First Semester Examination
2017/2018 Academic Session

January 2018

EAG345 – Geotechnical Analysis
(Analisis Geoteknik)

Duration : 3 hours
(Masa : 3 jam)

Please check that this examination paper consists of FIFTEEN (15) pages of printed material including appendix before you begin the examination.

[Sila pastikan bahawa kertas peperiksaan ini mengandungi LIMA BELAS (15) 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.]*

In the event of any discrepancies, the English version shall be used.

[Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah digunapakai.]

1. An embankment is to be constructed rapidly on a natural slope consisting of saturated clay. As an engineer, you are assigned to determine the safety of the slope. The check involves determining the shear stress developed along the most likely failure surface and comparing it against the shear strength of the soil.

Sebuah tambakan akan dibina secara pantas di atas sebuah cerun semulajadi yang mengandungi lempung tepu. Sebagai seorang jurutera, anda dikehendaki menentukan kestabilan cerun tersebut. Pemeriksaan termasuklah menentukan tegasan ricih yang berlaku di sepanjang permukaan kegagalan yang mungkin terjadi dan membandingkannya dengan kekuatan ricih tanah.

(a) Based on the location of the embankment and the underneath soil, describe the factors that may influence the shear strength of the soil.

Berdasarkan lokasi tambakan dan tanah dibawahnya, terangkan faktor-faktor yang mungkin mempengaruhi kekuatan ricih tanah.

[4 marks/*markah*]

(b) In order to determine the parameters needed to calculate the factor of safety, a Triaxial test shall be done. Select the suitable type of Triaxial test for this situation and explain the reasons behind the selection based on the outcome of the Triaxial test.

Bagi menentukan parameter yang diperlukan bagi pengiraan faktor keselamatan, suatu ujian Tigapaksi perlu dilakukan. Pilih ujian Tigapaksi yang sesuai bagi situasi ini dan terangkan sebab mengapa pemilihan dibuat berdasarkan hasil ujian Tigapaksi tersebut.

[6 marks/*markah*]

(c) The results shown in **Table 1** were obtained for peak failure in a series of Triaxial tests as chosen in (b), with pore pressure values given, on a specimens of a saturated clay. Determine the values of the effective stress parameters.

*Keputusan-keputusan yang ditunjukkan dalam **Jadual 1** diperolehi bagi kegagalan puncak dalam siri ujian Tigapaksi seperti dalam (b), dengan tekanan liang yang diberikan, pada spesimen lempung tepu. Tentukan nilai-nilai parameter tegasan efektif.*

[10 marks/*markah*]

Table 1/*Jadual 1*

All-around pressure/ *Tekanan keliling* (kN/m^2)	Principal stress difference/ *Perbezaan tegasan prinsipal* (kN/m^2)	Pore water pressure/ *Tekanan liang air* (kN/m^2)
150	182	76
300	324	146
450	479	211

2. (a) The British Standard Code of Practices BS 5930:1991 gave a list of the primary objectives of Soil Investigations. Explain the **FOUR (4)** objectives.

*'Kaedah Praktis Kod Piawaian British BS 5930:1991' memberikan senarai objektif utama bagi Penyiasatan Tapak. Terangkan **EMPAT (4)** objektif tersebut.*

[8 marks/*markah*]

(b) A 5-story apartment is to be built on the center of an area as **Figure 1**. Using your knowledge and guidance on spacing of ground investigation points (Eurocode 7, Part 2:2007), explain the suitable arrangement of boreholes and other suitable soil investigation methods to be used for the work. Use sketch to assist your explanation.

*Sebuah pangsapuri 5 tingkat akan dibina ditengah sebuah kawasan seperti **Rajah 1**. Menggunakan pengetahuan anda dan kaedah sela titik-titik penyiasatan tapak (Eurocode 7, Part 2:2007), terangkan kaedah penyusunan yang sesuai bagi lubang jara dan kaedah-kaedah penyiasatan tapak lain yang sesuai untuk kerja berkenaan. Gunakan lakaran bagi membantu penerangan anda.*

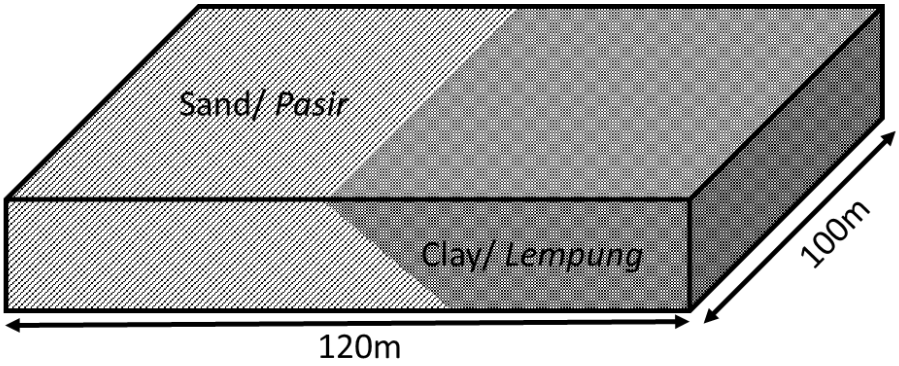

Figure 1/*Rajah 1*

[6 marks/*markah*]

(c) A detail boring log is given in **Appendix**. Calculate the SPT-N number and the corrected N number using any correlation that you know.

