SULIT

BAHAGIAN PEPERIKSAAN DAN PENILAIAN
JABATAN PENDIDIKAN POLITEKNIK DAN KOLEJ KOMUNITI
KEMENTERIAN PENDIDIKAN MALAYSIA

JABATAN KEJURUTERAAN AWAM

PEPERIKSAAN AKHIR

SESI JUN 2018

DCC3103: GEOTECHNICAL ENGINEERING

TARIKH : 30 OKTOBER 2018
MASA : 8.30 PAGI - 10.30 PAGI (2 JAM)

Kertas ini mengandungi **DUA BELAS (12)** halaman bercetak.
Bahagian A: Struktur (2 soalan)
Bahagian B: Struktur (4 soalan)
Dokumen sokongan yang disertakan :

1. FORMULA
2. TAYLORS STABILITION CHART
3. SEMI LOG GRAPH
4. USCS TABLE
5. BEARING CAPACITY TABLE

JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN

(CLO yang tertera hanya sebagai rujukan)

SULIT

SECTION A : 50 MARKS

BAHAGIAN A : 50 MARKAH

INSTRUCTION:
This section consists of **TWO (2)** structured questions. Answer **ALL** questions.

ARAHAN :
Bahagian ini mengandungi ***DUA (2)*** *soalan berstruktur. Jawab* ***SEMUA*** *soalan.*

QUESTION 1

SOALAN 1

CLO1 C1

(a) List **SIX (6)** processes that are involved in a rock cycle.
Senaraikan ***ENAM (6)*** *proses yang terlibat dalam kitaran batuan.*

[6 marks]

[*6 markah*]

CLO1 C2

(b) Explain briefly about organic soil, residual soil and transported soil.
Terangkan mengenai tanah organik, tanah baki dan tanah terangkut.

[9 marks]

[*9 markah*]

CLO1 C3

(c) The result of Three Axial Flow Series Test for soil sample is shown in the **Table 1(c)** below. Calculate the value of soil cohesion, **c** and angle of friction, **Ø**.

Keputusan Ujian Tiga Paksi ***Jadual 1(c)*** *untuk sampel tanah adalah seperti jadual berikut. Kirakan nilai kejelekitan,* ***c*** *dan sudut geseran,* ***Ø*** *untuk tanah tersebut.*

[10 marks]

[10 markah]

Table 1(c) / *Jadual 1 (c)*

Sample *Sampel*	Minor normal Stress *Tegasan Normal Minor* σ_3 (kN/m^2)	Deviator Stress *Sisihan Piawai* $\sigma_1 - \sigma_3$ (kN/m^2)	Major Normal Stress *Tegasan Normal Major* σ_1 (kN/m^2)
A	20	150	170
B	80	160	240
C	245	195	440

QUESTION 2
SOALAN 2

CLO1
C2

(a) Explain **TWO (2)** differences between a shallow and deep foundations.
*Terangkan **DUA** (2) perbezaan antara asas cetek dan asas dalam.*

[8 marks]
[8 markah]

CLO2
C3

(b) **Figure 2 (b)** shows a cross section of a strip footing embedded in firm soil strata. The undrained cohesion value of the soil is 55KPa and the angle of friction is 10^0. Calculate the Ultimate Bearing Capacity of the footing if the Dry Unit Weight of soil is 19 kN/m^3 and the Saturated Unit Weight of soil is 20 kN/m^3. Ground water level (G.W.T) is at the base of the footing.

***Rajah 2 (b)** menunjukkan keratan rentas bagi asas jalur yang tertanam di dalam strata tanah. Nilai kejelekitan bagi tanah adalah 55KPa dan sudut geseran adalah 10^0. Kirakan keupayaan galas muktamad untuk asas berkenaan sekiranya berat unit tanah kering bagi tanah adalah 19 kN/m^3 dan berat unit tanah tepu adalah 20 kN/m^3. Paras air bumi (G.W.T.) berada di dasar asas.*

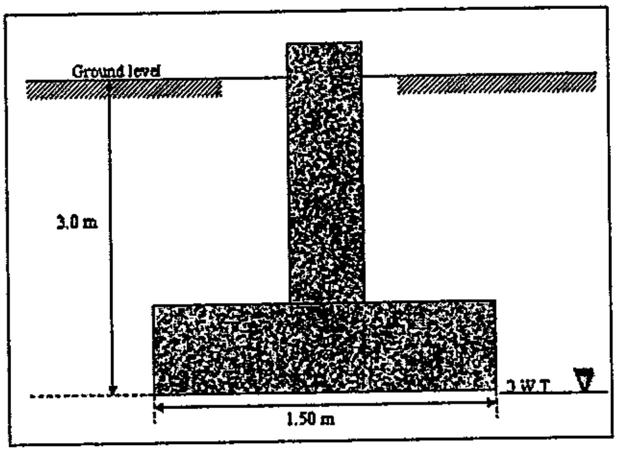


Figure 2(b) / ***Rajah 2 (b)***

[9 marks]
[9 markah]

CLO2
C4

(c) A strip footing is shown in **Figure 2(c)**. Using Terzaghi's bearing capacity factors, calculate the gross allowable load per unit area (q_{all}) that the foundation can carry. Given:

