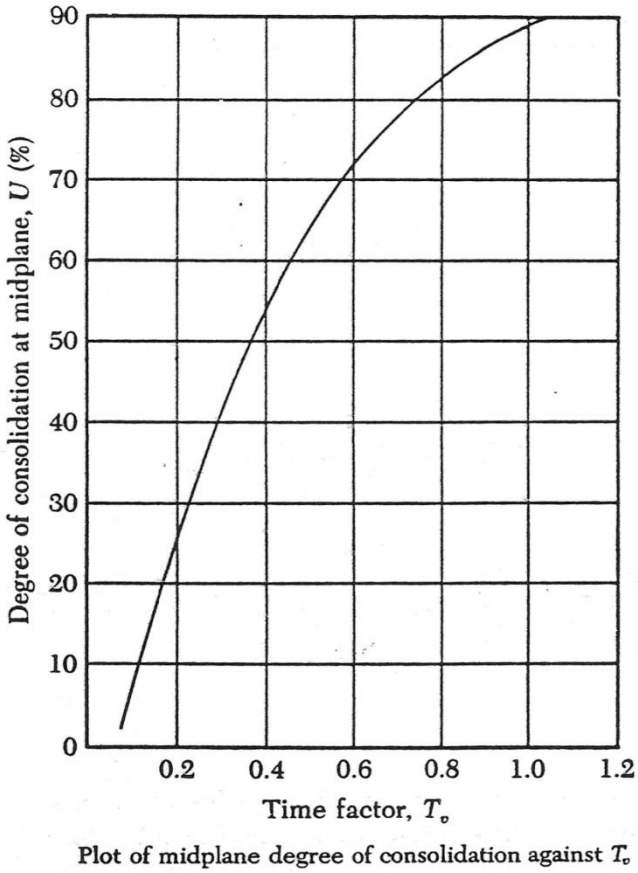
(ii) *Cadangkan kaedah yang bersesuaian untuk mengurangkan jumlah bebanan surcaj dan aplikasi masa yang diperlukan untuk menghapuskan keseluruhan pengukuhan peringkat pertama.*

[4 markah]



Plot of $\Delta p_{(f)}/\Delta p_{(p)}$ against U for various values of $\Delta p_{(p)}/p_o$

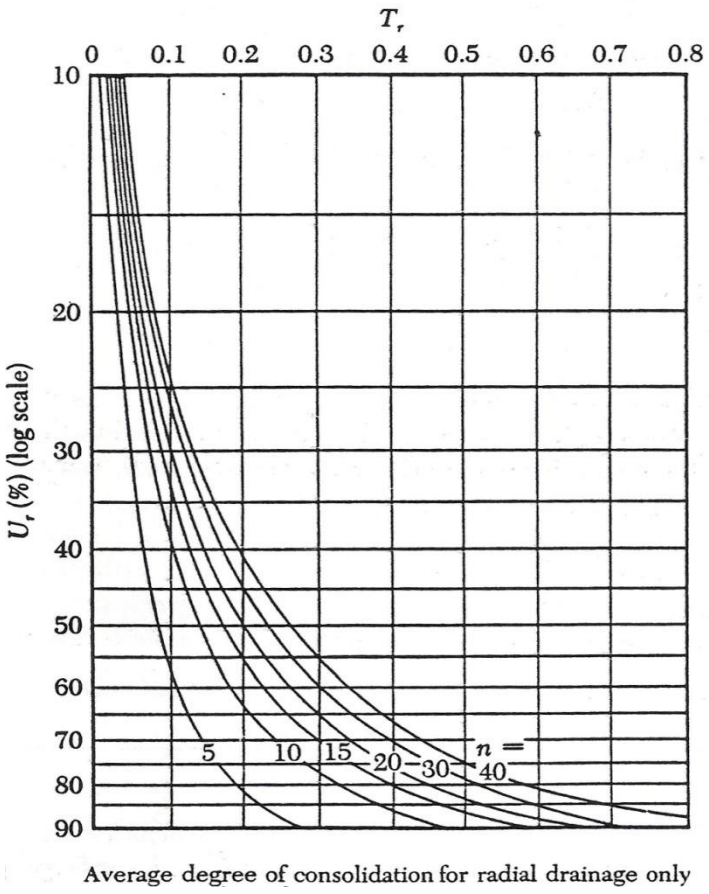
(a)



Plot of midplane degree of consolidation against T_v

(b)