*Satu log penggerekan diberikan seperti **Lampiran**. Kira nombor SPT-N dan nombor pembetulan N menggunakan sebarang hubungkait yang anda ketahui.*

[6 marks/*markah*]

3. (a) Distinguish significant differences between 'At Rest', 'Active' and 'Passive' earth pressures when applied to the design of retaining walls.

Bezakan perbezaan utama tekanan tanah 'Rehat', 'Aktif' dan 'Pasif' apabila digunakan dalam reka bentuk dinding penahan.

[6 marks/*markah*]

(b) Based on the gravity wall shown in **Figure 2** and using Rankine theory:

*Tembok penahan graviti yang ditunjukkan dalam **Rajah 2** dan menggunakan teori Rankine:*

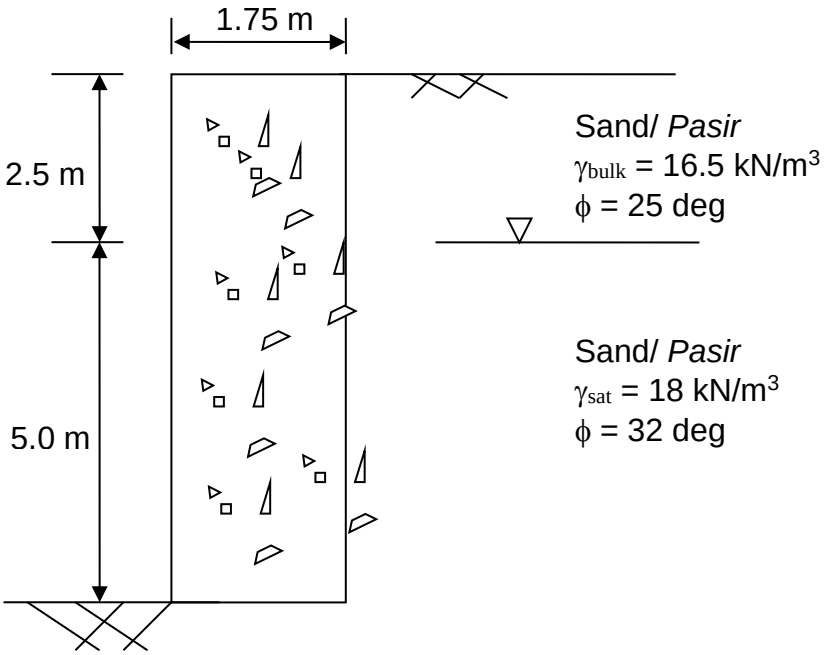

Figure 2/*Rajah 2*

(i) Sketch the soil and water pressure distributions acting at the back of the retaining wall.

Lakarkan taburan tekanan tanah dan air yang bertindak di belakang dinding tembok penahan.

[4 marks/*markah*]

(ii) Calculate the resultant active thrust per metre run of retaining wall.

Kirakan tujah paduan aktif per meter panjang dinding tembok penahan.

[5 marks/*markah*]

(iii) Determine the factor of safety against overturning of the wall by assuming the back of the wall is smooth (angle of wall friction is zero, δ=0). (5 marks)

Tentukan faktor keselamatan terhadap keterbalikan dinding menganggap belakang dinding adalah licin (sudut geseran dinding adalah sifar, δ=0).

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Given unit weight of concrete = 24 kN/m^3

Diberi berat unit konkrit = 24 kN/m^3

[5 marks/*markah*]

4. (a) List **FOUR (4)** earth retaining structures that are commonly used .

*Senaraikan **EMPAT (4)** struktur tembok penahan yang biasa dibina.*

[2 marks/*markah*]

(b) Based on the answer in 4 (a), sketch and show all the reactions acted within the retaining structures listed.

Berdasarkan jawapan di 4 (a) lakarkan dan tunjukkan semua daya tindakan bertindak pada tembok penahan yang disenaraikan.

[4 marks/*markah*]

(c) Describe Rankine's and Coulomb's theories for earth pressure analysis of retaining wall.

Terangkan teori Rankine dan teori Coulomb bagi analisis tekanan tanah bagi tembok penahan.

[6 marks/*markah*]

(d) Calculate the active thrust for retaining wall shown in **Figure 3**. Use Rankine's Active Pressure with (i) one (1) layer soil (given γ_{dry}= 17.3 kN/m^3) and (ii) ground water level at 9.1 m (given γ_{sat} = 17.3 kN/m^3)

*Kira tujah aktif bagi tembok penahan seperti ditunjukkan di **Rajah 3**. Guna teori Tekanan Aktif Rankine dengan (i) satu (1) lapisan tanah (diberikan γ_{dry} = 17.3 kN/m^3) dan (ii) paras air bumi pada 9.1 m (diberikan γ_{sat} = 17.3 kN/m^3).*

[8 marks/*markah*]

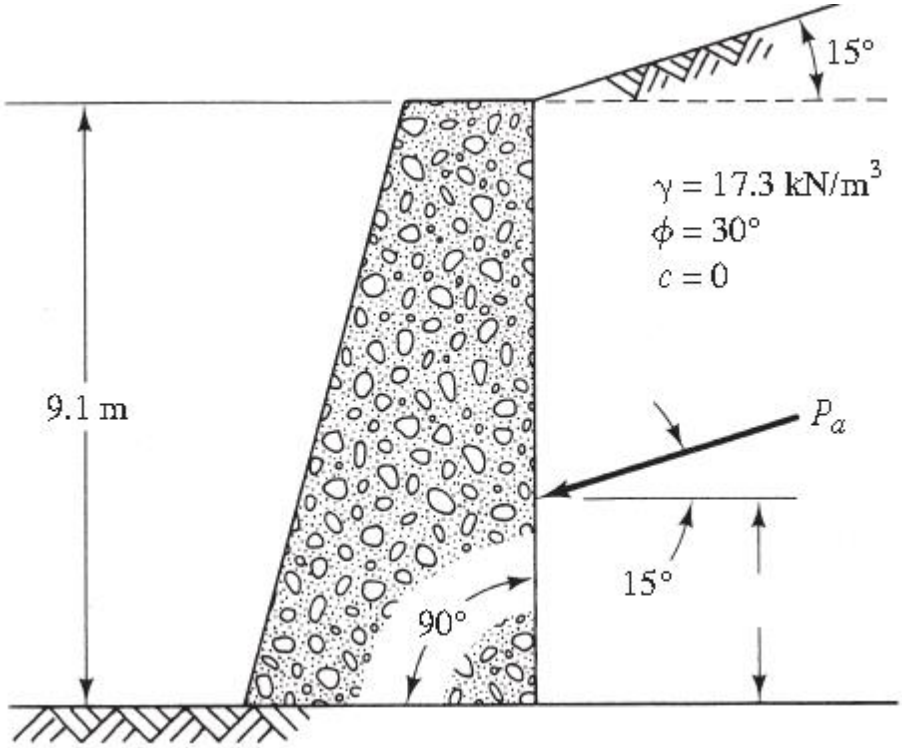

Figure 3/*Rajah 3*

5. A man-made slope is constructed as shown in **Figure 4**. In any situation, when the slope is imposed with external loading, it may fail when the soil reaches its capacity to withhold additional stresses imposed on the soil.

*Suatu cerun buatan manusia dibina seperti ditunjukkan di **Rajah 4**. Dalam mana-mana situasi, sekiranya cerun dikenakan beban luaran, ia mungkin akan gagal apabila tanah mencapai kapasiti maksimum bagi menanggung lebihan beban ke atasnya.*

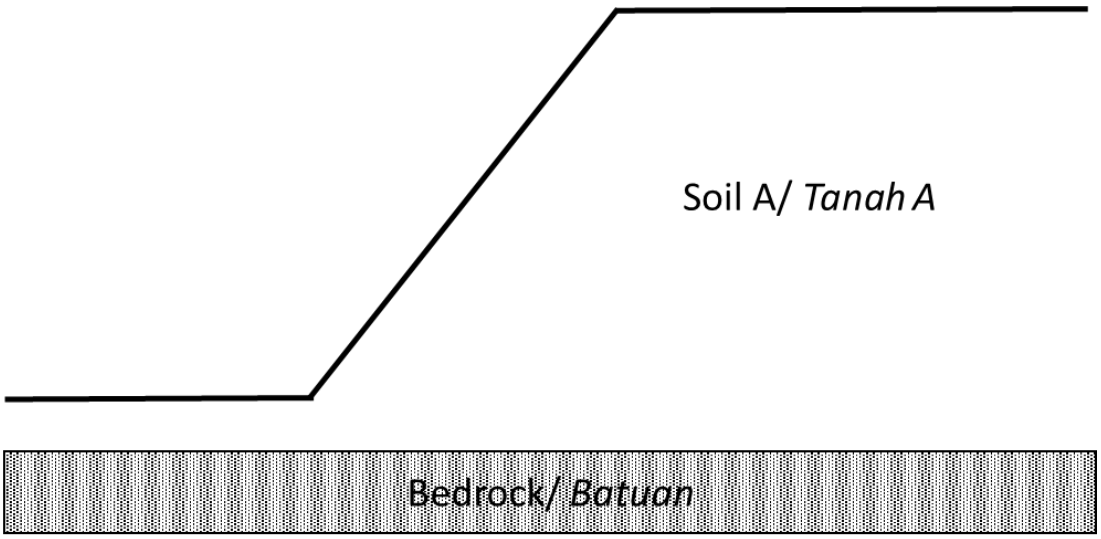

Figure 4/ *Rajah 4*

(a) Sketch the possible mode of failures for the slope and identify the possible solution method for the finite slope shown in **Figure 4**.

*Lakar kemungkinan mod-mod kegagalan bagi cerun tersebut dan kenalpasti kemungkinan kaedah penyelesaian bagi cerun terhingga yang ditunjukkan dalam **Rajah 4**.*

[10 marks/*markah*]

(b) A contractor cut a slope in soft clay with the sides rising at an angle of 70^0 to the horizontal plane. When the slope reaches 10 m height, the cut slope fails. An investigation was carried out and it was found that the slope has failed along a circular arc with the critical surface forming a toe circle as in **Figure 5**. Given parameters are $c_u = 38\ kN/m^2$ and $\gamma = 18\ kN/m^3$. (Refer Appendix).

*Dalam suatu projek perumahan tempatan, kontraktor ingin memotong cerun pada tanah liat lembut dengan sisinya yang dinaikkan pada sudut 70^0 daripada satah datar. Apabila cerun mencecah ketinggian 10 m, potongan cerun tersebut gagal. Penyiasatan dilakukan dan didapati cerun gagal selari lengkung bulatan dengan permukaan kritikal membentuk bulatan tapak luar seperti di **Rajah 5**. Diberi $c_u = 38\ kN/m^2$ dan $\gamma = 18\ kN/m^3$. (Rujuk Lampiran).*

(i) Determine the maximum depth up to which the excavation can be carried out.

Tentukan kedalaman maksimum yang dapat dikorek tanpa kegagalan.

[2 marks/*markah*]

(ii) Calculate the radius, r, of the critical circle when the factor of safety is equal to 1.

Kira jejari, r, bagi bulatan kritikal apabila faktor keselamatan bersamaan 1.

[3 marks/*markah*]

(iii) Determine the unsafe working distance $\overline{BC}$ at the crest of the slope.

Tentukan jarak tidak selamat $\overline{BC}$ pada puncak cerun tersebut.

[3 marks/*markah*]

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(iv) If the cut is made to a depth of 9 m, calculate the factor of safety for the slope.

Jika potongan dilakukan pada kedalaman 9 m, kira faktor keselamatan cerun tersebut.

[2 marks/*markah*]

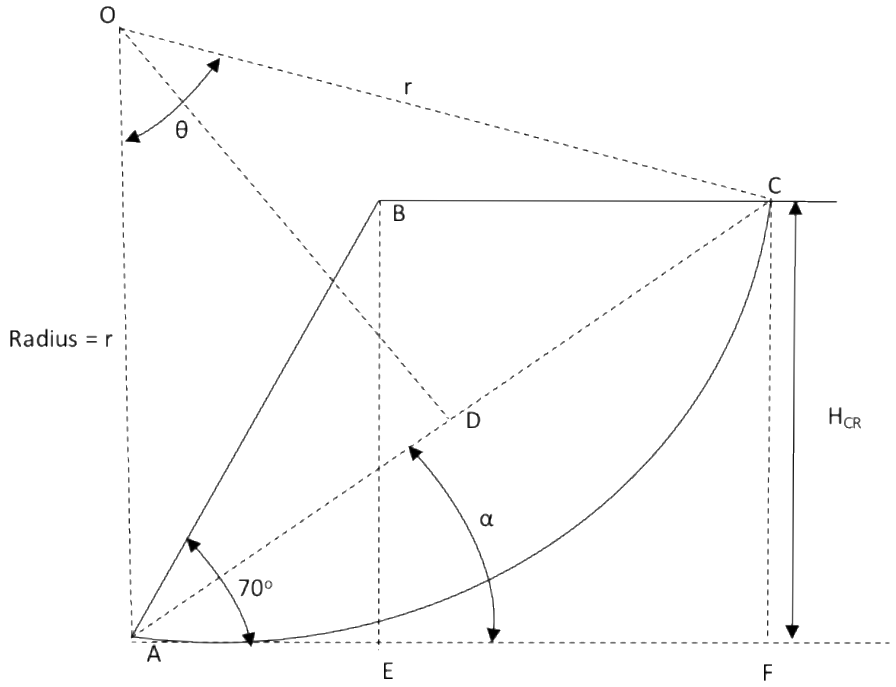


Figure 5/ *Rajah 5*

6. Determine if the arrangement given in **Figure 6** would breach the bearing capacity at point X. This is the cross sectional view of a strip loading. **Figure 6** and **Appendix** may be referred to in your solution.

*Tentukan sekiranya keadaan di **Rajah 6** akan melewati keupayaan galas pada kedudukan X. Ini gambar rajah rentas suatu bebanan jalur. **Rajah 6** dan **Lampiran** boleh dirujuk untuk penyelesaian anda.*

Consider :
Ambilkira :

(a) Bearing capacity failure by normal shear.

Kegagalan keupayaan galas biasa atau putaran.

[10 marks/*markah*]

(b) Bearing capacity failure by punching shear.

Kegagalan keupayaan galas ricih terbenam.

[10 marks/*markah*]

The following equation may be useful: $q_{ult} = cN_c + \gamma D_f N_q + 0.5\gamma BN_\gamma$

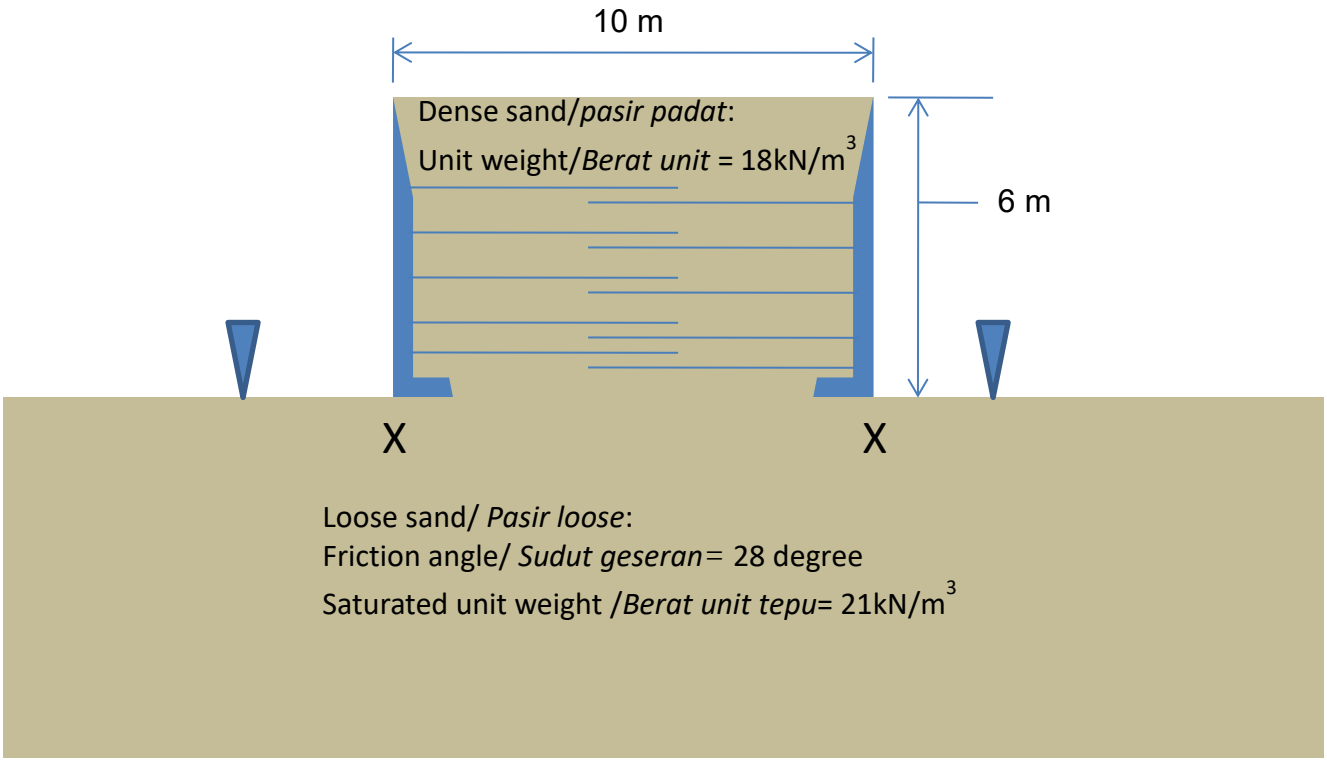
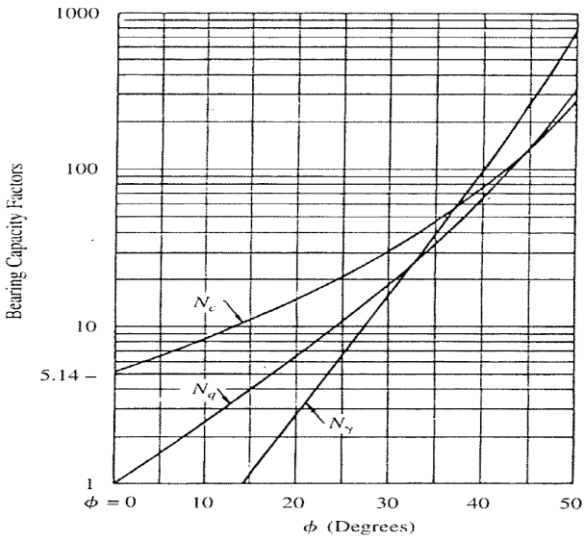


Figure 6/*Rajah 6*

APPENDIX /*LAMPIRAN*

Table – Terzaghi Bearing Capacity Factors
Jadual – Faktor Keupayaan Galas Terzaghi

□	N_c	N_q	$N_□$
0	5.7	1	0
5	7.3	1.6	0.5
10	9.6	2.7	1.2
15	12.9	4.4	2.5
20	17.7	7.4	5
25	25.1	12.7	9.7
30	37.2	22.5	19.7
34	52.6	36.5	35.0
35	57.8	41.4	42.4
40	95.7	81.3	100.4
45	172.3	173.3	297.5



