UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESI 2012/2013

COURSE NAME	:	GEOTECHNIC 1
COURSE CODE	:	BFC 21702
PROGRAMME	:	2 BFF
EXAMINATION DATE	:	DECEMBER 2012/JANUARY 2013
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	ANSWER **FOUR** QUESTIONS ONLY

THIS QUESTIONS PAPER CONSISTS OF **SIXTEEN (16)** PAGES

Q1 (a) Briefly explain (wherever possible with the aid of sketches/diagrams) or define the following terms:-

(i) Liquid limit (LL)

(ii) Liquidity Index (LI)

(iii) Plastic Limit (PL)

(iv) Plasticity Index (PI)

(v) Activity (A)

(5 marks)

(b) The two commonly used methods to determine the liquid limit of fine grained soils are the Casagrande Method and The Fall Cone Method. Describe briefly any **ONE (1)** of the methods and show how the liquid limit of the soil is being determined.

(5 marks)

(c) Results of grain size analysis and the Atterberg's limits of soils obtained from various sites are as follows:

Table 1

Site	Percent finer than (sieve analysis)				Liquid Limit, %	Plastic Limit, %
	Sieve No.4 4.75 mm	Sieve No.10 2.0 mm	Sieve No.40 0.425 mm	Sieve No.200 0.075 mm		
A	100	90	70	30	30	21
B	100	100	95	82	62	31
C	94	80	51	15	26	14

Classify soil from Site A and Site C using the Unified Soil Classification System (USCS)

(6 marks)

Classify soil from Site B and Site C using the AASHTO System.

(6 marks)

If soils from Site B and Site C are available to be used for constructing road embankments, comments on the site that you will choose as the most suitable for the purpose.

(3 marks)

Q2 (a) A moist soil has a moisture content of *w*, the void ratio of e and the specific gravity of G_s. Draw the phase diagram of the soil and expressed the dry unit weight (γ_d) and the degree of saturation (S_r) of the soil in terms of the given parameters.

(6 marks)

(b) For the construction of an earth dam it was calculated that the total volume of the dam is 5,000,000 m^3 and the void ratio of 0.78. For the construction, it was proposed that the soil being borrowed from a quarry which has a void ratio of 1.12. Estimate the total volume of the soil that must be borrowed from the quarry.

(5 marks)

(c) In its natural state, a moist soil has a volume of 5.66×10^{-3} m^3 and weighs 102.3×10^{-3} kN. The moisture content and the specific gravity of the soil solids are determined in the laboratory to be 11% and 2.7 respectively. Calculate the following:

(i) Dry unit weight of the soil, γ_d

(ii) Bulk unit weight of the soil, γ_b

(iii) Void ratio, e

(iv) Porosity, n

(v) Degree of saturation, Sr

(vi) Percentage of air, n_a

(vii) Volume occupied by water (m^3)

(7 marks)

Q3 (a) Compaction tests were carried out on a sandy silt soil using Standard Proctor and Modified Proctor test methods. Sketch a plot of compaction curves for both the test methods. Please also indicate on the plot the zero air voids curve and the 90% saturation curve.

(5 marks)

(b) After compaction was carried out for a construction project, a Sand Cone Replacement Test was conducted to determine the degree of compaction for the project. The results obtained from the test were as follows:-

- Weight of moist soil removed from a hole = 15.39 N
- Weight of the soil removed from the hole after drying = 13.39 N
- Weight of dry sand used to fill both the hole and the cone = 25.27 N
- Weight of dry sand used to fill both the cone = 13.88 N
- Unit weight of dry sand = 14.4 kN/m^3

Determine the compaction parameters i.e. moist unit weight, the dry unit weight and the moisture content at the project site.

(8 marks)

(c) A standard Proctor compaction test was conducted on a clayey soil sample. The results of the test were as follows:

Table 2

Moisture content, %	12.8	14.5	15.6	16.8	19.2
Mass of compacted soil, (g)	2010	2092	2114	2100	2055

Volume of the mould = 1000 cm^3
The specific gravity of the soil solid = 2.67

(i) Plot the compaction curve and the zero air void curve, and determine the maximu dry unit weight and the optimum moisture content.

(9 marks)

(ii) Based on the plot in **Q3(c)(i),** estimate the moisture content of the compacted soil if it was compacted at the maximum dry density and the compacted soil was submerged in water and gets fully saturated. Assume that there was no volume change of the compacted soil.

