UNIVERSITI SAINS MALAYSIA

First Semester Examination
2010/2011 Academic Session

November 2010

EAG 345/3 – Geotechnical Analysis

[*Analisis Geoteknik*]

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

Please check that this examination paper consists of **THIRTEEN (13)** pages of printed material including appendices before you begin the examination.
[*Sila pastikan bahawa kertas peperiksaan ini mengandungi* ***TIGA BELAS (13)*** *muka surat yang bercetak termasuk 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 pile foundation is planned to hold an ultimate load of 30 MN (Allowable load is 10 MN and Factor of Safety is 3.0). Each pile is 1.0 m in diameter and fixed at 40 m in maximum length. The pile is made of concrete and the soil is generally dense sand with saturated unit weight of 20 kN/m^3.

Assume the following:

i) Ground water is at the surface of the ground.

ii) Horizontal stress is related to vertical stress according to $\sigma_h = \sigma_v$

iii) $\tan\delta$ for concrete against dense sand is 0.45

iv) Critical depth is 20 times pile diameter.

Effective angle of internal friction is 38 degrees.

v) Total foundation capacity is sum of capacities of all individual piles.

vi) Shaft friction is given by $f.A_{surface} = \sum_{d=0}^{depth} (\tan\delta.\sigma_h)dA$

vii) End Bearing is given by $Q_{ult} = A_p q_{ult} = A_p p_v N_q^*$

viii) N_q^* values are as given in attachment (Fig. 1).

a) Draw the profiles for total horizontal ground stress versus depth, water pressure versus depth, and effective horizontal ground stress versus depth for the entire length of pile. Give consideration to critical depth.

[4 marks]

b) Draw the profile for unit shaft friction, in kPa, versus depth for the entire pile length.

[4 marks]

c) Determine theoretical total skin friction capacity for each pile, in MN.

[4 marks]

d) Determine theoretical end bearing capacity for each pile, in MN.

[4 marks]

e) Determine the required number of piles for the foundation

[4 marks]

2. A footing is planned to support an ultimate load of 3 MN (Allowable load is 1 MN and Factor of Safety is 3.0). The footing will be embedded 2.0 m below ground surface. The bulk density of earth material is 1700 kg/m^3 and the water table is very deep. Terzaghi's equation for ultimate bearing capacity, q_{ult}, for square foundation is given by: $q_{ult} = 1.3cN_c + 0.4B\gamma N_\gamma + qN_q$ while for circular foundation is given by: $q_{ult} = 1.3cN_c + 0.3B\gamma N_\gamma + qN_q$. Refer attachment (Table 1).

4. Determine the required size of a circular footing if the soil is cohesive (zero angle of friction) with cohesion value of 30 kPa.

[5 marks]

b) Determine the required size of a circular footing if the soil is granular (cohesion-less) with angle of friction of 40 degrees.

[5 marks]

c) Determine the required size of a square footing if the soil is cohesive (zero angle of friction) with cohesion value of 30 kPa.

[5 marks]

d) Determine the required size of a square footing if the soil is granular (cohesion-less) with angle of friction of 40 degrees.

[5 marks]

3. a) A direct shear test was performed on a 5.5x5.5 cm soil sample retrieved from a depth of 5 m for a Housing project. The test results are shown in the following table.

Test ujian	Normal load, kg Beban Normal, kg	Shearing load, kg Beban Ricihan, kg
1	4	5.80
2	8	6.94
3	12	8.10
4	16	9.60

Determine:

4. The strength parameters for the soil.

[5marks]

ii) σ_1 and σ_3, if a Mohr's circle is imposed for test 2.

[5 marks]

b) Isotropically Consoildated Undrained (CIU) triaxial tests were performed on a soil compacted to 95% of $\gamma_{d(max)}$ of Modified Proctor for a Dam project. Tests results are given in the following Table

Sample #	σ_3, kPa	$(\sigma_1-\sigma_3)$, kPa	u, kPa
1	70	230	-20
2	350	550	+90

Determine the shear strength parameters in terms of

4. Total stress

[5 marks]

ii) Effective stress

[5 marks]

4. a) Calculate the total active thrust on a vertical wall 5 m high retaining a sand deposit having $\varphi' = 35^\circ$ and $\gamma = 17$ kN/m^3. The surface of the deposit is horizontal and the water table is below the bottom of the wall.