Depth of foundation, Df = 1m

Breadth of foundation, B = 1.2m

Factor of safety, Fs = 3.0

Unit weight of soil, $\gamma = 30\ kN/m^3$

Cohesion of soil, $C = 50\ kN/m^2$

Friction Angle $Ø = 20^o$

*Satu asas rakit ditunjukkan dalam **Rajah 2(c)**. Dengan menggunakan Faktor keupayaan galas Terzaghi's, kirakan beban yang dibenarkan per unit luas (q_{all}) yang dapat ditanggung oleh asas. Di beri :*

Kedalaman asas, Df = 1m

Lebar asas, B = 1.2m

Faktor Keselamatan, Fs = 3.0

Berat unit tanah, $\gamma = 30\ kN/m^3$

Kejelekitan, $C = 50\ kN/m^2$

Sudut Geseran $Ø = 20^o$

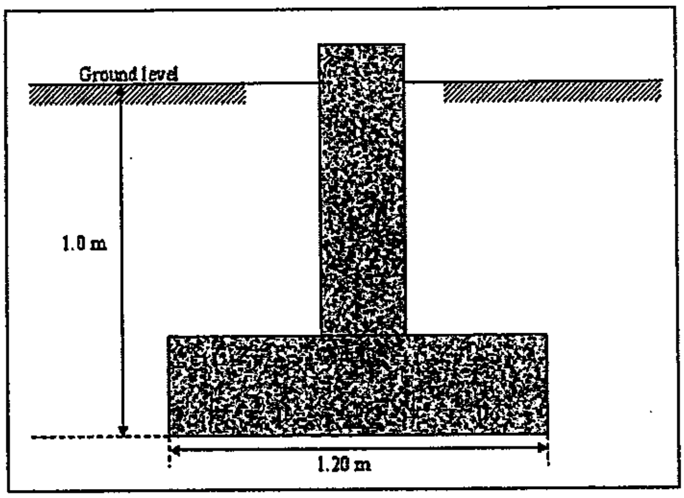


Figure 2(c) / ***Rajah 2(c)***

[8 marks]

[8 markah]

SECTION B : 50 MARKS

BAHAGIAN B : 50 MARKAH

INSTRUCTION:
This section consists of **FOUR (4)** structured questions. Answer **TWO (2)** questions only.

ARAHAN:
*Bahagian ini mengandungi **EMPAT (4)** soalan berstruktur. Jawab **DUA (2)** soalan sahaja.*

QUESTION 1

SOALAN 1

CLO2
C3

(a) The results of a particle sieve analysis are shown in **Table 1(a)** below:

*Hasil keputusan bagi analisis saiz zarah ditunjukkan dalam **Jadual 1 (a)** seperti di bawah :*

Table 1(a) / Jadual 1(a)

Sieve size *Saiz ayak* (mm)	Mass retained *Berat Tertahan* (g)
63	0.0
37.5	26
19	28
13.2	18
9.5	20
6.7	49
4.75	50
2.36	137
1.18	46
0.6	31
0.212	34
0.075	30

The total mass was 469g. Draw the particle size distribution curve and calculate the coefficient of uniformity, coefficient of curvature and type of soil.

Jumlah jisim adalah 469g. Lukiskan lengkung agihan saiz zarah tanah dan tentukan pekali keseragaman, pekali kelengkungan dan jenis tanah.

[15 marks]

[15 markah]

CLO2
C4

(b) The following are the results obtained from the standard compaction test.
Berikut adalah keputusan yang diperolehi daripada ujian pemadatan tanah.

Bulk Density *Ketumpatan pukal* (kg/m^3)	2060	2127	2154	2160	2142
Moisture content *Kandungan Lembapan* (%)	12	14	16	18	20

i. Draw the curve of dry density against moisture content
Lukiskan lengkung ketumpatan kering melawan kandungan lembapan

ii. Determine the maximum dry density and optimum moisture content of the soil.
Tentukan juga ketumpatan kering maksimum dan kandungan lembapan optimum.

[10 marks]
[10 markah]

CLO2
C3

QUESTION 2

SOALAN 2

(a) A retaining wall has a height of 8m serves to hold the sand. Given the weight of sand and stress coefficients of each horizon is 26 kN/m^3 and 0.27, calculate :

Satu tembok penahan mempunyai ketinggian 8m berfungsi untuk menahan tanah pasir. Diberi berat unit tanah pasir dan pekali tegasan ufuknya masing-masing adalah 26 kN/m^3 dan 0.27, kirakan :

i. Total thrust of sand on the wall
Jumlah tujahan tanah pasir ke atas tembok penahan.

[5 marks]
[*5 markah*]

ii. Total thrust of sand on the wall, if there is groundwater at level 3m below from the surface sand. Given sand saturated unit weight is 30 kN/m^3.

Jumlah tujahan tanah pasir ke atas tembok penahan sekiranya terdapat air bumi di paras 3m di bawah permukaan pasir. Diberi berat unit tepu tanah pasir ialah 30 kN/m^3.

[10 marks]
[*10 markah*]

CLO2
C4

(b) A retaining wall was built during the excavation as shown in **Figure 2(b).** By ignoring the passive pressure in front of the retaining wall.

*Sebuah tembok penahan dibina semasa kerja pengorekan dijalankan seperti dalam **Rajah 2(b)**. Dengan mengabaikan tekanan pasif dihadapan tembok penahan tersebut;*

i. Draw the active side pressure acting on the rear wall.
Lukiskan tekanan sisi aktif yang bertindak di belakang tembok.

[2 marks]
[2markah]

ii. Analyze the magnitude and location of the active thrust of soil behind the wall based on Rankine theory.