(3 marks)

Q4 (a) Two standard laboratory tests are used to determine the hydraulic conductivity of soils: the constant head test and the falling head test. Describe briefly the falling head test and show how hydraulic conductivity of soil was determined

(6 marks)

(b) A layered soil consisting of three different layers of soils have the following properties:

Table 3

Layer	Thickness (m)	Hydraulic conductivity (cm/sec)
1	1.5	10^{-5}
2	2.5	3.0×10^{-3}
3	3.0	3.5×10^{-5}

Estimate the equivalent hydraulic conductivity for flow in the vertical direction.

(6 marks)

For a constant head laboratory permeability test on fine sand specimen having a void ratio of 0.46, the following values are given:

- Length of specimen = 300 mm
- Diameter of specimen = 150 mm
- Head difference = 500 mm
- Water collected in 5 minutes = 350 cm^3

Determine:

(i) Hydraulic conductivity, k, of the soil in cm/sec.

(5 marks)

(ii) Discharge velocity in cm/sec

(4 marks)

(iii) Seepage velocity in cm/sec

(4 marks)

Q5 (a) Explain the meaning and significance of the term critical hydraulic gradient, i_c

(6 marks)

(b) Demonstrate how the effective stress in a soil mass is altered when water flows vertically downwards and vertically upwards.

(7 marks)

(c) A soil profile as shown in Figure **Q5** was obtained during a site investigation. Sketch graphs, showing the variations to a depth of 12m of:

(i) the total vertical pressure,

(4 marks)

(ii) the effective vertical pressure and

(4 marks)

(iii) the pore water pressure.

(4 marks)

Assume that the sand above the water level is dry.

Q6 (a) To determine the shear strength parameters of a silty clay soil, the consolidated undrained (CU) triaxial tests with pore water pressure measurement were used. Explain briefly the test and the shear strength parameters that can be obtained from these tests.

(6 marks)

(b) Describe briefly **TWO (2)** tests that were commonly used to determine the shear strength of soil in-situ.

(6 marks)

(c) A consolidated drained triaxial test was conducted on a normally consolidated clay. The confining pressure applied was 110.4 kN/m^2 and the deviatoric stress at failure was 172.5 kN/m^2. Determine the shear strength parameters of the clay and the angle that the failure plane makes with the major principal plane.

(13 marks)

S1 (a) Terangkan secara rIngkas (dimana perlu dengan menggunakan lakaran/rajah-rajah atau takrifkan ungkapan-ungkapan berikut:-

(i) Had Cecair (LL)

(ii) Indeks Kececairan (LI)

(iii) Had Plastik (PL)

(iv) Indeks Keplastikan (PI)

(v) Keaktifan (A)

(5 markah)

(b) Dua kaedah yang sering digunakan untuk menentukan had cecair bagi tanah berbijian halus ialah Kaedah Casagrande dan Kaedah Penusukan Kon. Terangkan secara rIngkas mana-mana **SATU (1)** dari kaedah tersebut dan tunjukkan bagaimana had cecair untuk sesuatu tanah itu ditentukan.

(5 markah)

(c) Keputusan analisis bijian dan had-had Atterberg untuk tanah-tanah dari pelbagai tapakbina adalah seperti berikut:-

Jadual 1

Tapak	Peratus Lulus (analisis ayakan)				Had Cecair , %	Had Plastik , %
	Sieve No.4 4.75 mm	Sieve No.10 2.0 mm	Sieve No.40 0.425 mm	Sieve No.200 0.075 mm		
A	100	90	70	30	30	21
B	100	100	95	82	62	31
C	94	80	51	15	26	14

(i) Kelaskan tanah daripada Tapak A dan Tapak C menggunakan Sistem Pengkelasan Tanah Bersekutu (USCS)

(6 markah)

(ii) Kelaskan tanah daripada Tapak B dan Tapak C menggunakan system AASHTO.

(6 markah)

(iii) Jika tanah-tanah daripada tapak B dab Tapak C yang boleh digunakan untuk pembinaan tambakan jalan, berikan komen anda mengenai tapak yang anda pilih dan lebih sesuai digunakan untuk tujuan ini.

(3 markah)

S2 (a) Suatu tanah lembap mempunyai kandungan lembapan *w*, nisbah lompang e, dan graviti tentu G_s. Lukis gambarajah fasa untuk tanah berkenaan dan nyatakan berat unit kering (γ_d) dan peratus ketepuan (S_r) tanah berkenaan dalam parameter-parameter yang diberikan.