[2 marks]

b) Determine the thrust on the wall in (a) if the water table rises to a level 2 m below the surface and $\gamma_{sat}=20$ kN/m^3.

[3 marks]

c) A 6 m high vertical frictionless retaining wall with horizontal backfill having a surcharge of 15 kN/m^2 is required to be analyzed for a highway project. The backfill material properties are: γ= 16.5 kN/m^3, φ'=26°, c′=10 kN/m^2.

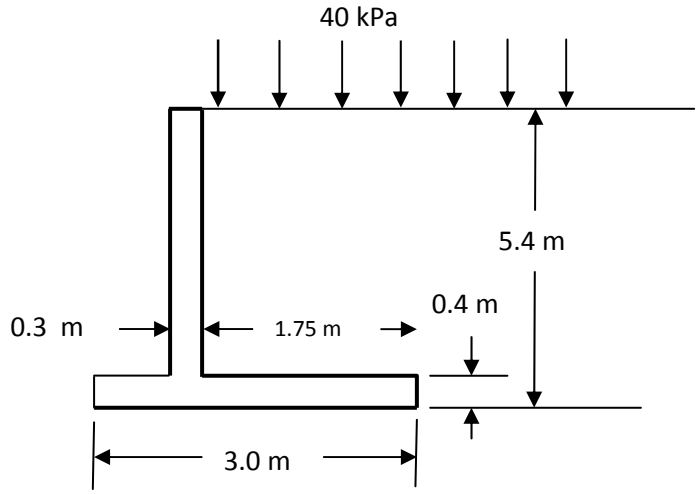
i) Show the pressure distribution against the wall and calculate the height of tension crack.

[2 marks]

ii) Determine the active force after the tension crack occurs.

[3 marks]

d) The cross section of a cantilever retaining wall is shown in the figure below. The appropriate parameters for the soil are: c′=0, φ'= 40°, γ= 17 kN/m^3, δ_{base}=30° $\gamma_{conc.}$=23.5 kN/m^3, water table-below the base of wall. Neglect passive resistance.



i) Calculate the factor of safety against sliding.

[4 marks]

ii) Determine the maximum and minimum pressure under the base of the retaining wall.

[6 marks]

5. a) Name the Slope Classifications and its causes of slope failures.

[5 marks]

b) Sketch Slope Failures and dercribe their failure conditions.

[5 marks]

c) Give an example of slope stability calculation and calculate its FOS. Comment on the analysis

[10 marks]

6. Site Investigation is the process by which geological, geotechnical and other relevant information which might affect the construction or performance of Civil Engineering or Building project acquired.

a) Describe Five (5) main objectives of Site Investigation which have been defined by the British Code Of Practise BS 5930.

[5 marks]

b) Discuss the overall process involved when carried out site investigation for a large project.

[5 marks]

c) What do you understand by “Standard Penetration Test”. Appendix 2 below show part of a bore-log for a bole hole carried out for a School Project In Perak. List down the SPT-N values for each layer from the record.

[10 marks]

1. *Suatu tapak cerucuk dirancang bagi menampung beban muktamad 30 MN (Bebanan dibenarkan 10 MN sementara Faktor Keselamatan 3.0). Setiap cerucuk bergaris pusat 1.0 m dan panjangnya ditetapkan 40 m. Cerucuk konkrit, sementara tanahnya pasir padat dengan berat unit tepunya 20kN/m^3. Anggap yang berikut:*

i) *Paras air di permukaan tanah.*

ii) *Tekanan sisi dan tekanan tegak menurut* $\sigma_h = \sigma_v \tan\delta$ *konkrit 0.45*

iii) *Kedalaman kritikal 20 kali garispusat cerucuk.*

iv) *Sudut ricih dalam berkesan 38 darjah.*

v) *Keupayaan tapak sama dengan jumlah keupayaan semua cerucuk.*

vi) *Keupayaan geseran dinding diberi* $f.A_{surface} = \sum_{d=0}^{depth} (\tan\delta.\sigma_h)dA$

vii) *Keupayaan galas hujung cerucuk diberi* $Q_{ult} = A_p q_{ult} = A_p p_v N_q^*$

viii) *Nilai* N_q^* *menurut lampiran (Rajah 1).*

a) *Lukiskan taburan jumlah tekanan mendatar lawan kedalaman, tekanan air lawan kedalaman, dan tekanan mendatar berkesan lawan kedalaman bagi sepanjang cerucuk. Ambil kira kedalaman kritikal.*