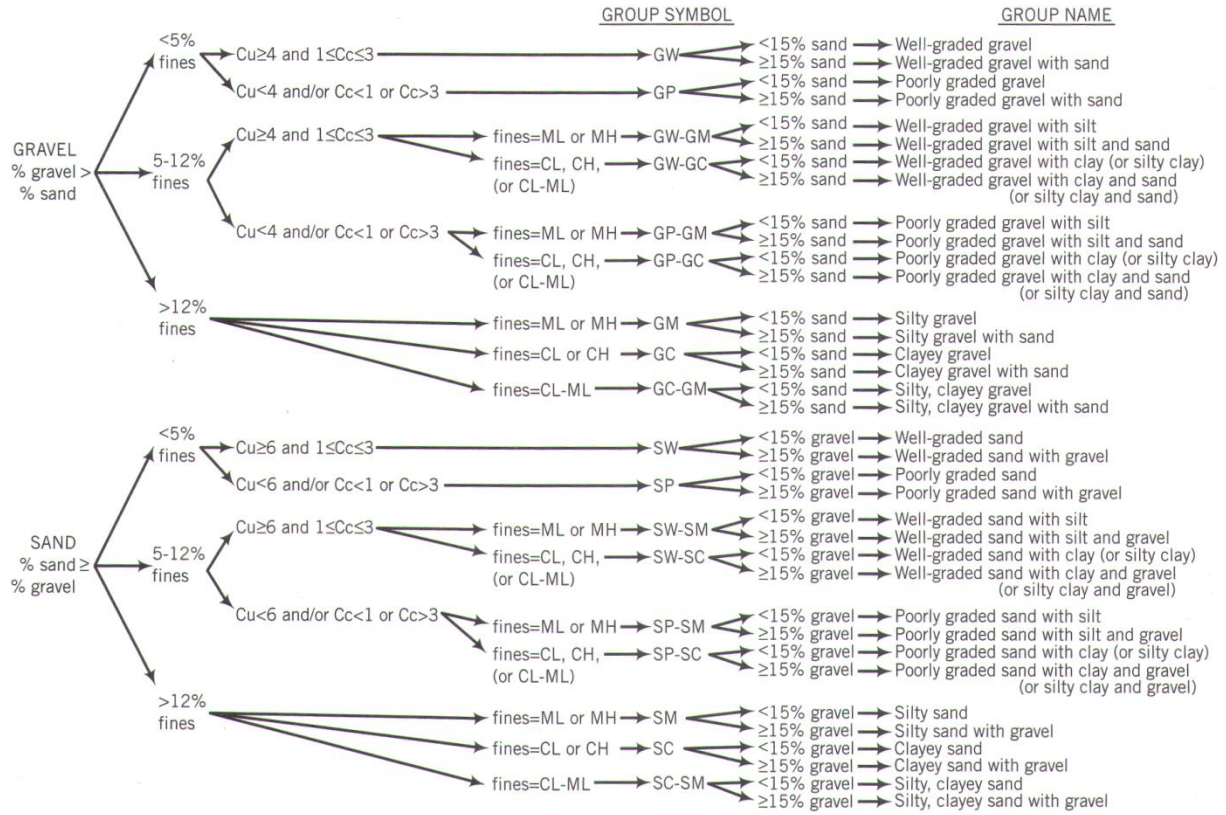
Rajah 5


T_r
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
10
20
30
40
50
60
70
80
90
U_r (%) (log scale)
5
10
15
20
30
40
n =
Average degree of consolidation for radial drainage only

(c)

Rajah 5

Appendix 1
Lampiran 1



[EAG 245/3]

Appendix 2
Lampiran 2

General classification	Granular materials (35% or less passing No. 200)							Silty-clay materials (More than 35% passing No. 200)			
Group classification	A-1		A-3	A-2				A-4	A-5	A-6	A-7 A-7-5, A-7-6
	A-1-a	A-1-b		A-2-4	A-2-5	A-2-6	A-2-7				
Sieve analysis, % passing											
No. 10 (2.00 mm)	50max	--------	-------	-------	-------	-------	-------	-------	-------	-------	-------
No. 40 (425µm)	30max	50max	51min	-------	-------	-------	-------	-------	-------	-------	-------
No. 200 (75 µm)	15max	25max	10max	35max	35max	36 max	35max	36min	36min	36min	36min
Characteristics of fraction passing No. 40 (425µm)											
Liquid limit	--------	--------		40max	41min	40max	41min	40max	41min	40max	41min
Plasticity index	6max		N.P	10max	10max	11min	11min	10max	10max	11min	11min
Usual types of significant constituents materials	Stone Fragments, Gravel And Sand		Fine sand	Silty or clayey gravel and sand				Silty soils		Clayey soils	
General rating as subgrade	Excellent to good							Fair to poor			

Plasticity index of A-7-5 subgroup is equal to or less than LL minus 30. Plasticity index of A-7-6 subgroup is greater than LL minus 30

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