(6 markah)

(b) Untuk pembinaan suatu empangan tanah adalah ditentukan yang isipadu empangan berkenaan ialah 5,000,000 m^3 dan nisbah lompang 0.78. Untuk pembinaan adalah dicadangkan tanah dipinjam dari suatu kuari yang mempunyai nisbah lompang 1.12. Anggarkan jumlah isipadu tanah yang harus dipinjam dari kuari berkenaan.

(5 markah)

(c) Dalam keadaan semulajadi, suatu tanah basah mempunyai isipadu 5.66×10^{-3} m^3 dan berat 102.3×10^{-3} kN. Kandungan lembapan dan graviti tentu tanah berkenaan seperti yang ditentukan dalam makmal adalah masing-masing 11% dan 2.7. Tentukan perkara-perkara berikut:-

(i) Berat unit kering tanah berkenaan, γ_d

(ii) Berat unit pukal tanah berkenaan, γ_b

(iii) Nisbah lompang, e

(iv) Keliangan, n

(v) Peratus ketepuan, Sr

(vi) Peratus udara, n_a

(vii) Isipadu yang diliputi oleh air (m^3)

(7 markah)

S3 (a) Ujikaji-ujikaji pemadatan telah dilakukan keatas tanah kelodak berpasir menggunakan Kaedah Proctor Piawai dan Kaedah Proctor Ubahsuai. Lakarkan satu plot menunjukkan lengkung-lengkung pemadatan untuk kedua-dua kaedah berkenaan. Nyatakan juga diatas plot yang sama lengkung lompang udara sifar dan lengkung 90% ketepuan.

(5 markah)

(b) Selepas kerja-kerja pemadatan dilakukan untuk suatu projek pembinaan, satu Ujikaji Kon Penggantian Pasir telah dilakukan untuk menentukan darjah pemadatan projek berkenaan. Keputusan dari ujikaji-ujikaji tersebut adalah seperti berikut:-

- Berat tanah lembap yang dikeluarkan dari lubang = 15.39 N
- Berat tanah yang dikelurkan dari lubang satelah dikeringkan = 13.39 N
- Berat pasir yang digunakan untuk mengisi lubang dan kon = 25.27 N
- Berat pasir yang digunakan untuk mengisi kon = 13.88 N
- Berat unit kering pasir = 14.4 kN/m^3

Tentukan parameter-parameter pemadatan iaitu berat unit lembap, berat unit kering dan kandungan lembapan ditapak projek.

(8 markah)

(c) Satu ujikaji Proctor Piawai telah dilakukan keatas satu sampel tanahliat. Keputusan ujikaji berkenaan adalah seperti berikut:-

Jadual 2

Kandungan lembapan, %	12.8	14.5	15.6	16.8	19.2
Jisim tanah terpadat, (g)	2010	2092	2114	2100	2055

Isipadu Acuan = 1000 cm^3
Graviti tentu tanah = 2.67

(i) Plot lengkung pemadatan lengkung lompang udara sifar dan tentukan berat unit kering maksimum dan kandungan lembapan optimum

(9 marks)

(ii) Berdasarkan plot **S3(c)(i),** tentukan kandungan lembapan untuk tanah yang terpadat jika tanah berkenaan dipadatkan ke berat unit kering maksimum dan tanah terpadat tersebut ditenggelami air dan menjadi tepu sepenuhnya. Anggapkan tiada ada perubahan isipadu berlaku pada tanah yang terpadat.

(3 markah)

S4 (a) Dua ujikaji makmal piawai telah digunakan untuk menentukan pekali ketelapan sesuatu tanah: ujikaji turus tetap dan ujikaji turus menurun. Terangkan secara ringkas ujikaji turus menurun dan tunjukkan bagaimana pekali ketelapan tanah ditentukan.

(6 markah)

(b) Suatu tanah berlapis mempunyai tiga lapisan tanah yang mempunyai ciri-ciri seperti berikut:-

Jadual 3

Lapisan	Tebal (m)	Pekali ketelapan (cm/sec)
1	1.5	10^{-5}
2	2.5	3.0×10^{-3}
3	3.0	3.5×10^{-5}

Tentukan pekali ketelapan imbangan untuk aliran arah memugak.