[4 markah]

b) *Lukiskan taburan geseran unit dinding cerucuk, dalam kPa, lawan kedalaman bagi sepanjang cerucuk.*

[4 markah]

c) *Tentukan jumlah geseran dinding bagi setiap cerucuk, dalam MN.*

[4 markah]

d) *Tentukan kekuatan galas hujung cerucuk, dalam MN.*

[4 markah]

e) *Tentukan jumlah cerucuk yang diperlukan bagi tapak tersebut.*

[4 markah]

2. *Suatu tapak dirancang bagi menyokong bebanan muktamad 3 MN (bebanan dibenar 1 MN sementara Faktor Keselamatan 3.0). Tapak terletak di kedalaman 2.0 m. Ketumpatan pukal tanah 1700 kg/m^3 dan paras airnya sangat dalam. Persamaan Terzaghi bagi Keupayaan Galas Muktamad, q_{ult}, bagi tapak segi empat sama diberi sebagai: $q_{ult} = 1.3cN_c + 0.4B\gamma N_\gamma + qN_q$ sementara bagi tapak bulat diberi sebagai: $q_{ult} = 1.3cN_c + 0.3B\gamma N_\gamma + qN_q$. Rujuk lampiran (Jadual 1).*

a) Tentukan saiz tapak bulat jika tanah lempung (sudut ricih kosong) dengan nilai kejelekitan 30 kPa.

[5 markah]

b) Tentukan saiz tapak bulat jika tanah berbutir (kejeleketan kosong) dengan sudut ricihnya 40 darjah.

[5 markah]

c) Tentukan saiz tapak segiempat sama jika tanah lempung (sudut ricih kosong) dengan nilai kejelekitan 30 kPa.

[5 markah]

d) Tentukan saiz tapak segiempat sama jika tanah berbutir (kejeleketan kosong) dengan sudut ricihnya 40 darjah.

[5 markah]

3. *a) Suatu Ujian ricih Terus telah di jalankan keatas 5.5x5.5 cm sampel tanah yang di ambil pada kedalaman 5m bagi suatu projek perumahan. Keputusan Ujian adalah seperti yang di beri:*

Ujian	*Beban Normal, kg*	*Beban Ricihan, kg*
1	*4*	*5.80*
2	*8*	*6.94*
3	*12*	*8.10*
4	*16*	*9.60*

Tentukan:

i) Parameter kekuatan tanah

[5 markah]

ii) σ_1 dan σ_3, Sekiranya bulatan Mohr di jalankan keatas ujian 2

[5 markah]

c) *Ujian Triaxial Pengukuhan Isotropik Tak Tersalir (CIU) di uji pada pemadatan tanah 95% $\gamma_{d(max)}$ bagi Proktor Ubahsuai untuk Projek Empangan. Keputusan ujian adalah seperti berikut:*

Sampel #	*σ_3, kPa*	*(σ_1-σ_3), kPa*	*u, kPa*
1	*70*	*230*	*-20*
2	*350*	*550*	*+90*

Tentukan parameter kekuatan rich dalam terbitan

i) Tegasan Jumlah

[5 markah]

ii) Tegasan Berkesan

[5 markah]

4. a) *Kira jumlah daya aktif pada dinding menegak ketinggian 5m yang menahan pasir berkandungan $\varphi' = 35^\circ$ and $\gamma = 17$ kN/m^3. Permukaan tanah tersebut adalah mendatar dan paras airbumi adalah jauh di bawah tembok.*

[2 markah]

b) *Tentukan daya pada tembok di (a) sekiranya paras airbumi naik ke paras 2m dari bawah paras permukaaan dan γ_{sat}=20 kN/m^3.*

[3 markah]

c) *Analisa satu projek Lebuhraya bagi sebuah Tembok penahan setinggi 6m yang tiada gesearan mempunyai tanah di belakang yang mendatar dan kenaan beban teragih adalah 15kN/m^3 . Tanah kambus balik menpunyai kandungan seperti berikut: γ= 16.5 kN/m^3, φ′=26˚, c′=10 kN/m^2.*