Terzaghi Bearing Capacity Chart
Charta Keupayaan Galas Terzaghi

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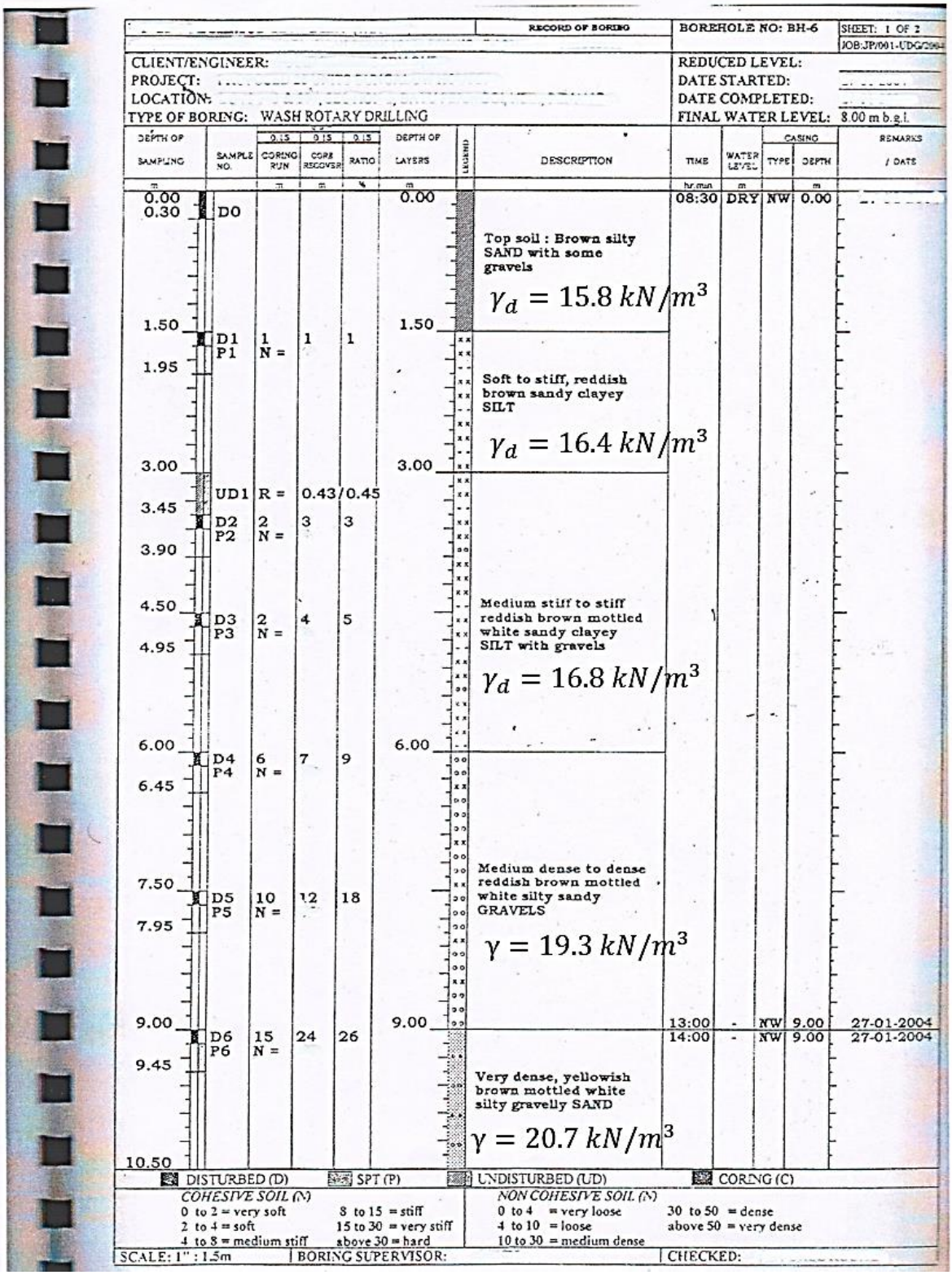

RECORD OF BORING — BOREHOLE NO: BH-6 — SHEET: 1 OF 2 — JOB:JP/001-UDG/2004

CLIENT/ENGINEER:
PROJECT:
LOCATION:
TYPE OF BORING: WASH ROTARY DRILLING

REDUCED LEVEL:
DATE STARTED:
DATE COMPLETED:
FINAL WATER LEVEL: 8.00 m b.g.l.

DEPTH OF SAMPLING (m)	SAMPLE NO.	CORING RUN (0.15) (m)	CORE RECOVER (0.15) (m)	RATIO (0.15) (%)	DEPTH OF LAYERS (m)	DESCRIPTION	TIME (hr.min)	WATER LEVEL (m)	CASING TYPE	CASING DEPTH (m)	REMARKS / DATE
0.00					0.00		08:30	DRY	NW	0.00	
0.30	D0					Top soil : Brown silty SAND with some gravels $\gamma_d = 15.8\ kN/m^3$					
1.50	D1 P1	1 N =	1	1	1.50						
1.95						Soft to stiff, reddish brown sandy clayey SILT $\gamma_d = 16.4\ kN/m^3$					
3.00					3.00						
3.45	UD1	R =	0.43	0.45							
3.90	D2 P2	2 N =	3	3							
4.50	D3 P3	2 N =	4	5		Medium stiff to stiff reddish brown mottled white sandy clayey SILT with gravels $\gamma_d = 16.8\ kN/m^3$					
4.95											
6.00					6.00						
6.45	D4 P4	6 N =	7	9							
7.50						Medium dense to dense reddish brown mottled white silty sandy GRAVELS $\gamma = 19.3\ kN/m^3$					
7.95	D5 P5	10 N =	12	18							
9.00					9.00		13:00	-	NW	9.00	27-01-2004
9.45	D6 P6	15 N =	24	26		Very dense, yellowish brown mottled white silty gravelly SAND $\gamma = 20.7\ kN/m^3$	14:00	-	NW	9.00	27-01-2004
10.50											

DISTURBED (D) — SPT (P) — UNDISTURBED (UD) — CORING (C)

COHESIVE SOIL (N)
0 to 2 = very soft
2 to 4 = soft
4 to 8 = medium stiff
8 to 15 = stiff
15 to 30 = very stiff
above 30 = hard

NON COHESIVE SOIL (N)
0 to 4 = very loose
4 to 10 = loose
10 to 30 = medium dense
30 to 50 = dense
above 50 = very dense

SCALE: 1" : 1.5m — BORING SUPERVISOR: — CHECKED:

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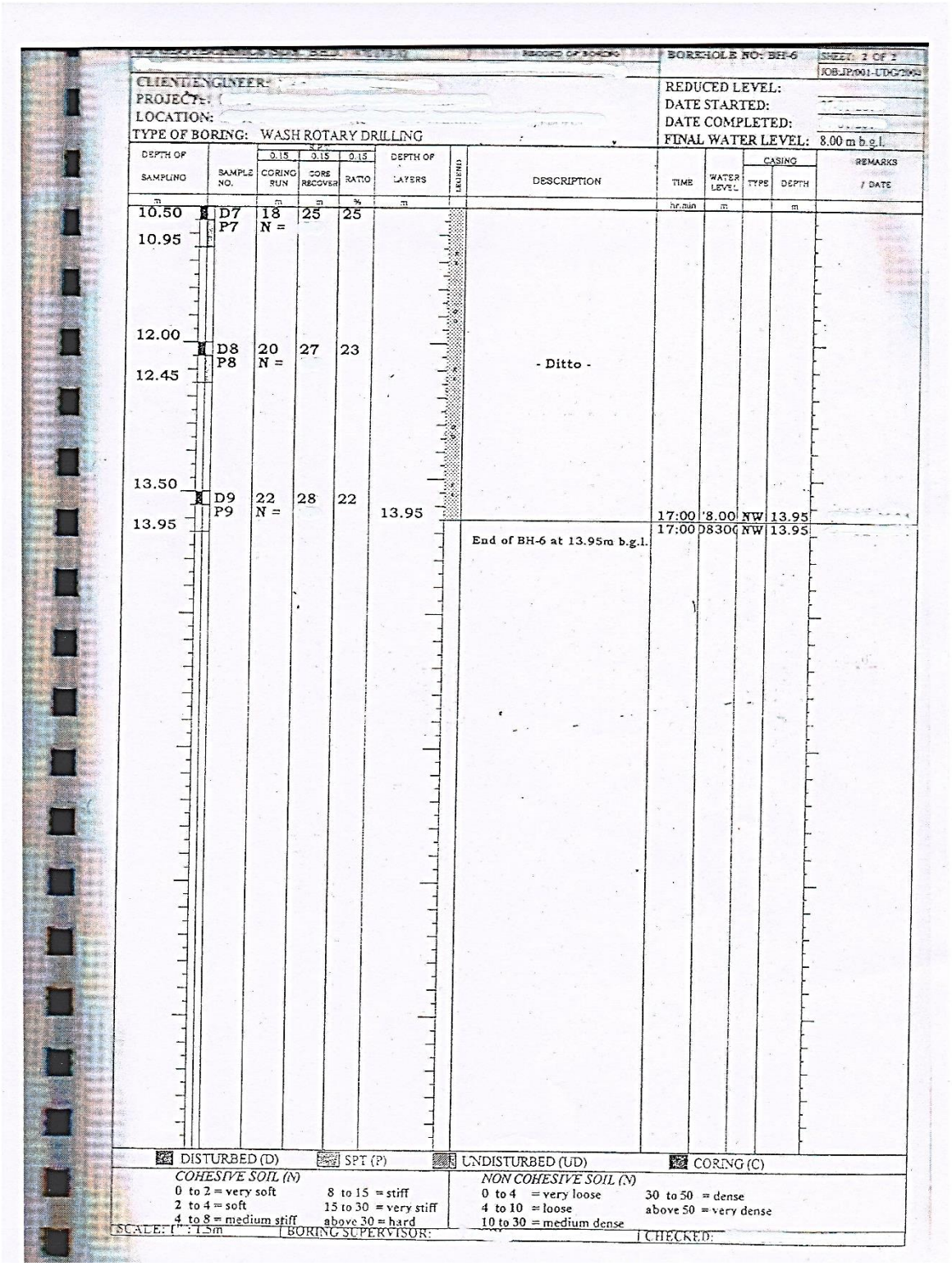


RECORD OF BOREHOLE

BOREHOLE NO: BH-6 SHEET: 2 OF 2

JOB:JP/001-UDG/2

CLIENT/ENGINEER:

PROJECT:

LOCATION:

TYPE OF BORING: WASH ROTARY DRILLING

REDUCED LEVEL:

DATE STARTED:

DATE COMPLETED:

FINAL WATER LEVEL: 8.00 m b.g.l.

DEPTH OF SAMPLING (m)	SAMPLE NO.	CORING RUN (0.15 m)	CORE RECOVER (0.15 m)	RATIO (0.15 m)	DEPTH OF LAYERS (m)	LEGEND	DESCRIPTION	TIME (hr.min)	WATER LEVEL (m)	CASING TYPE	CASING DEPTH (m)	REMARKS / DATE
10.50	D7	18	25	25								
	P7	N =										
10.95												
12.00	D8	20	27	23								
	P8	N =					- Ditto -					
12.45												
13.50	D9	22	28	22								
	P9	N =			13.95			17:00	8.00	NW	13.95	
13.95								17:00	8300	NW	13.95	
							End of BH-6 at 13.95m b.g.l.					

DISTURBED (D) SPT (P) UNDISTURBED (UD) CORING (C)

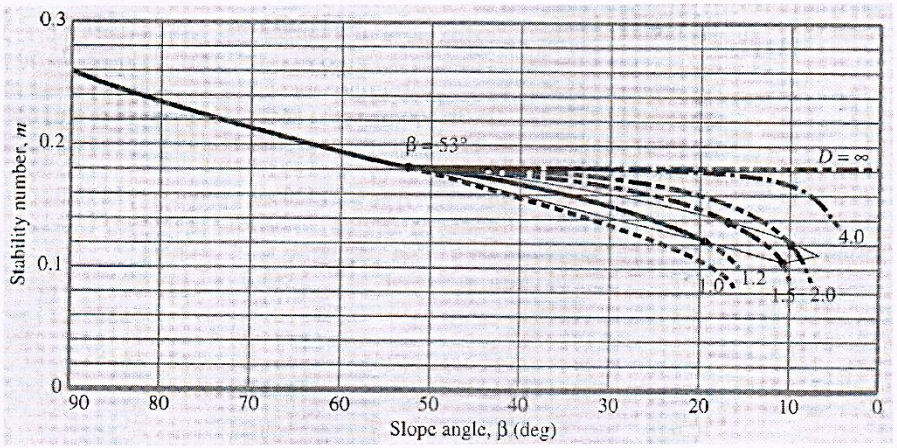
COHESIVE SOIL (N)

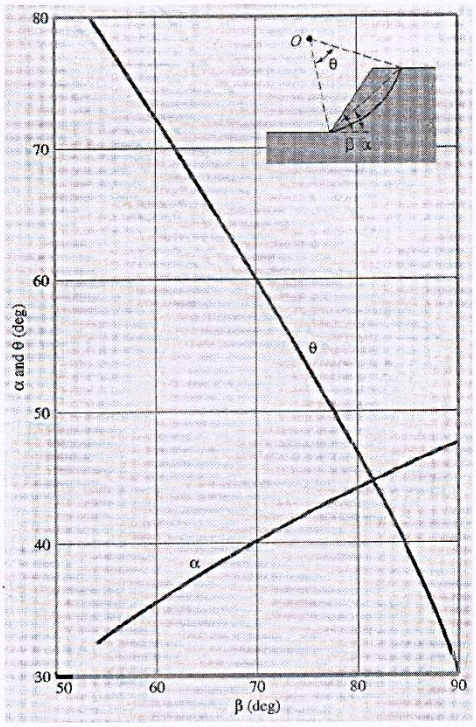
0 to 2 = very soft
2 to 4 = soft
4 to 8 = medium stiff
8 to 15 = stiff
15 to 30 = very stiff
above 30 = hard

NON COHESIVE SOIL (N)

0 to 4 = very loose
4 to 10 = loose
10 to 30 = medium dense
30 to 50 = dense
above 50 = very dense

SCALE: 1" : 1.5m BORING SUPERVISOR: CHECKED:


Stability number, m
0.3
0.2
0.1
0
β = 53°
D = ∞
4.0
1.0
1.2
1.5
2.0
90
80
70
60
50
40
30
20
10
0
Slope angle, β (deg)


α and θ (deg)
80
70
60
50
40
30
O
θ
β
α
θ
α
50
60
70
80
90
β (deg)

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