(6 markah)

(c) Untuk ujikaji turus tetap dimakmal bagi menentukan pekali ketelapan spesimen pasir halus yang mempunyai nisbah lompang 0.46, nilai-nilai berikut telah diberikan:

- Panjang spesimen = 300 mm
- Garispusat spesimen = 150 mm
- Perbezaan turus = 500 mm
- Isipadu air yang diukur dalam 5 minit = 350 cm^3

Tentukan:

(i) Pekali ketelapan, k, untuk tanah dalam cm/sec.

(5 markah)

(ii) Kelajuan discaj dalam cm/sec

(4 markah)

(iii) Kelajuan resipan dalam cm/sec

(4 markah)

S5 (a) Terangkan makna dan kepentingan pernyataan kecerunan hidarul genting, i_c .

(6 markah)

(b) Tunjukkan bagaimana tegasan kesan untuk suatu jisim tanah berubah apabila berlaku pengaliran memugak keatas dan memugak kebawah.

(7 markah)

(c) Satu profail tanah adalah seperti di Rajah **Q5** didapati semasa suatu penyiasatan tapak. Lakarkan graf-graf yang menunjukkan perubahan hingga kedalaman 12 m untuk:

(i) tegasan jumlah memugak,

(4 markah)

(ii) tegasan kesan memugak dan

(4 markah)

(iii) tekanan air liang.

(4 markah)

Anggapkan yang pasir diatas permukaan air adalah kering.

S6 (a) Untuk menentukan parameter-parameter kekuatan tanah untuk tanahliat berkelodak, ujikaji terkukuh tak tersalir (CU) dengan pengukuran tekanan air liang telah digunakan. Terangkan secara rengkas ujikaji berkenaan dan parameter-parameter kekutan riceh tanah yang boleh ditentukan menggunakan ujikaji-ujikaji ini.

(6 markah)

(b) Terangkan secara ringkas **DUA (2)** ujikaji yang biasa digunakan bagi menentukan kekuatan riceh tanh di-situ.

(6 markah)

(c) Suatu ujikaji tiga paksi terkukuh tersalir dilakukan keatas tanah liat terkukuh biasa. Tegasan kurungan yang dikenakan ialah 110.4 kN/m^2 dan tegasan sisih ketika gagal ialah 172.5 kN/m^2. Tentukan parameter-parameter kekuatan riceh tanah liat berkenaan dan sudut satah kegagalan dengan satah tegasan utama major.

(13 markah)

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Ground Level 0 m----------
Ground water table -1 m---------- Fine sand; Gs= 2.65, e=0.6

-5 m----------
Silt; Gs= 2.7, w= 18.5%

-8 m----------

Sandy Clay;
Saturated unit weight = 21.4 kN/m3

-12 m----------

FIGURES Q5

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Classification of highway subgrade materials

General classification	**Granular materials (35% or less of total sample passing No. 200)**						
	A-1			**A-2**			
Group classification	A-1-a	A-1-b	A-3	A-2-4	A-2-5	A-2-6	A-2-7
Sieve analysis (percent passing)							
No. 10	50 max.						
No. 40	30 max.	50 max.	51 min.				
No. 200	15 max.	25 max.	10 max.	35 max.	35 max.	35 max.	35 max.
Characteristics of fraction passing No. 40							
Liquid limit				40 max.	41 min.	40 max.	41 min.
Plasticity index	6 max.		NP	10 max.	10 max.	11 min.	11 min.
Usual types of significant constituent materials	Stone fragments, gravel, and sand		Fine sand	Silty or clayey gravel and sand			
General subgrade rating	Excellent to good						

General classification	**Silt-clay materials (more than 35% of total sample passing No. 200)**			
Group classification	A-4	A-5	A-6	A-7 A-7-5* A-7-6†
Sieve analysis (percent passing)				
No. 10				
No. 40				
No. 200	36 min.	36 min.	36 min.	36 min.
Characteristics of fraction passing No. 40				
Liquid limit	40 max.	41 min.	40 max.	41 min.
Plasticity index	10 max.	10 max.	11 min.	11 min.
Usual types of significant constituent materials	Silty soils		Clayey soils	
General subgrade rating	Fair to poor			

*For A-7-5, $PI \leq LL - 30$
†For A-7-6, $PI > LL - 30$

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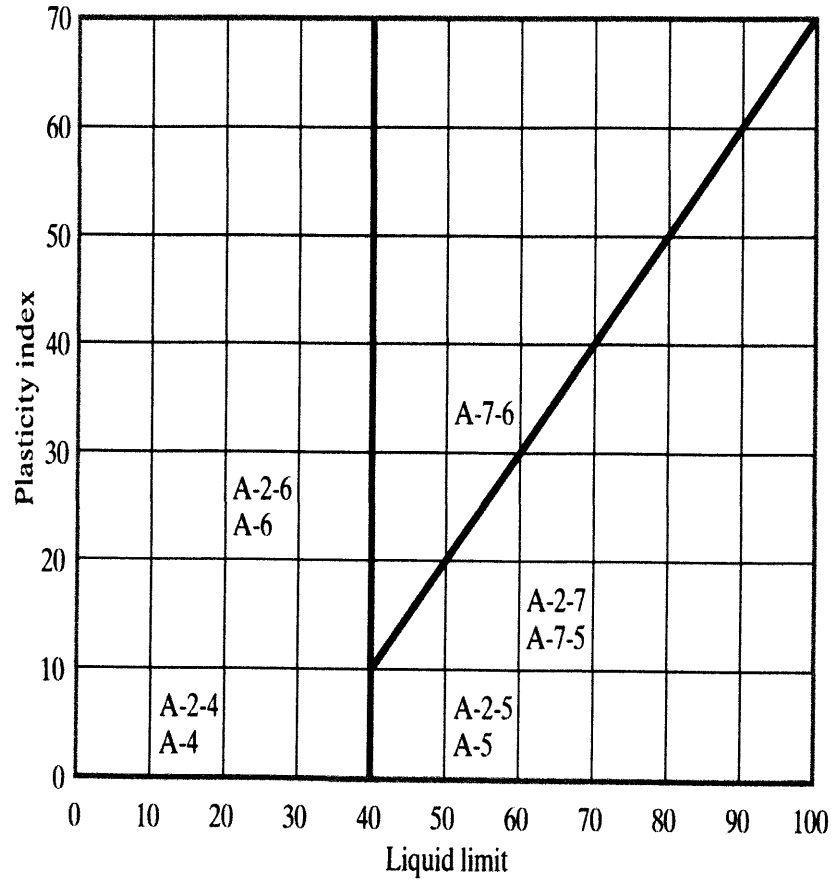

Range of liquid limit and plasticity index for soils in groups A-2, A-4, A-5, A-6, and A-7

Group Index (GI)

$$GI = (F_{200} - 35)[0.2 + 0.005(LL - 40)] + 0.01\,(F_{200} - 15)(PI - 10)$$

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Unified Soil Classification System (Based on Material Passing 75-mm Sieve)

Criteria for Assigning Group Symbols				Group Symbol
Coarse-Grained Soils More than 50% of retained on No. 200 sieve	**Gravels** More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines[a]	$C_u \geq 4$ and $1 \leq C_c \leq 3^c$	GW
			$C_u < 4$ and/or $1 > C_c > 3^c$	GP
		Gravels with Fines More than 12% fines[a,d]	$PI < 4$ or plots below "A" line (Figure 4.2)	GM
			$PI > 7$ and plots on or above "A" line (Figure 4.2)	GC
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines[b]	$C_u \geq 6$ and $1 \leq C_c \leq 3^c$	SW
			$C_u < 6$ and/or $1 > C_c > 3^c$	SP
		Sands with Fines More than 12% fines[b,d]	$PI < 4$ or plots below "A" line (Figure 4.2)	SM
			$PI > 7$ and plots on or above "A" line (Figure 4.2)	SC
Fine-Grained Soils 50% or more passes No. 200 sieve	**Silts and Clays** Liquid limit less than 50	Inorganic	$PI > 7$ and plots on or above "A" line (Figure 4.2)[e]	CL
			$PI < 4$ or plots below "A" line (Figure 4.2)[e]	ML
		Organic	$\frac{\text{Liquid limit-oven dried}}{\text{Liquid limit-not dried}} < 0.75$; see Figure 4.2; OL zone	OL
	Silts and Clays Liquid limit 50 or more	Inorganic	PI plots on or above "A" line (Figure 4.2)	CH
			PI plots below "A" line (Figure 4.2)	MH
		Organic	$\frac{\text{Liquid limit-oven dried}}{\text{Liquid limit-not dried}} < 0.75$; see Figure 4.2; OH zone	OH
Highly Organic Soils	Primarily organic matter, dark in color, and organic odor			Pt

[a] Gravels with 5 to 12% fine require dual symbols: GW-GM, GW-GC, GP-GM, GP-GC.