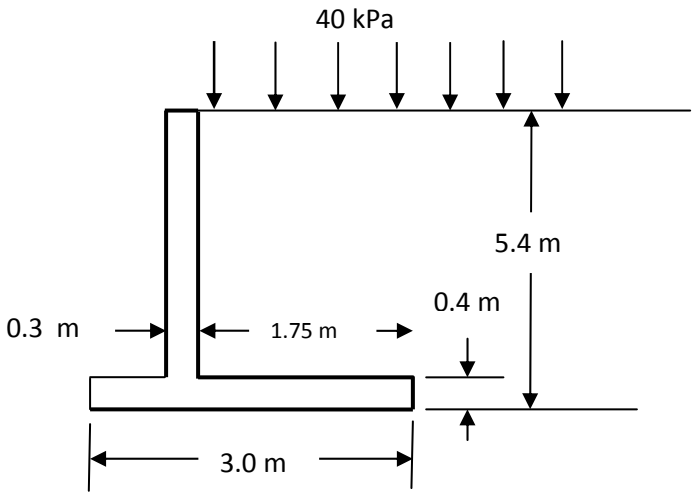
i) *Tunjukan taburan tekanan keatas tembok dan kira ketinggian retak tegangan.*

[2 markah]

ii) *Tentukan daya aktif selepas kejadian retak tegangan.*

[3 markah]

d) *Keratan rentas untuk tembok terjulur ditunjukan dalam gambarajah di bawah. Parameter yang sesuai untuk tanah adalah : c′=0, φ′= 40˚, γ= 17 kN/m^3, δ_{base}=30˚ $\gamma_{conc.}$=23.5 kN/m^3, paras airbumi adalah di bawah dasar tembok. Abaikan rintangan pasif.*



i) *Kira faktor keselamatan keatas kegelinciran*

[4 markah]

ii) *Tentukan tekanan maksimum dan minimum dibawad dasar tembok penahan.*

[6 markah]

5. a) *Namakan klasifikasi cerun and apakah penyebab kegagalan cerun.*

[5 markah]

b) *Lakarkan kegagalan cerun dan terangkan keadaan kegagalannya*

[5 markah]

c) *Cadangkan satu contoh pengiraan kestabilan cerun dan kira faktor keselamatan. Komen analisis tersebut*

[10 markah]

6. *Penyiasatan tapak adalah proses memperolehi maklumat-maklumat geologi, geoteknik dan perkara berkaitan yang akan mempengaruhi prestasi sesuatu projek kejuruteraan awam atau bangunan.*

a) *Huraikan Lima (5) Objektif utama Penyaiasatan Tapak yang diberikan oleh Kod amalan Britsih , BS 5930.*

(5 markah)

b) *Bincangkan proses keseluruhan yang terlibat apabila menjalankan penyiasatan tapak untuk projek mega.*

(5 markah)

c) *Apakah yang anda faham dengan " Ujian Penusukan Piawai". Lampiran 2 di bawah menunjukkan sebahagian dari log gerudi untuk suatu lubang Jara yang dijalankan untuk suatu projek Pembinaan Sekolah di Negeri Perak. Senaraikan nilai SPT-N untuk setiap lapisan seperti yang terdapat dalam rekod.*

(10 markah)

APPENDIX 1

LAMPIRAN 1

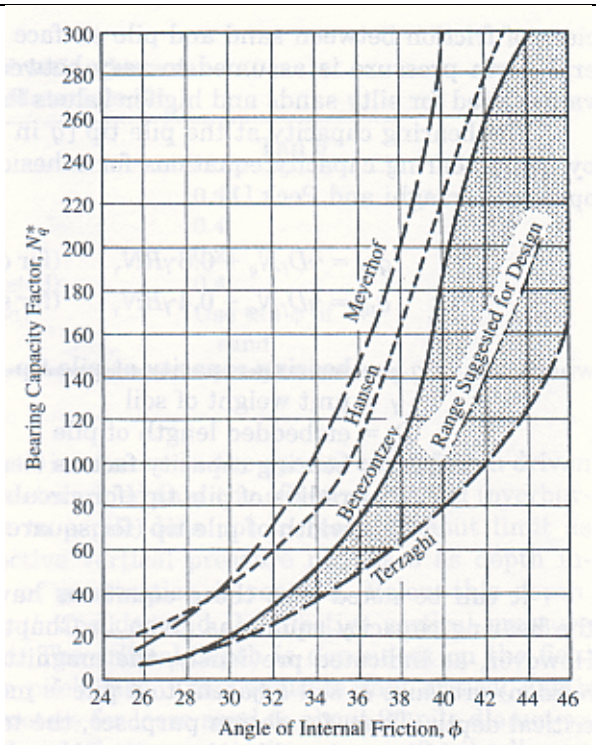


Fig. 1/*Rajah 1* – Angle of internal friction versus bearing capacity factor, N_q*.