Analisis magnitud dan kedudukan tujah aktif tanah dibelakang tembok tersebut berdasarkan teori Rankine.

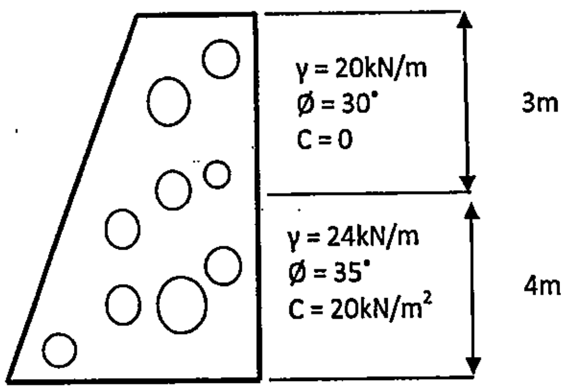


Figure 2(b) / *Rajah 2(b)*

[8 marks]
[8 markah]

QUESTION 3

SOALAN 3

CLO2
C3

(a) A cutting in a saturated clay has a depth of 10 meter. At a depth of 5 meter below the ground level of the cutting is a layer of hard rock. The clay has an undrained cohesion of 35 kPa and a bulk unit weight of 19 kN/m^3. Calculate the maximum safe slope angle with a safety factor of 1.2 for a short-term shear failure.

Satu pemotongan dibuat terhadap tanah liat tepu yang mempunyai kedalaman 10 meter. Pada kedalaman 5 meter dari bawah aras tanah yang dipotong adalah merupakan lapisan batuan. Tanah liat mempunyai nilai kejelikitan 35KPa dan berat unit pukal 19 kN/m^3. Kirakan sudut selamat maksima bagi cerun dengan faktor keselamatan adalah 1.2 bagi kegagalan ricih bagi jangka masa singkat.

[15 marks]

[15 *markah*]

CLO2
C4

(b) By referring to **Figure 3(b)**, analyse the slope stability data on **Table 3(b)** by using suitable method.

Merujuk pada ***Rajah 3(b)*** *dan data* ***Jadual 3(b)****, analisis kestabilan cerun dengan menggunakan kaedah yang sesuai.*

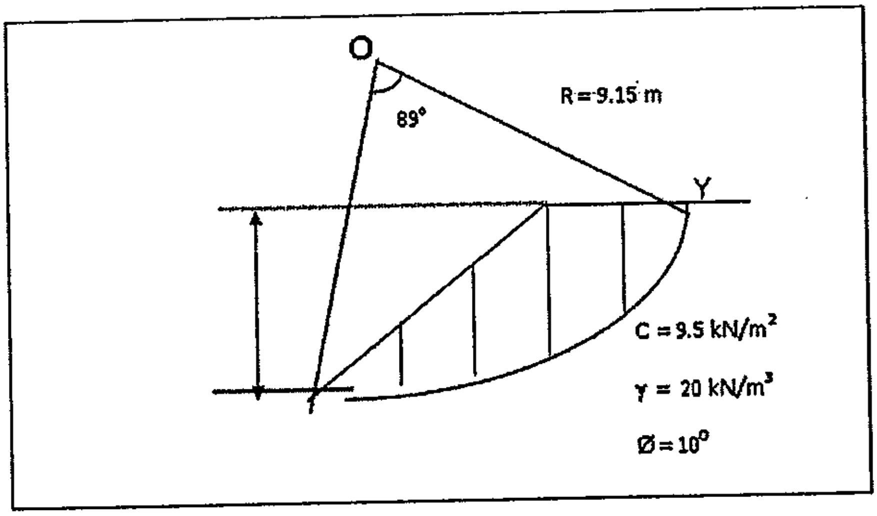


Figure 3(b)/ Rajah 3(b)

Table 3 (b)/Jadual 3(b)

Slices	α^o	Height, Z(m)	Width, b(m)
1	-10	0.95	2.3
2	4	2.44	2.5
3	20	3.32	2.5
4	35	3.51	2.5
5	57	1.74	2.4

[10 marks]
[10 *markah*]

QUESTION 4

SOALAN 4

CLO2
C3

(a) Sketch the flow net for the seepage under or through the dam containing equipotential lines , N_e and flow lines, N_f.

Lakarkan carta aliran bagi resipan yang melalui atau di bawah empangan yang mengandungi garisan sama upaya, Ne dan garisan aliran, Nf.

(i)

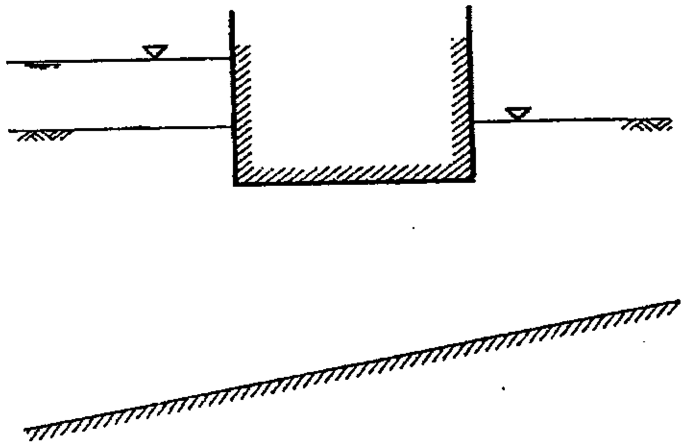


Figure 4a (i)

(ii)

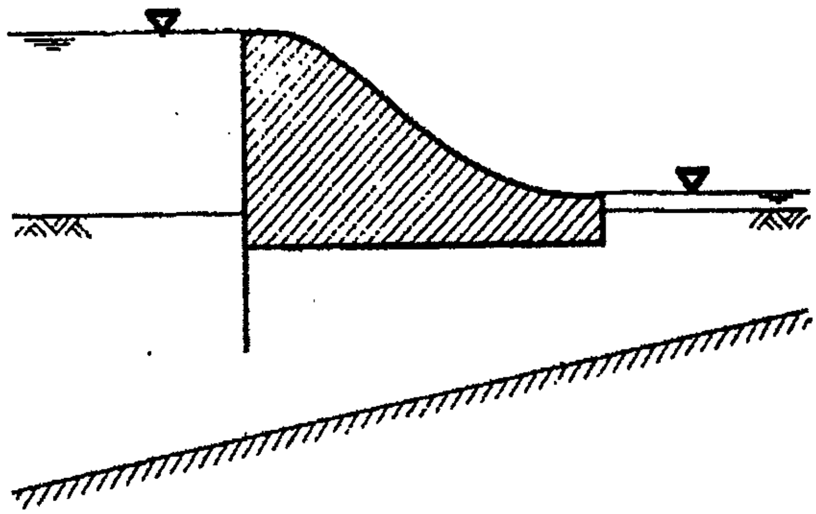


Figure 4a (ii)

[15 marks]

[15 *markah*]

CLO2
C4

(b) The cross-section of a homogeneous earth dam is shown in **Figure 4 (b).** The coefficient of permeability is 4.5 x 10^{-6} m/s. Sketch a flow net and evaluate the quantity of seepage in m^3/day per meter run with the toe filter as shown in **Figure 4 (b).**

*Satu keratan rentas empangan tanah homogen ditunjukkan di dalan **Rajah 4 (b).** Pekali kebolehtelapan ialah 4.5 x 10^{-6} m/s. Lakarkan jaringan aliran dan nilaikan kuantiti resipan dalam unit m^3/hari per meter serta terdapatnya penapis dibahagian hujung empangan seperti yang ditunjukkan dalam **Rajah 4 (b).***

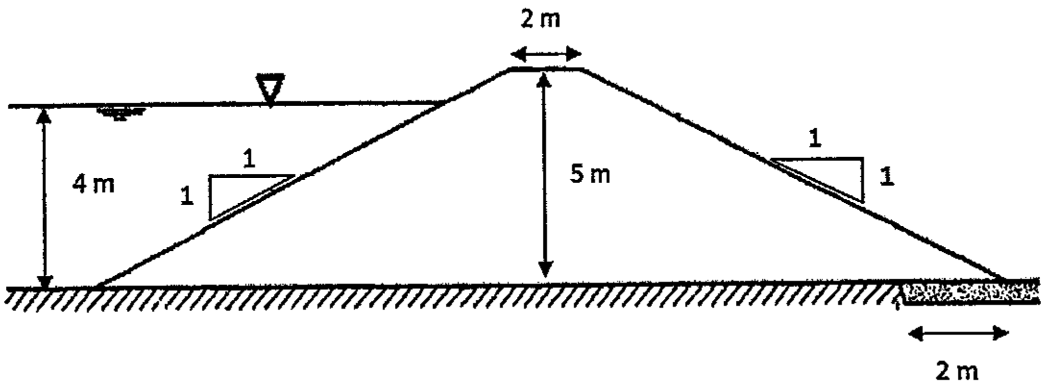


Figure 4 (b) / *Rajah 4 (b)*

[10 marks]
[10 *markah*]

SOALAN TAMAT

LAMPIRAN FORMULA (DCC3103 – GEOTECHNICAL ENGINEERING)

$$Q = k\ H\ \frac{Nf}{Ne}$$

$$I = \frac{\Delta h}{\Delta s}$$

$$u_x = u_w(\frac{N_x}{N_e}.\Delta H - (-Z_x)$$

$$K_a = \frac{1-\sin\phi}{1+\sin\phi}$$

$$K_p = \frac{1+\sin\phi}{1-\sin\phi}$$

$$\rho_b = \frac{M_T}{V_T}$$

$$PI = LL - PL$$

$$LI = \frac{w - PL}{PI}$$

$$Z_c = \frac{2C}{\gamma}\sqrt{\frac{1}{Ka}}$$

$$\sigma_a = ka\ [\gamma Z+q] - 2C\sqrt{Ka}$$

$$Z_c = \frac{2C}{\gamma}\sqrt{\frac{1}{Ka}}$$

Correction Table $\frac{\Delta a}{a+\Delta a}$ Earth Dam (Non Filter)