[b] Sands with 5 to 12% fines require dual symbols: SW-SM, SW-SC, SP-SM, SP-SC.

[c] $C_u = \frac{D_{60}}{D_{10}}$; $C_c = \frac{(D_{30})^2}{D_{60} \times D_{10}}$

[d] If $4 \leq PI \leq 7$ and plots in the hatched area in Figure 4.2, use dual symbol GC-GM or SC-SM.

[e] If $4 \leq PI \leq 7$ and plots in the hatched area in Figure 4.2, use dual symbol CL-ML.

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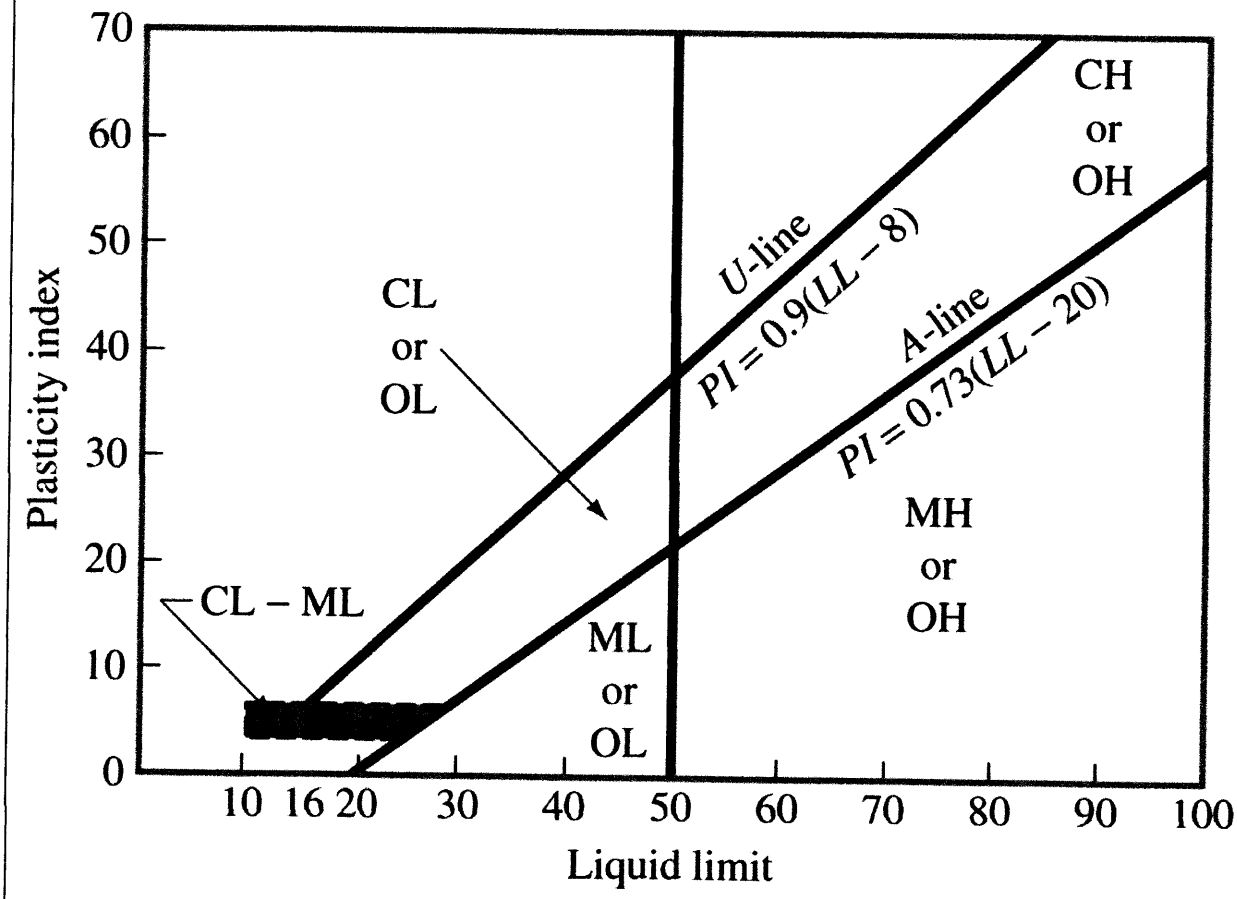

Plasticity chart