▼ **TABLE 12.1** Terzaghi's Bearing Capacity Factors — N_c, N_q and N_γ — Eqs (12.11), (12.12), and (12.13)

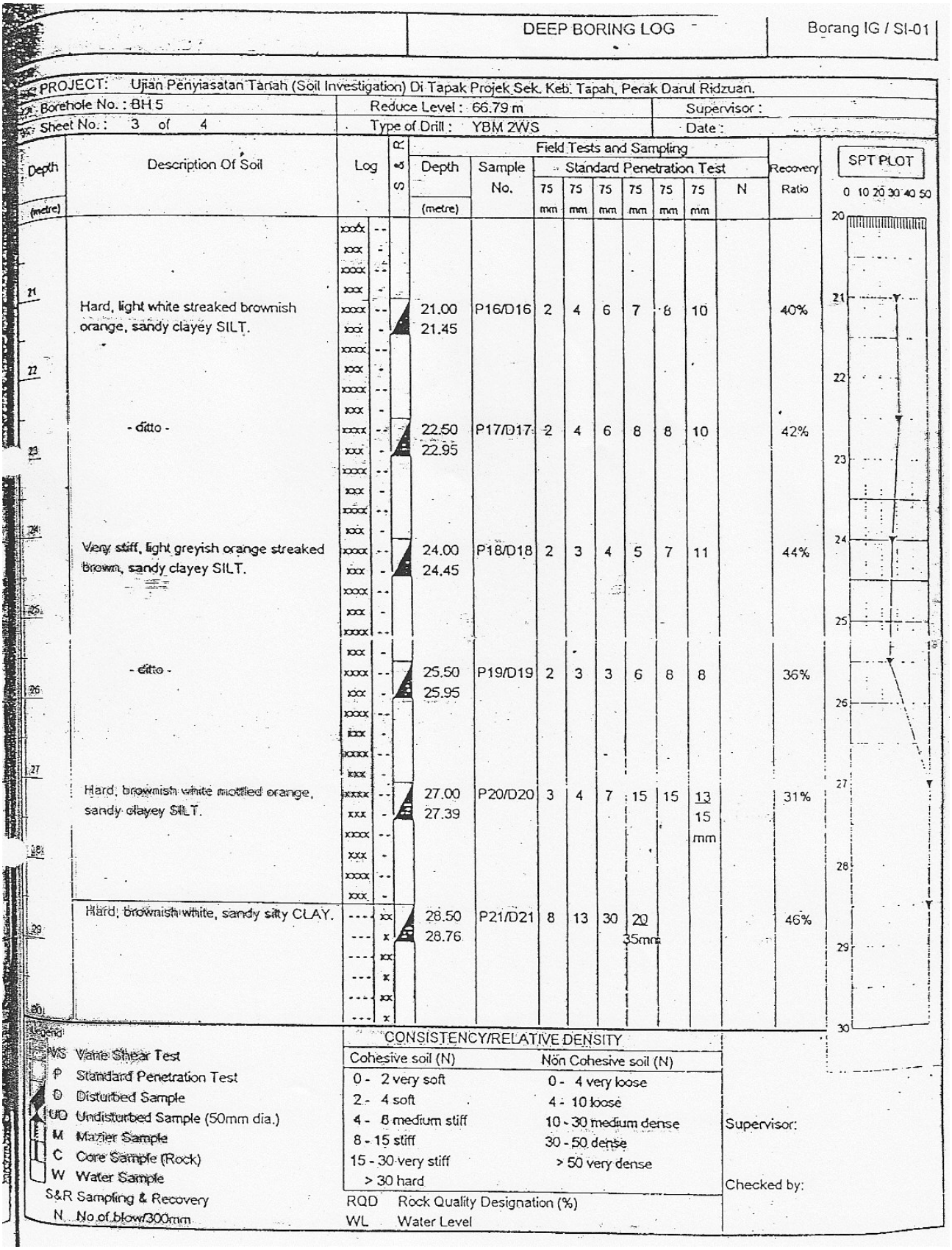
ϕ (deg)	N_c	N_q	N_γ^*	ϕ (deg)	N_c	N_q	N_γ^*
0	5.70	1.00	0.00	26	27.09	14.21	9.84
1	6.00	1.10	0.01	27	29.24	15.90	11.60
2	6.30	1.22	0.04	28	31.61	17.81	13.70
3	6.62	1.35	0.06	29	34.24	19.98	16.18
4	6.97	1.49	0.10	30	37.16	22.46	19.13
5	7.34	1.64	0.14	31	40.41	25.28	22.65
6	7.73	1.81	0.20	32	44.04	28.52	26.87
7	8.15	2.00	0.27	33	48.09	32.23	31.94
8	8.60	2.21	0.35	34	52.64	36.50	38.04
9	9.09	2.44	0.44	35	57.75	41.44	45.41
10	9.61	2.69	0.56	36	63.53	47.16	54.36
11	10.16	2.98	0.69	37	70.01	53.80	65.27
12	10.76	3.29	0.85	38	77.50	61.55	78.61
13	11.41	3.63	1.04	39	85.97	70.61	95.03
14	12.11	4.02	1.26	40	95.66	81.27	115.31
15	12.86	4.45	1.52	41	106.81	93.85	140.51
16	13.68	4.92	1.82	42	119.67	108.75	171.99
17	14.60	5.45	2.18	43	134.58	126.50	211.56
18	15.12	6.04	2.59	44	151.95	147.74	261.60
19	16.56	6.70	3.07	45	172.28	173.28	325.34
20	17.69	7.44	3.64	46	196.22	204.19	407.11
21	18.92	8.26	4.31	47	224.55	241.80	512.84
22	20.27	9.19	5.09	48	258.28	287.85	650.67
23	21.75	10.23	6.00	49	298.71	344.63	831.99
24	23.36	11.40	7.08	50	347.50	415.14	1072.80
25	25.13	12.72	8.34				

