UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2012/2013

COURSE NAME	:	GEOTECHNICS I
COURSE CODE	:	BFC21702
PROGRAMME	:	3 BFF
EXAMINATION DATE	:	JUNE 2013
DURATION	:	2.5 HOURS
INSTRUCTIONS	:	ANSWER **FOUR (4)** QUESTIONS ONLY

THIS PAPER CONSISTS OF **SEVENTEEN (17)** PAGES

Q1. (a) Briefly describe three common types of clay minerals in terms of their structures and specific surfaces.

(5 marks)

(b) In classifying soils using the Malaysian/British Classification system, some important parameters of the soils were required. Discuss the parameters required in classifying soil using the system for sandy soil having about 30% fine fractions

(5 marks)

(c) Results of a sieve analysis and the Atterberg's limits of a soil are as follows:

Sieve Analysis

Sieve No.	Sieve Opening (mm)	Mass of soil retained on each sieve (g)
4	4.76	0
10	2.00	21.6
20	0.85	49.5
40	0.425	102.6
60	0.25	89.1
100	0.15	95.6
200	0.075	60.4
Pan	-	31.2

Atterberg's Limit Tests

Liquid limit, % = 43

Plastic limit, % = 22

(i) Plot a grain size distribution curve and determine D_{10}, D_{30} and D_{60}.

(6 marks)

(ii) Classify the soil using the American Association Highways and Transportation Officials (AASHTO) System and the Unified Soil Classification System (USCS).

(6 marks)

(iii) Comment on the suitability of the soil being used as a sub-grade material for a road construction project.

(3 marks)

Q2. (a) A soil sample was mixed thoroughly with enough water to behave like a liquid. The moisture content of the mixture was slowly reduced to zero. During the process of the reduction, the mixture which initially behaved like a liquid finally behaved like a solid. Describe the phases that the soil went through and named the boundaries between the phases.

(7 marks)

(b) Briefly describe or define the following terms that are used in describing or classifying a soil:

(i) Flow curve,

(ii) Activity, and

(iii) Relative density.

(6 marks)

(c) A soil sample has a bulk unit weight (γ_b) of 19.6 kN/m^3 and a dry unit weight (γ_d) of 17.7 kN/m^3. If the specific gravity of the soil solids (G_s) is 2.70, calculate the following:

(i) Void ratio, e

(ii) Porosity, n

(iii) Degree of saturation, S_r

(iv) Moisture content, *w*

(12 marks)

Q3. (a) Describe briefly (wherever necessary with the aid of diagrams) **THREE (3)** factors that affect compaction process.

(6 marks)

(b) Most compaction in the field is done with the use of rollers. The four common types of rollers in the field are smooth-wheel roller, pneumatic rubber-tired roller, sheepsfoot roller and vibratory roller. Describe briefly any **TWO (2)** of the above mentioned rollers.

(6 marks)

(c) The results of a standard Proctor compaction test was conducted on a soil sample are as shown in Table **1**. The volume of the mold used was 943.3 cm^3. The hammer used has a weight of 24.4 N and a drop height of 304.8mm.

Table **1** : Compaction Test Results

Test No.	Weight of wet soil in the mold (N)	Moisture content (%)
1	14.5	8.4
2	18.46	10.2
3	20.77	12.3
4	17.88	14.6
5	16.15	16.8

The specific gravity of the soil solid = 2.72

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

(8 marks)

(ii) Calculate the compaction energy used in one test.

(2 marks)

(iii) Determine the void ratio and the degree of saturation at the optimum moisture content.

(3 marks)

Q4. (a) The hydraulic conductivity of soils in the field can be determined by conducting pumping from wells test. Describe briefly the method to determine hydraulic conductivity using pumping test from a well in an unconfined permeable layer underlain by an impermeable stratum. Show how hydraulic conductivity of the soil was determined.

(6 marks)

(b) A permeable layer is sandwiched between two impervious layers as shown in Figure **Q 4**. With the coefficient of hydraulic conductivity of the permeable, k = 0.04 cm/sec and H = 3m, H_1 = 2.5m, h =2.8m, L = 25m and $\alpha = 10^{o}$, calculate the flow rate in m^3/sec/m through the permeable layer.

(6 marks)

(c) For a falling head laboratory permeability test on a clayey soil specimen having a void ratio of 0.3, the following values are given:

Length of the soil specimen	=	200 mm
Area of the soil specimen	=	1000 mm^2
Area of the standpipe	=	40 mm^2

Head difference at time t = 0 is 500 mm

Head difference at time t = 3min is 300 mm

Determine:

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

(5 marks)

(ii) Discharge and seepage velocity in cm/sec

(4 marks)

(iii) What was the head difference at time t = 100 sec.?

(4 marks)

Q5. (a) The concept of total stress, effective stress and the pore water pressure in soil can be best understood using a piston and spring analogy. With the aid of sketches, briefly explain the piston analogy concept and relate how this concept can help explain the relationship between the total stress, effective stress and the pore water pressure.

(8 marks)

(b) A 9-m thick layer of stiff saturated clay is underlain by a layer of sand (Figure **Q5a**). The sand is under artesian pressure of 3.6m of water. Calculate the maximum depth of cut that can be made in the clay layer.

(5 marks)

(c) A soil profile as shown in Figure **Q5 b** was obtained during a site investigation. Sketch graphs, showing the variations to a depth of 10m of:

(i) the total vertical pressure,

(ii) the pore water pressure and

(iii) the effective vertical pressure.

Assume that the sand above the water level is fully saturated.

(3 @ 4 marks = 12 marks)

Q6. (a) Describe briefly the three types of triaxial test and the various shear strength parameters determined from each of the test.

(6 marks)

(b) In Malaysia, one of the most commonly used indirect methods of determining the shear strength parameters of soil in-situ is the Standard Penetration Test (SPT). Describe briefly how SPT was done and how shear strength parameters were determine from the SPT values.

(6 marks)

(c) The results of a consolidated undrained (CU) triaxial test with pore pressure measurement on a normally consolidated soil specimen are as follows:

- Chamber confining pressure = 140 kN/m^2
- Deviator stress at failure = 126 kN/m^2

- Pore water pressure at failure = 76.5 kN/m^2

(i) Determine the total and effective shear strength parameters of the soil.

(8 marks)

(ii) Based on the effective Mohr-Coulomb failure envelope, what is the angle Θ that the failure plane makes with the major principal stress?

(3 marks)

(iii) Determine the normal effective stress and the shear stress on the failure plane.

(2 marks)

- End of Question -

TERJEMAHAN

S1. (a) Terangkan dengan rengkas tiga jenis mineral tanah liat yang biasa dari segi struktur dan permukaan tentu mereka.

(5 markah)

(b) Dalam mengkelaskan tanah-tanah menggunakan Sistem Pengkelasan Malaysia/British, beberapa parameter-parameter tanah berkenaan perlulah ditentukan. Bincangkan parameter-parameter yang diperlukan menggunakan sistem ini untuk mengkelas tanah berpasir yang mempunyai 30% tanah bersaiz halus.

(5 markah)

(c) Keputusan ujikaji-ujikaji analisis ayakan dan had-had Atterberg untuk suatu tanah adalah seperti berikut:

Analisis Ayakan

No. Ayak	Pembukaan Ayak (mm)	Jisim tanah yang tertahan atas setiap ayak (g)
4	4.76	0
10	2.00	21.6
20	0.85	49.5
40	0.425	102.6
60	0.25	89.1
100	0.15	95.6
200	0.075	60.4
Pan	-	31.2

Ujikaji-ujikaji Had Atterberg

Had Cecair, % = 43

Had Plastik, % = 22

(i) Plot lengkung taburan saiz zarah dan tentukan D_{10}, D_{30} dan D_{60}.

(6 markah)

(ii) Kelaskan tanah berkenaan menggunakan Sistem Pertubuhan-pertubuhan Lebuhraya dan Pegawai-pegawai Pengangkutan Amerika (AASHTO) dan Sistem Pengkelasan Tanah Bersekutu (USCS).

(6 markah)

(iii) Komen mengenai kebolehgunaan tanah ini untuk digunakan sebagai bahan subgred satu projek pembinaan jalanraya.

(3 markah)

S2. (a) Satu sampel tanah tanah telah dicampurkan dengan secukup air dan dibancuh sehingga ianya menjadi seperti cecair. Adunan ini kemundianya dikurangkan peratus kandungan lembapannya perlahan-lahan sehingga kandungan lembapan menjadi sifar. Dalam proses pengurangan kandungan lembapan, adunan ini yang mulanya bertindak seperti cecair akhirnya bertindak seperti pepejal. Dalam proses pengeringan ini, terangkan fasa-fasa yang dilalui oleh tanah dan namakan sempadan-sempadan antara fasa-fasa.

(7 markah)

(b) Terangkan secara rengkas atau takrifkan terma-terma berikut yang digunakan bagi menerangkan atau mengkelaskan sesuatu tanah:

(i) Lengkung aliran,

(ii) Keaktifan, dan

(iii) Ketumpatan bandingan.

(6 markah)

(c) Satu sampel tanah mempunyai berat unit pukal (γ_b) bernilai 19.6 kN/m^3 dan berat unit kering (γ_d) bernilai 17.7 kN/m^3. Jika graviti tentu pepejal tanah (G_s) ialah 2.70, kira perkara-perkara berikut:

(i) Nisbah lompang, e

(ii) Keliangan, n

(iii) Peratus ketepuan, S_r

(iv) Kandungan lembapan, *w*

(12 markah)

S3. (a) Terangkan dengan rengkas (dimana perlu dengan bantuan gambarajah-gambarajah) **TIGA (3)** faktor yang boleh mempengaruhi proses pemadatan.

(6 markah)

(b) Kebanyakkan pemadatan ditapakbina telah dilakukan menggunakan penggelek-penggelek. Empat jenis penggelek yang biasa digunakan ditapakbina ialah penggelek bertayar licin, penggelek bertayar getah knumat , penggelek kaki kambing dan penggelek bergetar. Terangkan secara rengkas mana-mana **DUA (2)** diantara penggelek-penggelek yang dinyatakan diatas.

(6 markah)

(c) Keputusan ujikaji pemadatan Proctor piawai yang dilakukan keatas satu sampel tanah adalah seperti yang ditunjukkan di Jadual **1**. Isipadu acuan yang digunakan ialah 943.3 cm^3. Berat tukul yang digunakan ialah 24.4 N dan ketinggian jatuh ialah 304.8mm.

Jadual **1** : Keputusan Ujikaji-Ujikaji Pemadatan

No. Ujikaji	Berat tanah lembap dalam acuan (N)	Kandungan lembapan (%)
1	14.5	8.4
2	18.46	10.2
3	20.77	12.3
4	17.88	14.6
5	16.15	16.8

Graviti tentu pepejal tanah = 2.72

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

(8 markah)

(ii) Kira tenaga pemadatan yang digunakan untuk satu ujikaji.

(2 markah)

(iii) Tentukan nisbah lompang dan peratus ketepuan pada kandungan lembapan optimum.

(3 markah)

S4. (a) Pengaliran hidraul tanah-tanah ditapakbina boleh ditentukan dengan menjalankan ujikaji pengepaman dari telaga-telaga ujian. Terangkan secara rengkas kaedah yang digunakan untuk menentukan pengaliran hidraul menggunakan ujian pengepaman dari satu telaga dalam lapisan tanah telap tak terkurung yang dibawahnya terdapat satu lapisan tak telap. Tunjukkan bagaimana pengaliran hidraul boleh ditentukan.

(6 markah)

(b) Satu lapisan telap diapit oleh dua lapisan tak telap seperti yang ditunjukkan dalam Rajah **Q 4** . Dengan menggunakan pekali pengalir hidraul untuk tanah telap, k = 0.04 cm/sec dan H = 3m, H_1 = 2.5m, h =2.8m, L = 25m dan $\alpha = 10^{o}$, kira kadaralir dalam m^3/sec/m melalui lapisan tanah telap.

(6 markah)

(c) Untuk satu ujikaji ketelapan menggunkan turus menurun dimakmal yang dilakukan keatas suatu spesimen tanah liat bernisbah lompang 0.3, berikut adalah nilai-nilai yang telah diperolehi:

Panjang spesimen tanah	=	200 mm
Keluasan spesimen tanah	=	1000 mm^2
Keluasan paip tegak	=	40 mm^2

Perbezaan turus pada masa t = 0 ialah 500 mm

Perbezaan turus pada masa t = 3min ialah 300 mm

Tentukan:

i) Pengaliran hidraul, k, untuk tanah dalam cm/sec.

(5 markah)

i) Hadlaju keluar dan resipan dalam cm/sec

(4 markah)

ii) Apakah perbezaan turus pada masa t = 100 sec.?

(4 markah)

S5. (a) Konsep tegasan jumlah, tegasan kesan dan tekanan air liang dalam tanah boleh difahami dengan mudah menggunakan analogi sepring dan omboh. Dengan bantuan gambar rajah, terangkan secara rengkas konsep sepring dan omboh dan hubungkan bagaimana konsep ini dapat bantu menerangkan hubungkait antara tegasan jumlah, tegasan kesan dan tekanan air liang.

(8 markah)

(b) Satu lapisan 9 m tanah liat tegar tepu sapenuhnya didasari oleh lapisan pasir (Rajah **Q5 a**). Pasir ini mempunyai tekanan artes setinggi 3.6m air. Kira kedalaman maksimum korekan yang boleh dilakukan kedalam lapisan tanah liat.

(5 markah)

(c) Satu profail tanah seperti yang ditunjukkan dalam Rajah **Q5 b** didapati semasa suatu penyiasatan tapak. Lakarkan geraf-geraf yang menunjukkan perubahan pada keselruhan lapisan satebal 10m untuk:

(i) tegasan jumlah memugak,

(ii) tekanan air liang, dan

(iii) tegasan kesan memugak.

Anggapkan pasir diatas permukaan air bumi adalah tepu sapenuhnya.

(12 markah)

S6. (a) Terangkan secara rengkas **TIGA (3)** jenis ujikaji tiga paksi dan parameter-parameter kekuatan tanah yang boleh ditentukan bagi setiap ujikaji yang disenaraikan.

(6 markah)

(b) Di Malaysia, salah satu kaedah tak langsung yang digunakan bagi menentukan parameter-parameter kekuatan tanah di situ ialah dengan menggunakan Ujikaji Penusukan Piawai (SPT). Terangkan secara rengkas bagaimana SPT dilakukan dan bagaimana parameter-parameter kekuatan tanah ditentukan menggunakan nilai-nilai SPT.

(6 markah)

(c) Keputusan untuk suatu ujikaji tiga paksi terkukuh tak tersalir (CU) dengan pengukuran tekanan air liang ketas suatu spesimen tanah terkukuh biasa adalah seperti berikut:

- Tekanan kurungan balang = 140 kN/m^2
- Tegasan sisih ketika gagal = 126 kN/m^2
- Tekanan air liang ketika gagal = 76.5 kN/m^2

(i) Tentukan parameter-parameter kekuatan riceh jumlah dan kesan untuk tanah berkenaan.

(8 markah)

(ii) Berdasarkan kepada liputan kegagalan Mohr-Coulomb kesan, berapakah sudut Θ antara satah kegagalan dengan tegasan utama major.

(3 markah)

(iii) Tentukan tegasan normal kesan dan tegasan riceh diatas satah kegagalan.

(2 markah)

- Soalan Tamat -

FINAL EXAMINATION

SEMESTER/SESSION : II/2012/2013 PROGRAMME : 3BFF

COURSE NAME : GEOTECHNICS I COURSE CODE : BFC 21702

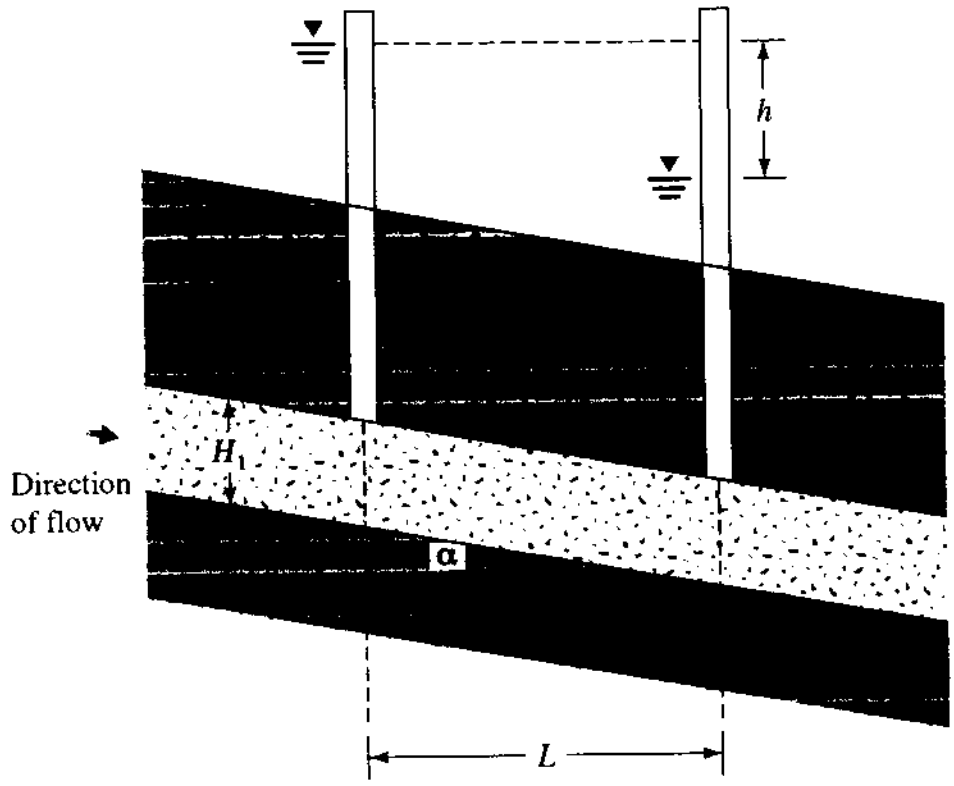

Fig. Q 4

FINAL EXAMINATION

SEMESTER/SESSION : II/2012/2013 PROGRAMME : 3BFF

COURSE NAME : GEOTECHNICS I COURSE CODE : BFC 21702

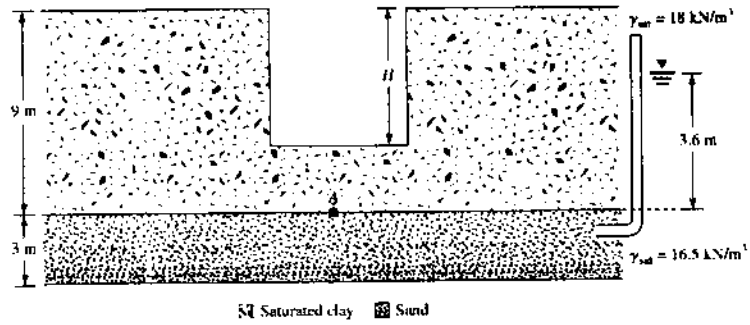

Fig Q 5 a

Ground Level 0 m----------

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

-2 m----------

Silt; Gs= 2.7, e = 0.52

-4 m----------

Clay; Gs= 2.72, w= 20.8%

-10 m----------

Fig. Q 5 b

FINAL EXAMINATION

SEMESTER/SESSION : II/2012/2013 PROGRAMME : 3BFF

COURSE NAME : GEOTECHNICS I COURSE CODE : BFC 21702

Table 5.1 Classification of Highway Subgrade Materials

General classification	Granular materials (35% or less of total sample passing No. 200)							Silt-clay materials (more than 35% of total sample passing No. 200)			
	A-1			A-2				A-7			
Group classification	A-1-a	A-1-b	A-3	A-2-4	A-2-5	A-2-6	A-2-7	A-4	A-5	A-6	A-7-5[a] A-7-6[b]
Sieve analysis (percentage 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.	36 min.	36 min.	36 min.	36 min.
Characteristics of fraction passing No. 40											
Liquid limit				40 max.	41 min.	40 max.	41 min.	40 max.	41 min.	40 max.	41 min.
Plasticity index	6 max.		NP	10 max.	10 max.	11 min.	11 min.	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				Silty soils		Clayey soils	
General subgrade rating	Excellent to good							Fair to poor			

[a] For A-7-5, $PI \leq LL - 30$
[b] For A-7-6, $PI > LL - 30$

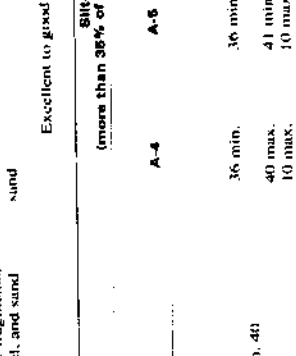

Figure 5.2 Range of liquid limit and plasticity index for soils in groups A-2, A-4, A-5, A-6, and A-7

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

FINAL EXAMINATION

SEMESTER/SESSION : II/2012/2013 PROGRAMME : 3BFF

COURSE NAME : GEOTECHNICS I COURSE CODE : BFC 21702

Table 5.2 Unified Soil Classification System (Based on Material Passing 76.2-mm Sieve)

Criteria for assigning group symbols				Group symbol
Coarse-grained soils More than 50% retained on No. 200 sieve	Gravels More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines[b]	$C_u \geq 4$ 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[d]	$PI < 4$ or plots below "A" line (Figure 5.3)	GM
			$PI > 7$ and plots on or above "A" line (Figure 5.3)	GC
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines[h]	$C_u \geq 6$ 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[d]	$PI < 4$ or plots below "A" line (Figure 5.3)	SM
			$PI > 7$ and plots on or above "A" line (Figure 5.3)	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 5.3)[e]	CL
			$PI < 4$ or plots below "A" line (Figure 5.3)[e]	ML
		Organic	Liquid limit — oven dried / Liquid limit — not dried < 0.75; see Figure 5.3; OL zone	OL
	Silts and clays Liquid limit 50 or more	Inorganic	PI plots on or above "A" line (Figure 5.3)	CH
			PI plots below "A" line (Figure 5.3)	MH
		Organic	Liquid limit — oven dried / Liquid limit — not dried < 0.75; see Figure 5.3; OH zone	OH
Highly Organic Soils	Primarily organic matter, dark in color, and organic odor			Pt

[a] Gravels with 5 to 12% fines 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] $C_u = \frac{D_{60}}{D_{10}}$ $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

[d] If $4 < PI \leq 7$ and plots in the hatched area in Figure 5.3, use dual symbol GC-GM or SC-SM.

[e] If $4 \leq PI \leq 7$ and plots in the hatched area in Figure 5.3, use dual symbol CL-ML.

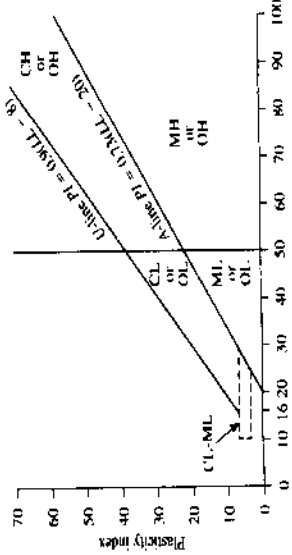

Figure 5.3 Plasticity chart