Slope,	30	60	90	120	150	180

$$FOS = \frac{CR^2\theta}{Wd}$$

$$FOS = \frac{C_A R^2 \theta_A + C_B R^2 \theta_B}{Wd}$$

$$P = \frac{Rv}{B}\left(1 \pm \frac{6e}{B}\right)$$

$$FOS = \frac{Rv \tan\delta}{RH}$$

$$e = B/2 - \bar{X}$$

$$FOS = \frac{\mu R}{\mu T}$$

$$Q = kH\frac{N_f}{N_e}$$

$$u_x = \gamma_w\ [h_x - (-Z_x)]$$

$$FOS = \frac{Cu}{N\gamma Z}$$

$$FOS = \frac{\sum CL' + wkos\alpha \tan\phi}{\sum w\sin\alpha}$$

$$FOS = \frac{\sum CL'(W\cos\alpha - \mu L')}{\sum W\sin\alpha}$$

$$FOS = \frac{CR^2\theta'}{Wd + PwYc}$$

$$G_s = \frac{M_s}{V_s\rho_w}$$

$$\rho_d = \frac{\rho_b}{1+w}$$

$$e = \frac{n}{1-n}$$

α						
$\frac{\Delta a}{a+\Delta a}$	0.37	0.32	0.25	0.18	0.10	0

STRIP FOUNDATION

$$q_u = c_u N_c + \gamma DNq + 0.5\gamma BN_\gamma$$

CIRCLE FOUNDATION

$$q_u = 1.3c_u N_c + \gamma DNq + 0.3\gamma BN_\gamma$$

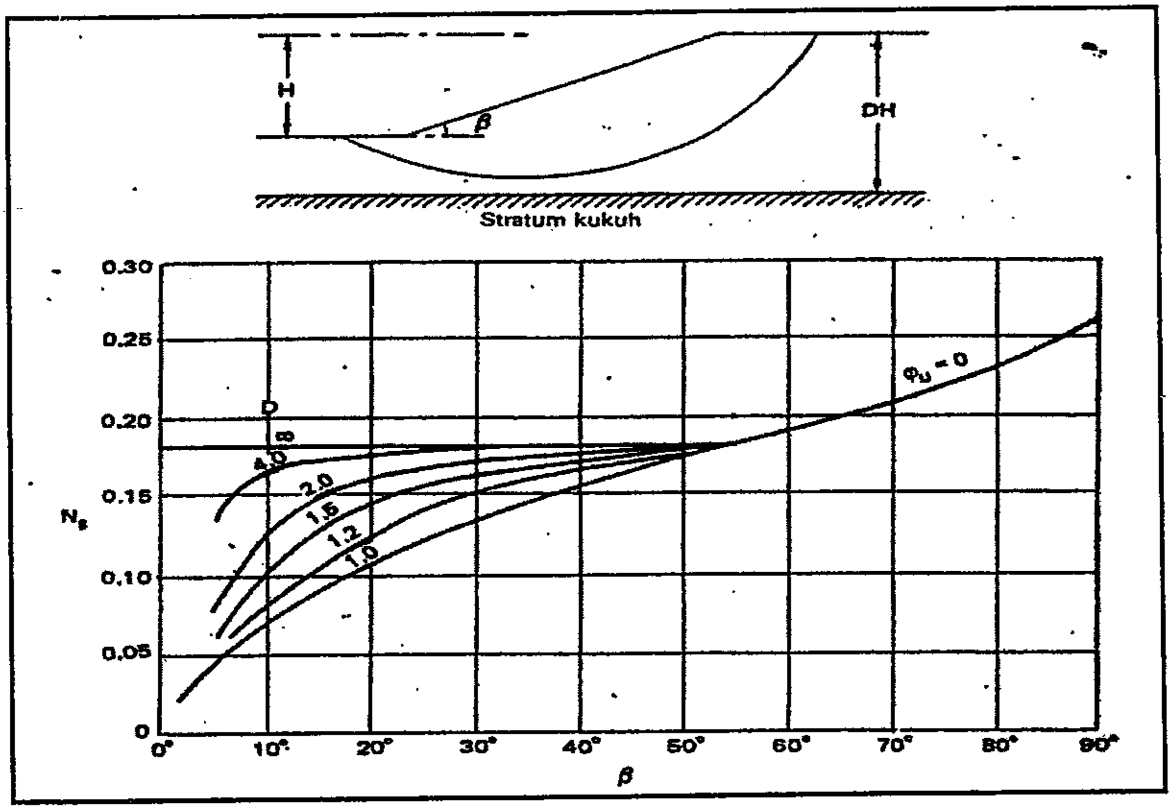
SQUARE SPREAD FOUNDATION

$$q_u = 1.3c_u N_c + \gamma DNq + 0.4\gamma BN_\gamma$$

RECTANGLE SPERAD FOUNDATION

$$q_u = c_u N_c [1+ 0.3 (B/L) + \gamma DNq + 0.5\gamma BN_\gamma[1-0.2 (B/L)]$$

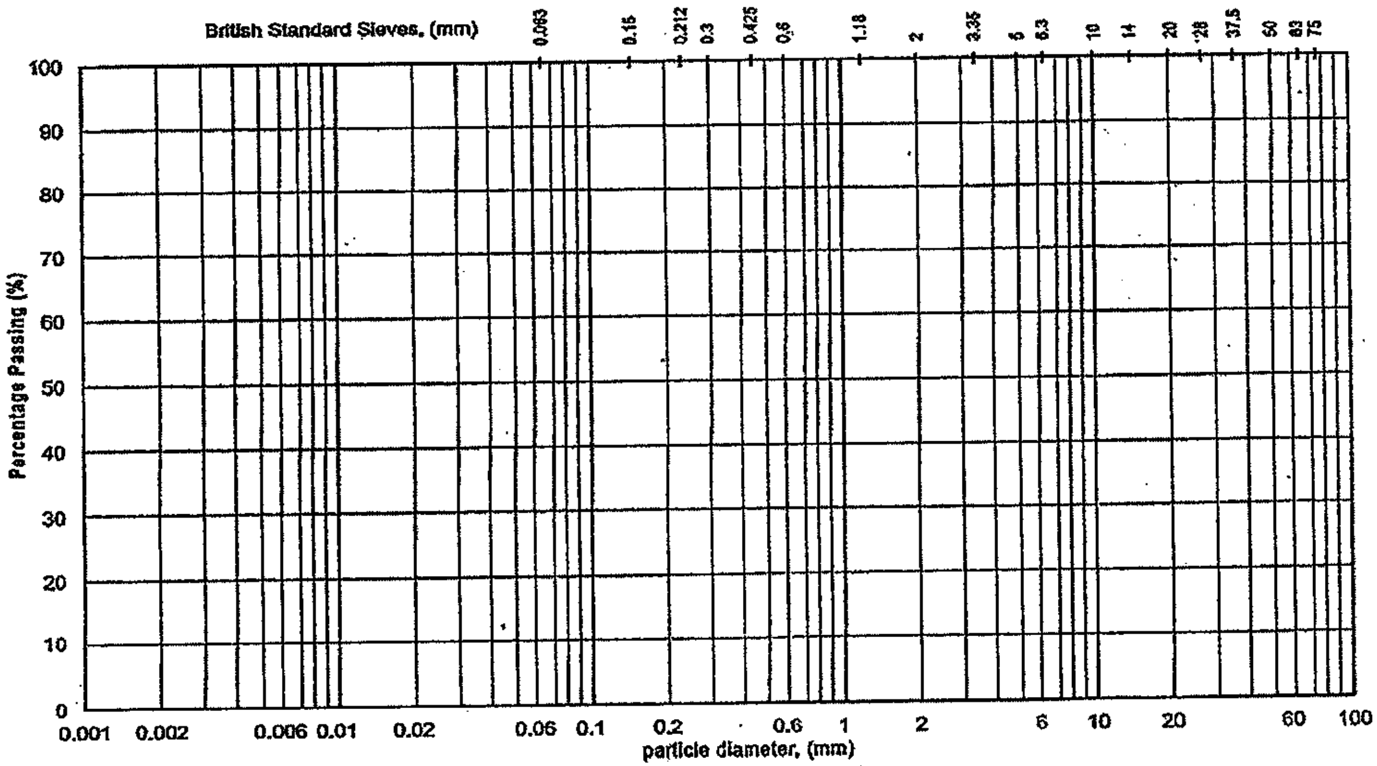
Taylor Stabilization Chart



GERAF SEMI LOG (JKA)

PARTICLE SIZE DISTRIBUTION

Job No.	Project		BH/Pit no.		Date
Site	Client		Sample no.		Tested by
Test method	Soil Descrip		Depth (m)		Checked by



CLAY	fine	medium	coarse	fine	medium	coarse	fine	medium	coarse	Cobbles
	SILT			SAND			GRAVEL			

GRADING CHARACTERISTICS	
% Gravel	
% Sand	
% Silt	
% Clay	
D_{90} (mm)	
D_{85} (mm)	
D_{60} (mm)	
D_{50} (mm)	
D_{30} (mm)	
D_{15} (mm)	
D_{10} (mm)	
C_u	
C_g	
Soil Classsification	
Remarks :	

UNIFIED SOIL CLASSIFICATION INCLUDING IDENTIFICATION AND DESCRIPTION

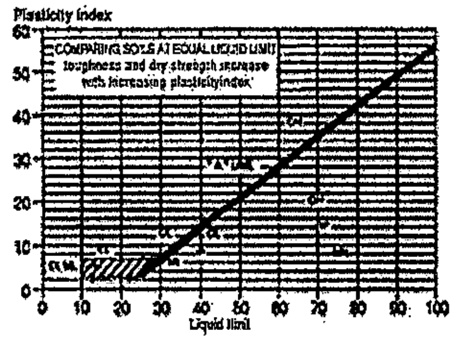
Major division	Subdivision	Field identification procedures (excluding particles larger than 3 inches and basing fractions on estimated weights)			Group symbols	Typical names	Information required for describing soils	Laboratory classification criteria
COARSE GRAINED SOILS More than half material is larger than No. 200 sieve size	GRAVELS More than half of coarse fraction is larger than No. 4 sieve size (For visual classification, the 1/4" size may be used as equivalent for the No. 4 sieve size) — CLEAN GRAVELS (Little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes			GW	Well graded gravels, gravel-sand mixtures, little or no fines	Give typical name; indicate approximate percentage of sand and gravel, max. size; angularity, surface condition, and hardness of the coarse grains; local or geological name and other pertinent descriptive information, and symbol in parentheses.	$C_u = \frac{D_{60}}{D_{10}}$ Greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between one and 3
	GRAVELS — CLEAN GRAVELS (Little or no fines)	Predominantly one size or a range of sizes with some intermediate sizes missing			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for GW
	GRAVELS — GRAVELS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below)			GM	Silty gravel, poorly graded gravel-sand silt mixtures	For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristics.	Atterberg limits above "A" line with PI greater than 7 — Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols
	GRAVELS — GRAVELS WITH FINES (Appreciable amount of fines)	Plastic fines (for identification procedures see CL below)			GC	Clayey gravels, poorly graded gravel-sand clay mixtures		Atterberg limits below "A" line or PI greater than 7
	SANDS More than half of coarse fraction is smaller than No. 4 sieve size — CLEAN SANDS (Little or no fines)	Wide range in grain sizes and substantial amount of all intermediate particle sizes			SW	Well graded sands, gravelly sands, little or no fines		$C_u = \frac{D_{60}}{D_{10}}$ Greater than 6; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between one and 3
	SANDS — CLEAN SANDS (Little or no fines)	Predominantly one size or a range of sizes with some intermediate sizes missing			SP	Poorly graded sand, gravelly sands, little or no fines	EXAMPLE	Not meeting all gradation requirements for SW
	SANDS — SANDS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see CL below)			SM	Silty sand, poorly graded sand-silt mixtures	Silty sand gravelly; about 20% hard, angular gravel particle $\frac{1}{2}$ - in maximum size; rounded and subangular sand grains coarse to fine; about 15% non-plastic fines with low dry strength; well compacted and moist in place; alluvial sand; (SM)	Atterberg limits below "A" line or PI less than 4 — Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols
	SANDS — SANDS WITH FINES (Appreciable amount of fines)	Plastic fines (for identification procedures see CL below)			SC	Clayey sand, poorly graded sand-clay mixtures		Atterberg limits above "A" line with PI greater than 7
FINE GRAINED SOILS More than half material is smaller than No. 200 sieve size (The No. 200 sieve size is about the smallest particle visible to the naked eye)	IDENTIFICATION PROCEDURES ON FRACTION SMALLER THAN No 40 SIEVE SIZE	DRY STRENGTH (CRUSHING CHARACTERISTICS)	DILATANCY (REACTION TO SHAKING)	TOUGHNESS (CONSISTENCY NEAR PLASTIC LIMIT)				
	SILTS AND CLAYS Liquid limit less than 50	None to slight	Quick to slow	None	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sand with slight plasticity	Give typical name; indicate degree and character of plasticity, amount and maximum size of coarse grains; color in wet condition, odor, if any, local or geologic name, and other pertinent descriptive information, and symbol in parentheses.	PLASTICITY CHART
	SILTS AND CLAYS Liquid limit less than 50	Medium to high	None to very slow	Medium	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays		
	SILTS AND CLAYS Liquid limit less than 50	Slight to medium	Slow	Slight	OL	Organic silts and organic silt-clays of low plasticity	For undisturbed soils add information on structure, stratification, consistency in undisturbed and remolded states, moisture and drainage conditions	
	SILTS AND CLAYS Liquid limit greater than 50	Slight to medium	Slow to none	Slight to medium	MH	Inorganic silt, micaceous or diatomaceous fine sandy or silty soils, elastic silts		
	SILTS AND CLAYS Liquid limit greater than 50	High to very high	None	High	CH	Inorganic clays of high plasticity	EXAMPLE:	
	SILTS AND CLAYS Liquid limit greater than 50	Medium to high	None to very slow	Slight to medium	OH	Organic clays of medium to high plasticity	Clayey silt, brown, slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; loess, (ML)	
HIGHLY ORGANIC SOILS		Readily identified by color, odor, spongy feel and frequently by fibrous texture			Pt	Peat and other organic soils		

Use grain size curve in indentifying the fractions as given under field identification

Determine percentages of gravel and sand from grain size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size) coarse grained soils are classified as follow:
Less than 5% GW, GP, SW, SP.
More than 12% GM, GC, SM, SC.
5% to 12% Borderline cases requiring use of dual symbols

PLASTICITY CHART

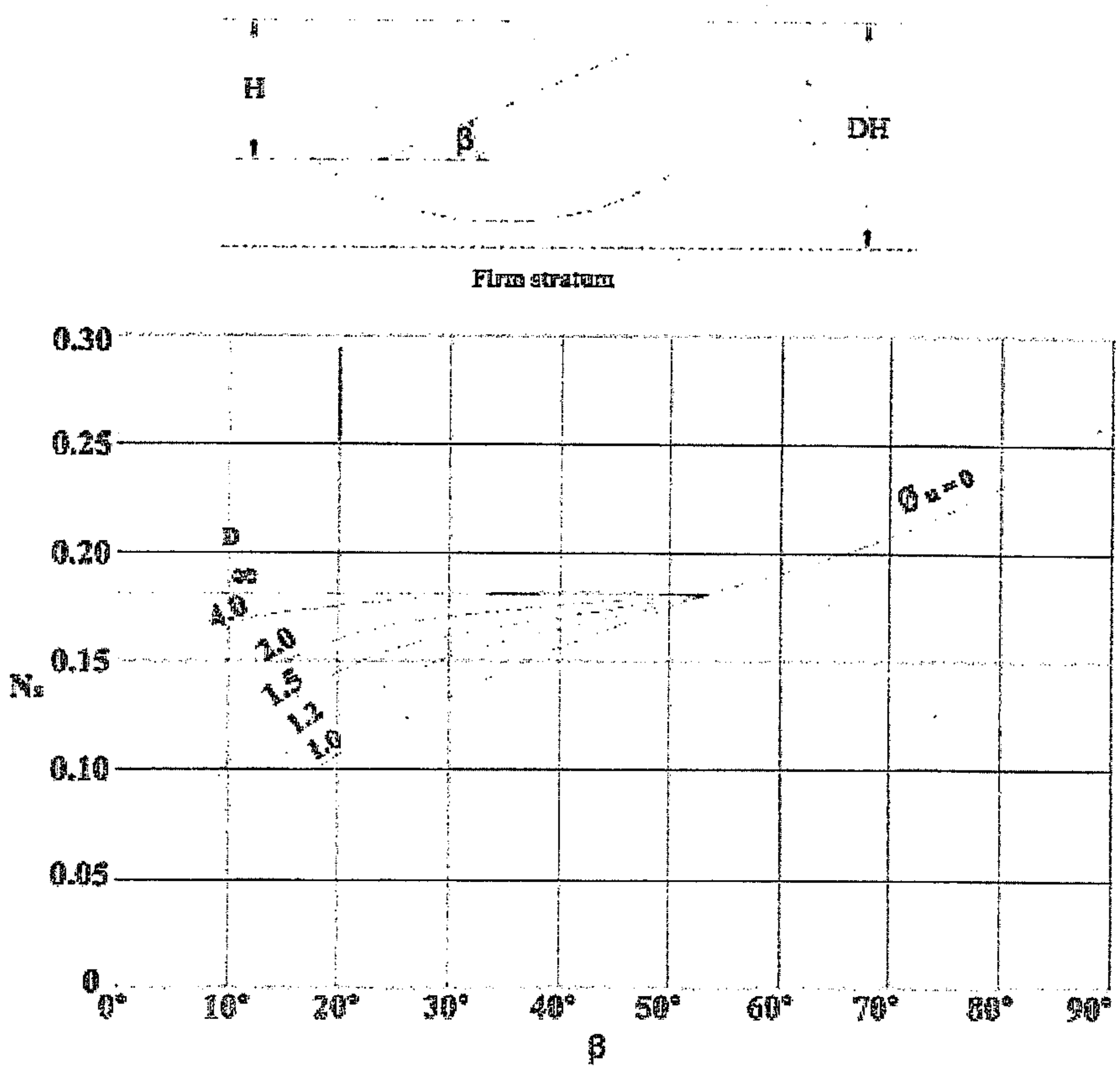
FOR LABORATORY CLASSIFICATION OF FINE GRAINED SOILS



BEARING CAPACITY FACTORS FOR GENERAL SHEAR

BEARING CAPACITY FACTORS FOR GENERAL SHEAR

ANGLE OF FRICTION φ (DEGREES)	TERZAGHI N_c	TERZAGHI N_q	TERZAGHI N_γ	MEYERHOF N_c	MEYERHOF N_q	MEYERHOF N_γ	HANSEN N_c	HANSEN N_q	HANSEN N_γ
0	5.70	1.00	0.00	5.10	1.00	0.00	5.10	1.00	0.00
2	6.30	1.22	0.18	5.63	1.20	0.01	5.63	1.20	0.01
4	6.97	1.49	0.38	6.19	1.43	0.04	6.19	1.43	0.05
5	7.34	1.64	0.50	6.49	1.57	0.07	6.49	1.57	0.07
6	7.73	1.81	0.62	6.81	1.72	0.11	6.81	1.72	0.11
8	8.60	2.21	0.91	7.53	2.06	0.21	7.53	2.06	0.22
10	9.60	2.69	1.21	8.34	2.47	0.37	8.34	2.47	0.39
12	10.76	3.29	1.70	9.28	2.97	0.60	9.28	2.97	0.63
14	12.11	4.02	2.23	10.37	3.59	0.92	10.37	3.59	0.97
15	12.86	4.45	2.50	10.98	3.94	1.13	10.98	3.94	1.18
16	13.68	4.92	2.94	11.63	4.34	1.37	11.63	4.34	1.43
18	15.52	6.04	3.87	13.10	5.26	2.00	13.10	5.26	2.08
20	17.69	7.44	4.97	14.83	6.40	2.87	14.83	6.40	2.95
22	20.27	9.19	6.61	16.88	7.82	4.07	16.88	7.82	4.13
24	23.36	11.40	8.58	19.32	9.60	5.72	19.32	9.60	5.75
25	25.13	12.72	9.70	20.72	10.66	6.77	20.72	10.66	6.76
26	27.09	14.21	11.35	22.25	11.85	8.00	22.25	11.85	7.94
28	31.61	17.81	15.15	25.80	14.72	11.19	25.80	14.72	10.94
30	37.16	22.46	19.73	30.14	18.40	15.67	30.14	18.40	15.07
32	44.04	28.52	27.49	35.49	23.18	22.02	35.49	23.18	20.79
34	52.64	36.50	36.96	42.16	29.44	31.15	42.16	29.44	28.77
35	57.75	41.44	42.40	46.12	33.30	37.15	46.12	33.30	33.92
36	63.53	47.16	51.70	50.59	37.75	44.43	50.59	37.75	40.05
38	77.50	61.55	73.47	61.35	48.93	64.07	61.35	48.93	56.17
40	95.66	81.27	100.39	75.31	64.20	93.69	75.31	64.20	79.54
42	119.67	108.75	165.69	93.71	85.37	139.32	93.71	85.37	113.96
44	151.95	147.74	248.29	118.37	115.31	211.41	118.37	115.31	165.58
45	172.29	173.29	294.50	133.87	134.87	262.74	133.87	134.87	200.81
46	196.22	204.19	426.96	152.10	158.50	328.73	152.10	158.50	244.65
48	258.29	287.85	742.61	199.26	222.30	526.45	199.26	222.30	368.67
50	347.51	415.15	1153.15	266.88	319.06	873.86	266.88	319.06	568.57



Taylor's stability coefficients $\phi_u = 0$. (Reproduced by permission of the Boston of Civil Engineers)