[a] From Kumbhojkar (1993)

Table 1/*Jadual 1* – Values of bearing capacity factors for given angles of internal friction

APPENDIX 2

LAMPIRAN 2



DEEP BORING LOG — Borang IG / SI-01

PROJECT: Ujian Penyiasatan Tanah (Soil Investigation) Di Tapak Projek Sek. Keb. Tapah, Perak Darul Ridzuan.

Borehole No. : BH 5 | Reduce Level : 66.79 m | Supervisor :

Sheet No. : 3 of 4 | Type of Drill : YBM 2WS | Date :

Depth (metre)	Description Of Soil	Log	S&R	Depth (metre)	Sample No.	Standard Penetration Test 75 mm	75 mm	75 mm	75 mm	75 mm	75 mm	N	Recovery Ratio
21	Hard, light white streaked brownish orange, sandy clayey SILT.			21.00 – 21.45	P16/D16	2	4	6	7	8	10		40%
22	- ditto -			22.50 – 22.95	P17/D17	2	4	6	8	8	10		42%
24	Very stiff, light greyish orange streaked brown, sandy clayey SILT.			24.00 – 24.45	P18/D18	2	3	4	5	7	11		44%
26	- ditto -			25.50 – 25.95	P19/D19	2	3	3	6	8	8		36%
27	Hard, brownish white mottled orange, sandy clayey SILT.			27.00 – 27.39	P20/D20	3	4	7	15	15	13 / 15 mm		31%
29	Hard, brownish white, sandy silty CLAY.			28.50 – 28.76	P21/D21	8	13	30	20 / 35mm				46%

SPT PLOT: 0 10 20 30 40 50

Legend

VS Vane Shear Test
P Standard Penetration Test
D Disturbed Sample
UD Undisturbed Sample (50mm dia.)
M Mazier Sample
C Core Sample (Rock)
W Water Sample
S&R Sampling & Recovery
N No.of blow/300mm

CONSISTENCY/RELATIVE DENSITY

Cohesive soil (N)	Non Cohesive soil (N)
0 - 2 very soft	0 - 4 very loose
2 - 4 soft	4 - 10 loose
4 - 8 medium stiff	10 - 30 medium dense
8 - 15 stiff	30 - 50 dense
15 - 30 very stiff	> 50 very dense
> 30 hard	

RQD Rock Quality Designation (%)
WL Water Level

Supervisor:

Checked by: