

**SOIL INVESTIGATION FOR
DEVELOPMENT
AT
NEW UPPER CHANGI ROAD**

(Past Soil Investigation done on October 1996 as part of
URA's infrastructure implementation for Tanah Merah
coordination area)



KWANG SING ENGINEERING PTE LTD

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REPORT

ON

SOIL INVESTIGATION

ON

LAND PARCELS D, E, F, G & H

AT

NEW UPPER CHANGI ROAD, SINGAPORE

FOR

URBAN REDEVELOPMENT AUTHORITY

Our Reference : K96/294

Date : 03 October 1996

SOIL INVESTIGATION

AT

NEW UPPER CHANGI ROAD, SINGAPORE

1. INTRODUCTION

This report represents the results of the surface exploration for soil investigation at New Upper Changi Road, Singapore for Urban Redevelopment Authority.

The boreholes were drilled at locations as shown in the Borehole Location Plan.

The work was carried out according to the instructions given by the Consulting Engineers.

The Soil Investigation was carried out in accordance with the British Standard Code of Practice BS 5930 : 1981 (Formerly CP 2001 : 1957) "Site Investigation".

2. SCOPE OF WORK

The purposes of the Soil Investigation were:

- a: To explore the sub-surface conditions of the Proposed Development area
and to provide general data relating to the Project.

- b. To carry out Field Standard Penetration Test (S.P.T. - 63.5 kg hammer having a free fall of 760mm) to determine the natural bearing resistance of the subsoil for the purpose of design.
- c. To obtain disturbed and undisturbed soil samples for carrying out the laboratory tests to determine the natural and relevant physical properties of the subsoil pertaining to the site for the purpose of design.

3. **FIELD EXPLORATION**

Field exploration programme was conducted during the period from 06 September 1996 to 23 September 1996. The programme was supervised by personnel from our office who were responsible for preparing Log of Boring and obtaining undisturbed samples of the subsurface soils.

A total of Twenty-One (21) boreholes were drilled in locations as shown in Appendix A- Borehole Location Plan.

The boreholes were determined at depth after achieving 2 consecutive SPT values of over 100 blows.

8. SUBSURFACE & SUBSOIL GEOLOGY

The site is an open field covered with turfing and a few trees. The site is bounded on the south by the New Upper Changi Road and on the east by Bedok Walk. It is directly opposite the Tanah Merah MRT Station.

The site is subdivided into Land Parcel A, B, C, D, E, F, G & H. Report on boreholes at Parcel A & B was submitted earlier and Parcel C is not accessible for performance yet.

The Land Parcels covered by this report are therefore D, E, F, G & H.

A) Land Parcel D (BH22, BH27 & BH31)

The subsoil within the boreholes varies and mainly consists of the following strata:-

- 1) Top Soil of a thin stratum (1.30m) of loose clayey fine to coarse SAND.
- 2) Underneath is a stratum of very soft marine CLAY with traces of seashells and organic stains. It is almost 4.40m thick.

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- 3) The 3rd stratum is firm to stiff silty CLAY for BH22, very loose clayey fine to coarse SAND for BH27 and soft sandy CLAY for BH31.
- 4) The 4th stratum is very soft marine CLAY for BH22, dense to very dense clayey fine to coarse SAND for BH27 and medium dense clayey fine to coarse SAND for BH31.
- 5) The 5th stratum is medium dense to dense clayey fine to coarse SAND for BH22 and BH31.
- 6) Bottom Soil of very dense clayey fine to coarse SAND.

The water-tables were found at about 1.40m depth.

B) Land Parcel E (BH25, BH26 and BH30)

The subsoil within the vicinity of the 3 boreholes consists mainly of the following strata:-

- 1) Top Soil of very loose silty fine to coarse SAND.
- 2) Underneath is very soft marine CLAY with traces of seashells.
- 3) The 3rd stratum is very loose clayey fine to coarse SAND.
- 4) The 4th stratum is dense to very dense clayey fine to coarse SAND.
- 5) Bottom Soil of very dense clayey fine to coarse SAND.

The water-tables were found at 1.30m (BH25), 1.90m (BH26) and 2.60m (BH30).

C) Land Parcel F (BH23, BH24, BH28 and BH29)

The subsoil within the vicinity of the 4 boreholes consists mainly of the following strata:-

- 1) Top Soil of loose silty fine to coarse SAND (FILL) found in BH23 only.
- 2) Top Soil of a thin layer of firm silty CLAY.
- 3) Underneath is a thick layer of very soft marine CLAY with shell fragments.
- 4) The 3rd stratum is medium dense clayey fine to coarse SAND with fine grained quartz gravels.
- 5) Bottom Soil of very dense clayey fine to coarse SAND.

The water-tables were found at 2.40m (BH23), 3.20m (BH24), 1.10m(BH28) and 1.10m (BH29).

D) Land Parcel G (BH11, BH14, BH15, BH18 and BH19)

The subsoil within the vicinity of the 5 Nos. of boreholes consists mainly of the following strata:-

- 1) Top Soil of very loose silty fine to coarse SAND.
- 2) Underneath is loose to slightly dense clayey fine to coarse SAND with a few fine grained quartz gravels.

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- 3) The 3rd stratum is very dense clayey fine to coarse SAND with a few fine grained quartz gravels.
- 4) The 4th stratum is dense to very dense clayey fine to coarse SAND.
- 5) Bottom Soil of very dense clayey fine to coarse SAND.

The water-table was found at 1.60m (BH11), 0.70m (BH14), 2.10m (BH15), 0.75m (BH18) and 1.80m (BH19).

E) Land Parcel H (BH12, BH13, BH16 and BH17)

The subsoil within the vicinity of the 4 boreholes consists mainly of the following strata:-

- 1) Top Soil of loose clayey fine to coarse SAND.
- 2) Underneath is a thick layer of soft sandy CLAY.
- 3) The 3rd stratum is loose to slightly dense clayey fine to coarse SAND.
- 4) Bottom Soil of very dense clayey fine to coarse SAND.

The water-table was found at 0.35m (BH12), Nil (BH14), 0.80m (BH16) and 0.40m (BH17).

F) Access Road (BH20 & BH21)

The subsoil within the vicinity of the 2 boreholes consists mainly of the following strata:-

- 1) Top Soil of firm silty CLAY. This is only 0.90m thick.
- 2) Underneath is a thick layer of very soft marine CLAY with traces of seashells.
- 3) The 3rd stratum is firm silty CLAY.
- 4) The 4th stratum is very soft marine CLAY with traces of seashells.
- 5) The 5th stratum is medium dense clayey fine to coarse SAND.
- 6) Bottom Soil of very dense clayey fine to coarse SAND.

The water-table was found at 2.10m (BH20) and 0.75m (BH21).

9. ENGINEERING CONSIDERATION

The Top Soil of this site is generally loose clayey fine to coarse SAND with low SPT values and hence low soil bearing capacity.

In addition, in many land parcels, the 2nd or 3rd strata are composed of thick soft marine CLAY or sandy CLAY which are not yet fully consolidated as evidenced by the very low SPT value. Thus concrete footing cannot be used as foundation.

A suitable piling system should be chosen.

As the site is in very close proximity with the MRT station, the piling system to be chosen should be free of vibration and sound pollution. Large diameter borepiles should be used for large loading in the case of construction of condominium or warehouse.

Bored type micropiles should be chosen if the loading is not big (less than 700KN per pile).

The required pile length would varies for different land parcels.

Negative skin friction should be considered in case marine CLAY stratum exists in the boreholes.

However, it must be stressed that the interpretation of the data of this report and the final recommendation of the type of foundation to adopt should rest with the Client's Consulting Engineers.

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The following appendix are attached and complete this report.

Appendix A - Key Plan / Borehole Location Plan

Appendix B - Log of Boring

Appendix C - Probable Soil Profile

Appendix D - Water Standpipe / Piezometer Readings

Appendix E - Laboratory Soil Test Report

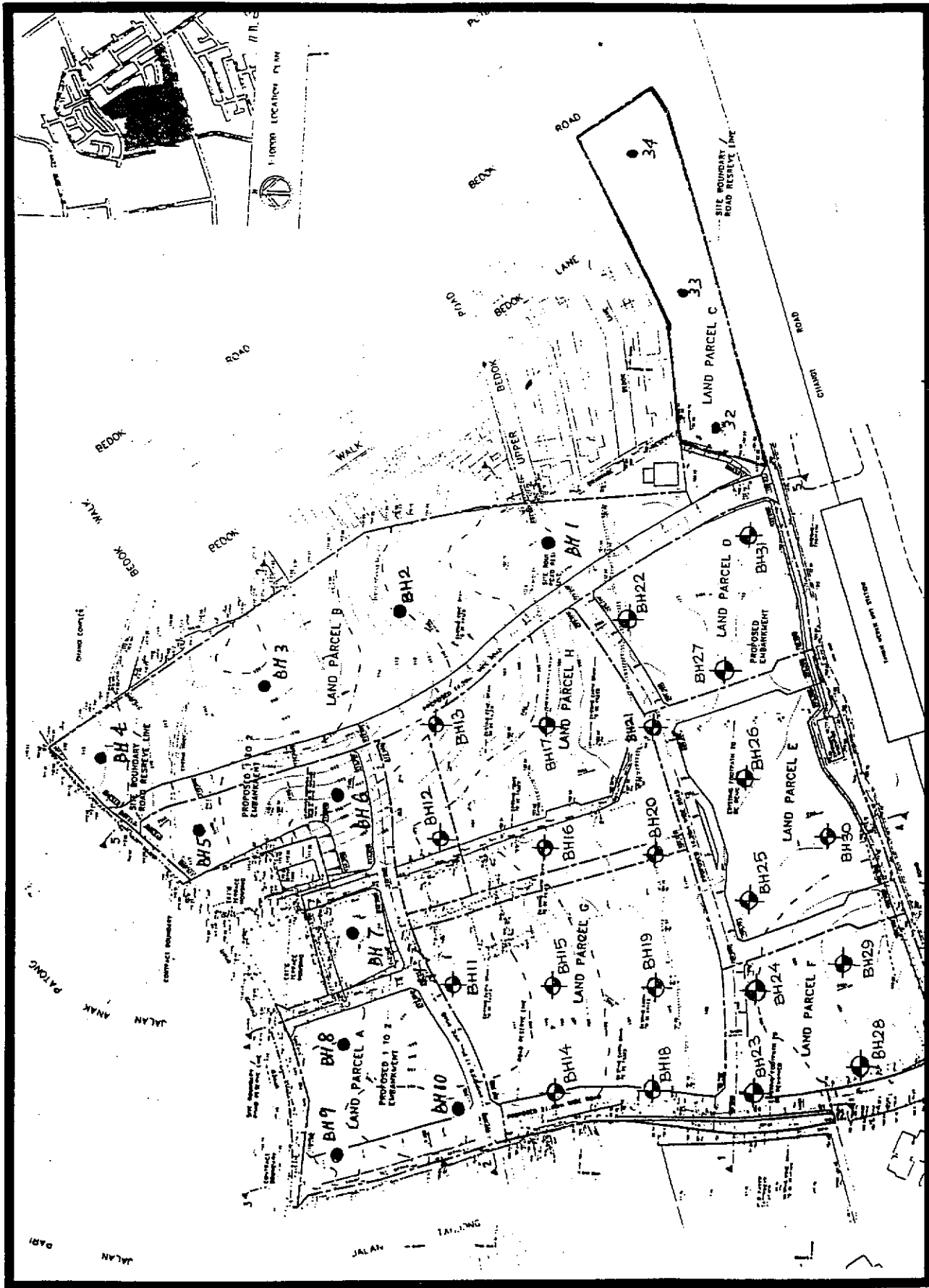
Should there be any question regarding our work, we should be pleased to discuss them with you.

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APPENDIX A

KEY PLAN / BOREHOLE LOCATION PLAN



BOREHOLE LOCATION PLAN

APPENDIX B

LOG OF BORING

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REPORT ON DRILL HOLE / BOREHOLL NO. BH22 Sheet 2 of 2

Client / Consultant Urban Redevelopment Authority
 Job No./Tender No. K96/294
 Location New Upper Changi Road, Singapore
 Ex. Ground Level/Sea Bed Level _____
 Coordinates N E

Orientation Vertical
 Method Rotary Drilling
 Machine D2G
 Core Barrel Flushing Medium Water
 Date From 17/09/96 To 19/09/96

Date & Water Level	Sample					Leg-end	Depth (M)	Description of Strata
	Soil Sample		Type	Core				
	Depth	Blows		Rec%	Rqd%			
19/09/96	12.00 - 12.45	(21)	SPT6			[Pattern]	17.40	Medium dense to dense light greenish gray clayey fine to coarse SAND
	15.00 - 15.45	(31)	SPT7					
	18.00 - 18.45	(76)	SPT8			[Pattern]	24.40	Very dense gray and dark yellowish brown clayey fine to coarse SAND
	21.00 - 21.43	(100/28cm)	SPT9					
	24.00 - 24.40	(100/25cm)	SPT10					

U: Undisturbed Sample S: S.P.T
 L: Liner Sample (:): N Value/305mm
 M: Mazier Sample -: Hole Depth
 D: Disturbed Sample W: Water Sample
 (A Numerical figure after a symbol designates the size of sample in mm)

Remarks: Bottom of Hole ↘

Driller : Ganesan

Supervisor : Bala


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REPORT ON DRILL HOLE / BOREHOLE NO. BH27 Sheet 1 of 3

Client / Consultant Urban Redevelopment Authority Orientation Vertical
 Job No./Tender No. K96/294 Method Rotary Drilling
 Location New Upper Changi Road, Singapore Machine D2G
 Ex. Ground Level/Ses Bed Level _____ Core Barrel Flushing Medium Water
 Coordinates N _____ E _____ Date From 20/09/96 To 21/09/96

Date & Water Level	Sample				Leg-end	Depth (M)	Description of Strata	
	Soil Sample		Type	Core				
	Depth	Blows		Rec%				Rqd%
20/09/96			DS1				Loose dark yellowish brown clayey fine to coarse SAND	
 1.50m			DS2			1.40	Very soft bluish gray marine CLAY with traces of seashells	
	1.50 - 2.30		UD1					
	2.30 - 2.75	(1)	SPT1					
	3.00 - 3.40		UD2					
	3.40 - 3.85	(1)	SPT2					
	4.50 - 4.95	(1)	SPT3			5.80	Very loose light greenish gray clayey fine to coarse SAND	
	6.00 - 6.50		DS3					
	6.50 - 6.95	(5)	SPT4			8.50	Very dense grayish and dark yellowish brown clayey fine to coarse SAND with fine grained quartz gravel	
	9.00 - 9.45	(41)	DS4			12.00		

U: Undisturbed Sample S: S.P.T
 L: Liner Sample (:): N Value/305mm
 M: Mazier Sample -: Hole Depth
 D: Disturbed Sample W: Water Sample
 (A Numerical figure after a symbol designates the size of sample in mm)

Remarks:
 Water Standpipe Installed at the depth of 6.00m

Driller : V.MuthuSupervisor : Bala

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REPORT ON DRILL HOLE / BOREHOLL NO. BH27 Sheet 3 of 3Client / Consultant Urban Redevelopment AuthorityOrientation VerticalJob No./Tender No. K96/294Method Rotary DrillingLocation New Upper Changli Road, SingaporeMachine D2G



Ex.Ground Level/Sea Bed Level _____

Core Barrel Flushing Medium Water

Coordinates N _____

E _____

Date From 20/09/96 To 21/09/96

Date & Water Level	Sample					Leg- end	Depth (M)	Description of Strata
	Soil Sample		Type	Core				
	Depth	Blows		Rec%	Rqd%			
	24.00 - 24.41	(100/26cm)	SPT10					Very dense grayish and dark yellowish brown clayey fine to coarse SAND
	27.00 - 27.38	(100/23cm)	SPT11				27.38	
								Bottom of Hole 

U: Undisturbed Sample

S: S.P.T

Remarks:

L: Liner Sample

(): N Value/305mm

M: Mazier Sample

-: Hole Depth

D: Disturbed Sample

W: Water Sample

(A Numerical figure after a symbol designates the size of sample in mm)

Driller : V.Muthu

Supervisor : _____

Bala


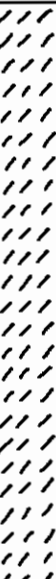
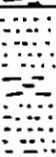
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REPORT ON DRILL HOLE / BOREHOLE NO. BH31 Sheet 1 of 3

Client / Consultant	<u>Urban Redevelopment Authority</u>	Orientation	<u>Vertical</u>
Job No./Tender No.	<u>K96/294</u>	Method	<u>Rotary Drilling</u>
Location	<u>New Upper Changli Road, Singapore</u>	Machine	<u>D2G</u>
Ex.Ground Level/Sea Bed Level		Core Barrel	<u>Flushing Medium</u> <u>Water</u>
Coordinates N	<u>E</u>	Date From	<u>20/09/96</u> To <u>21/09/96</u>

Date & Water Level	Sample				Leg-end	Depth (M)	Description of Strata	
	Soil Sample		Type	Core				
	Depth	Blows		Rec%				Rqd%
20/09/96			DS1			1.10	Loose dark gray and reddish brown clayey fine to coarse SAND	
 1.40m	1.50 - 2.40		DS2 UD1			8.50	Very soft bluish gray marine CLAY with shell fragments and organic stains	
	2.40 - 2.85	(1)	SPT1					
	3.00 - 3.60		UD2					
	3.60 - 4.05	(1)	SPT2					
	4.50 - 5.50		UD3					
	5.50 - 5.95	(1)	SPT3					
	6.00 - 6.45	(2)	SPT4					
	9.00 - 9.40		DS3 UD4					11.20
9.40 - 9.85	(3)	SPT5						
			DS4			12.00	Medium dense yellowish brown clayey fine to coarse SAND	

U: Undisturbed Sample S: S.P.T
 L: Liner Sample (:): N Value/305mm
 M: Mazier Sample -: Hole Depth
 D: Disturbed Sample W: Water Sample
 (A Numerical figure after a symbol designates the size of sample in mm)

Remarks:
 Water Standpipe Installed at the depth of 6.00m

Driller : Ganesan Supervisor : Bala

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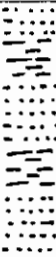



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REPORT ON DRILL HOLE / BOREHOLL NO. BH31 Sheet 2 of 3

Client / Consultant Urban Redevelopment Authority
 Job No./Tender No. K96/294
 Location New Upper Changi Road, Singapore
 Ex. Ground Level/Sea Bed Level _____
 Coordinates N E

Orientation Vertical
 Method Rotary Drilling
 Machine D2G
 Core Barrel Flushing Medium : Water
 Date From 20/09/96 To 21/09/96

Date & Water Level	Sample					Leg- end	Depth (M)	Description of Strata
	Soil Sample		Type	Core				
	Depth	Blows		Rec%	Rqd%			
21/09/96	12.00 - 12.45	(23)	SPT6				14.80	Medium dense yellowish brown clayey fine to coarse SAND
	15.00 - 15.45	(49)	DS5 SPT7					
	18.00 - 18.45	(52)	SPT8					Dense to very dense gray and light yellowish brown clayey fine to coarse SAND
	21.00 - 21.45	(50)	SPT9				24.00	

U: Undisturbed Sample S: S.P.T
 L: Liner Sample (:): N Value/305mm
 M: Mazier Sample -: Hole Depth
 D: Disturbed Sample W: Water Sample
 (A Numerical figure after a symbol designates the size of sample in mm)

Remarks:

Driller : Ganesan

Supervisor :

Bala

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REPORT ON DRILL HOLE / BOREHOLL NO. BH31 Sheet 3 of 3

Client / Consultant Urban Redevelopment Authority
 Job No./Tender No. K96/294
 Location New Upper Changi Road, Singapore
 Ex.Ground Level/Sea Bed Level _____
 Coordinates N E

Orientation Vertical
 Method Rotary Drilling
 Machine D2G
 Core Barrel Flushing Medium Water
 Date From 20/09/96 To 21/09/96

Date & Water Level	Sample				Leg-end	Depth (M)	Description of Strata	
	Soil Sample		Type	Core				
	Depth	Blows		Rec%				Rqd%
	24.00 - 24.45	(78)	DS6 SPT9				Very dense dark yellowish brown and light greenish gray clayey fine to coarse SAND	
	27.00 - 27.41	(100/26cm)	SPT10					
	30.00 - 30.38	(100/23cm)	SPT11			30.38		
							Bottom of Hole 	

U: Undisturbed Sample S: S.P.T
 L: Liner Sample (:): N Value/305mm
 M: Mazier Sample -: Hole Depth
 D: Disturbed Sample W: Water Sample
 (A Numerical figure after a symbol designates the size of sample in mm)

Remarks:

Driller : Ganesan

Supervisor : Bala

WATER STANDPIPE / PIEZOMETER READINGS

CLIENT : URBAN REDEVELOPMENT AUTHORITY

PROJECT : NEW UPPER CHANGI ROAD, SINGAPORE

Date	Time	BH12 Depth of Installation 6.00m	BH17 Depth of Installation 6.00m	BH25 Depth of Installation 6.00m	BH27 Depth of Installation 6.00m	BH31 Depth of Installation 6.00m
18.09.96	08.45	-	-	0.73	-	-
	18.30	-	-	0.75	-	-
19.09.96	09.15	-	-	0.74	-	-
	18.00	-	-	0.76	-	-
20.09.96	09.00	-	-	0.74	-	-
	15.45	-	-	0.76	-	-
21.09.96	08.45	0.28	0.43	0.75	-	-
	18.00	0.30	0.45	0.77	-	-
23.09.96	09.30	0.28	0.44	0.76	1.32	1.54
	18.30	0.30	0.45	0.78	1.34	1.57
24.09.96	09.15	0.27	0.43	0.76	1.30	1.55
	18.15	0.30	0.45	0.78	1.32	1.58
25.09.96	08.45	0.20	0.44	0.75	1.32	1.56
	18.30	0.22	0.45	0.78	1.34	1.58

CLIENT: Kwang Sing Engrg Pte Ltd

PROJECT : New Upper Changi Road, Land Parcel D

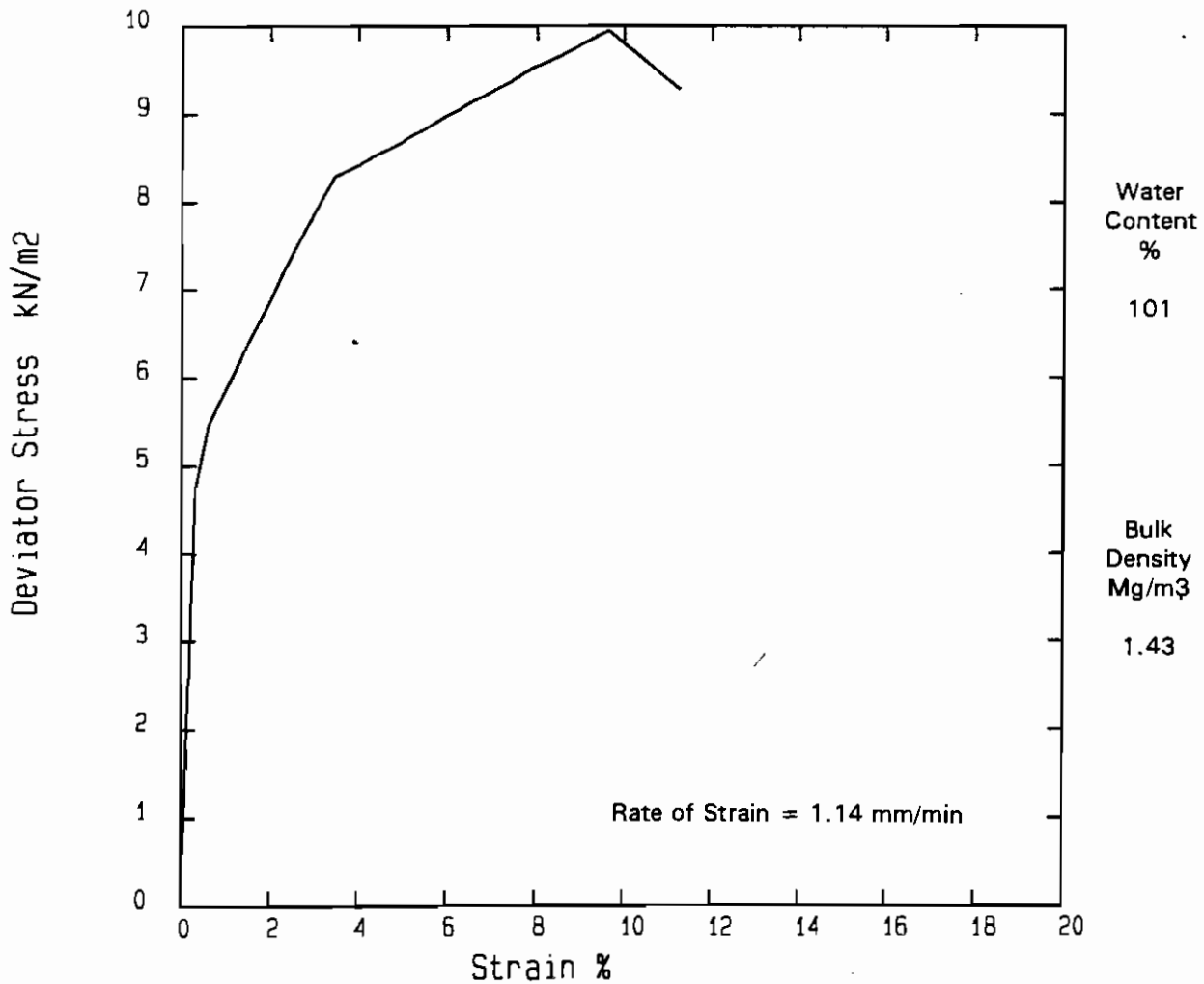
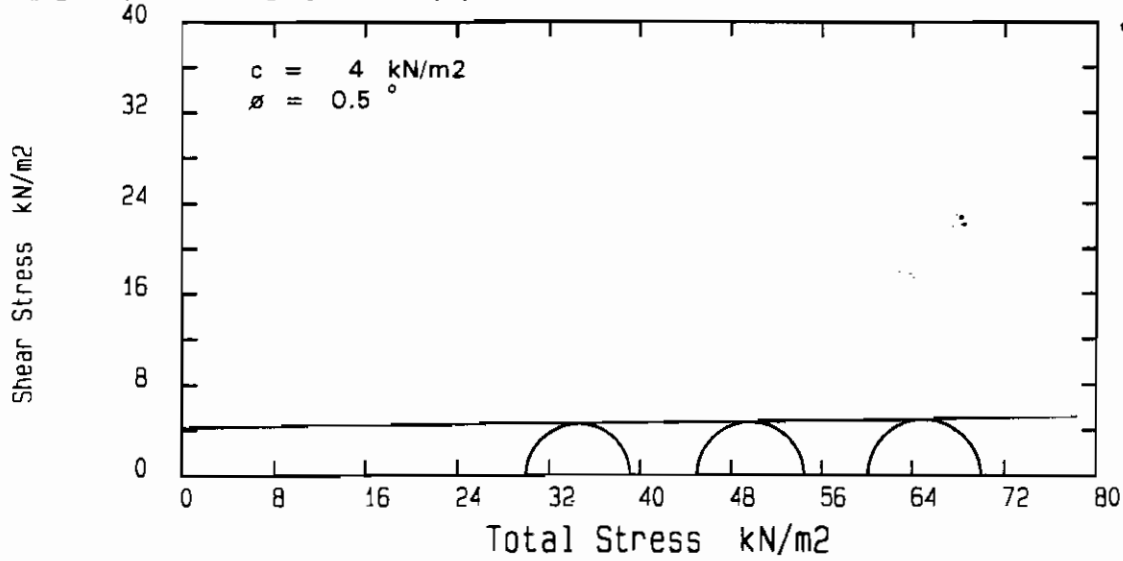
BORING NO.		22				27		31					
SAMPLE NO.		UD1	UD2	UD3	UD4	UD1	UD2	UD1	UD3				
SOIL TYPE		CH	CH	CL	CL	CH	CH	CH	CH				
DEPTH, m		1.50	3.00	4.50	6.00	1.50	3.00	1.50	4.50				
		2.40	3.80	5.20	6.90	2.30	3.40	2.40	5.50				
Natural Moisture Content		%	101	94	30	37	100	101	91	88			
Bulk Density		Mg/m3	1.43	1.45	1.93	1.86	1.44	1.44	1.48	1.49			
Dry Density		Mg/m3	0.71	0.75	1.48	1.36	0.72	0.72	0.77	0.79			
Atterberg Limit	Liquid Limit	%											
	Plastic Limit	%											
	Plasticity Index	%											
Grain Size Analysis	Gravel	%											
	Sand	%											
	Silt or Clay	%											
Organic Content		%											
Carbonate Content		%											
Shrinkage Limit		%											
Specific Gravity of Soil													
Bulk Specific Gravity of Rock													
Torvane Lab. Vane	Cohesion	kN/m2											
	Cohesion, Undisturbed	kN/m2											
	Cohesion, Remolded	kN/m2											
Unconfined Compression	Shear Strength	kN/m2											
	Uncon. Comp. Strength	MN/m2											
	Tensile Strength	MN/m2											
Point Load	Type of Test *1												
	Compressive Strength	MN/m2											
Triaxial Compression	Type of Test *2		UUU	UUU	UUU	UUU	UUU	UUU	UUU	UUU			
	Cohesion	kN/m2	4	6	20	67	3	4	5	6			
	Phi angle	degree	0.5	0.5	2.5	1	0.5	0.5	1	0			
Direct Shear	Type of Test *2												
	Cohesion	kN/m2											
	Phi Angle	degree											
Consolidation	Type of Test *3												
	Initial Void Ratio												
	Degree of Saturation	%											
	Preconsolidation Press.	kN/m2											
Compression Index													
Permeability	Coefficient at 20 deg. C	m/s											
Compaction (Cohesive) (Cohesionless)	Maximum Dry Density	Mg/m3											
	Optimum m/c	%											
	Minimum Dry Density	Mg/m3											
CBR	CBR % at 2.5mm												
	CBR % at 5.0mm												
Stake Durability Index													

Legend : *3 O – Oedometer
 *1 A – Axial H – Hydrocon
 D – Diametral R – Remolded
 *2 UU – Unconsolidated Undrained M – Multi-stage
 CIU – Consolidated Isotropic Undrained
 CID – Consolidated Isotropic Drained
 QU – Quick Undrained
 SUU – Saturated UU w/pore water pressure

REMARKS

Unconsolidated Undrained Triaxial Compression

BS 1377 : Part 7 : 1990 #9



Sample type UD
 Sample Description Very soft green. gray marine CLAY w/organic stains & traces of shells
 Boring No: 22 Sample No: 1 Depth: 1.50-2.40m

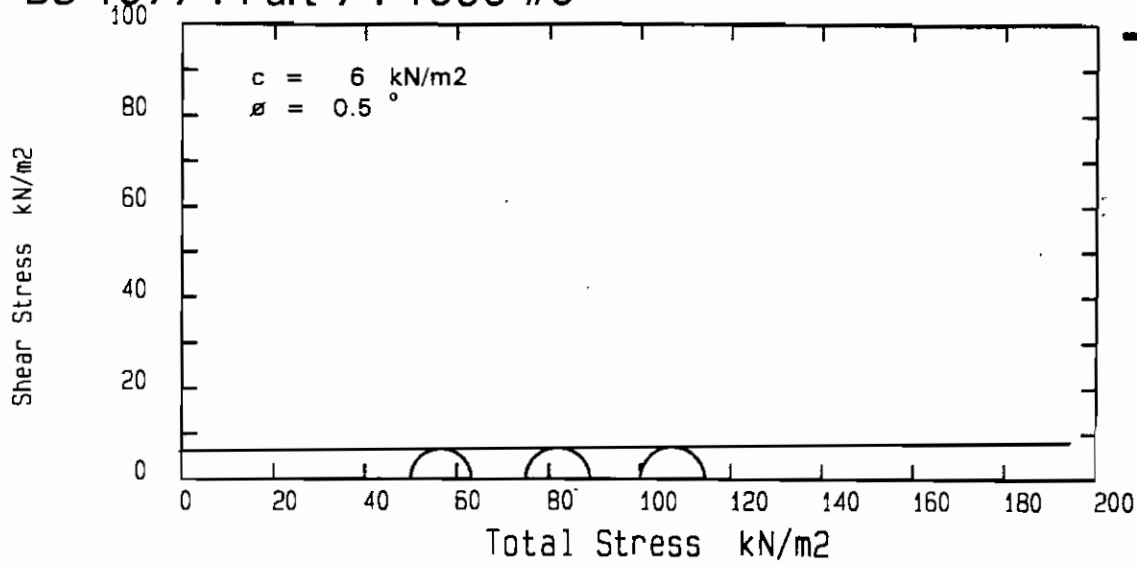


Project : New Upper Changi Road, Land Parcel D

Job No : 0
 Plate :

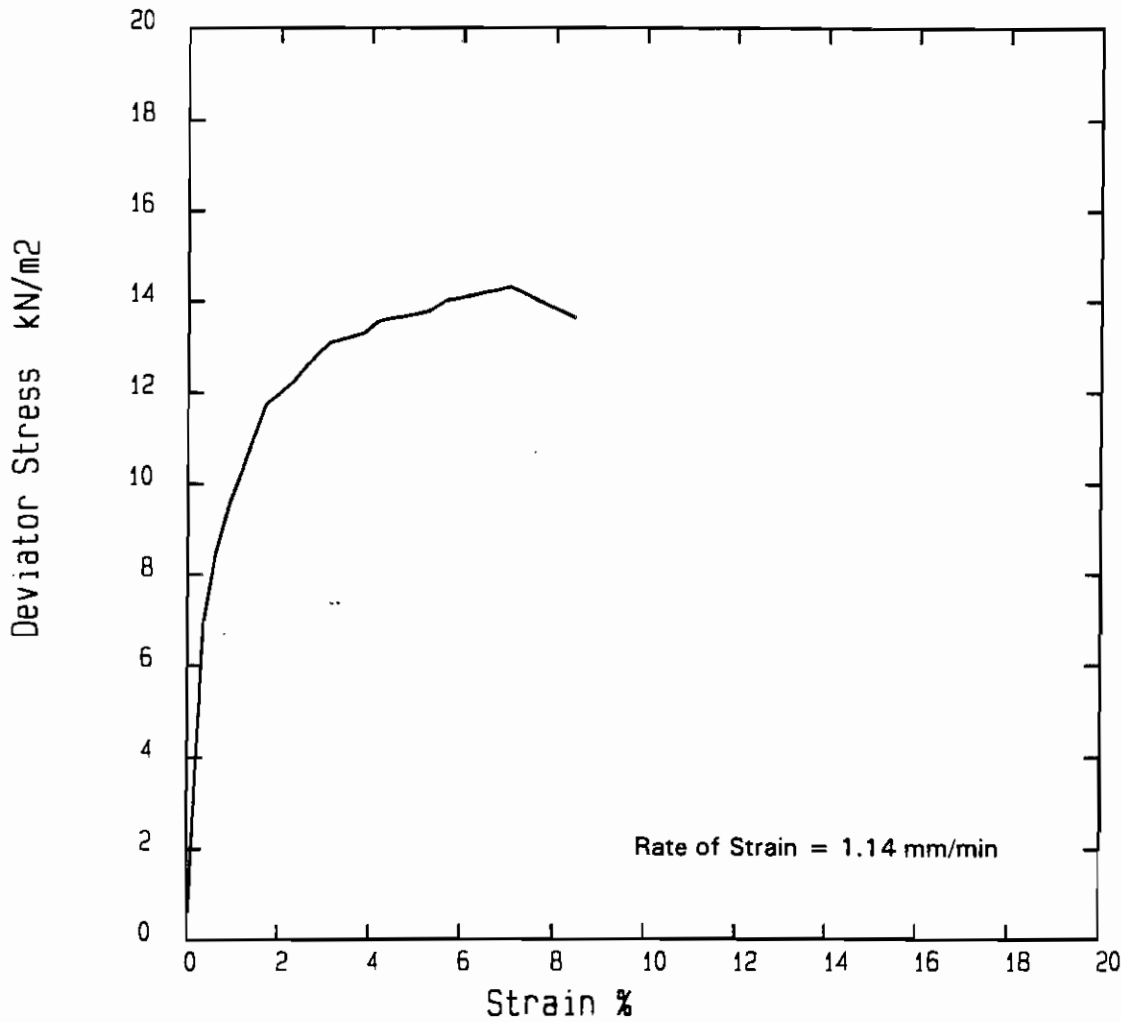
Unconsolidated Undrained Triaxial Compression

BS 1377 : Part 7 : 1990 #9



Cell Pressure
kN/m²

50
75
100



Water Content %

94

Bulk Density Mg/m³

1.45

Sample type UD
 Sample Description Very soft green, gray marine CLAY w/organic stains & traces of shells
 Boring No : 22 Sample No: 2 Depth : 3.00-3.80m

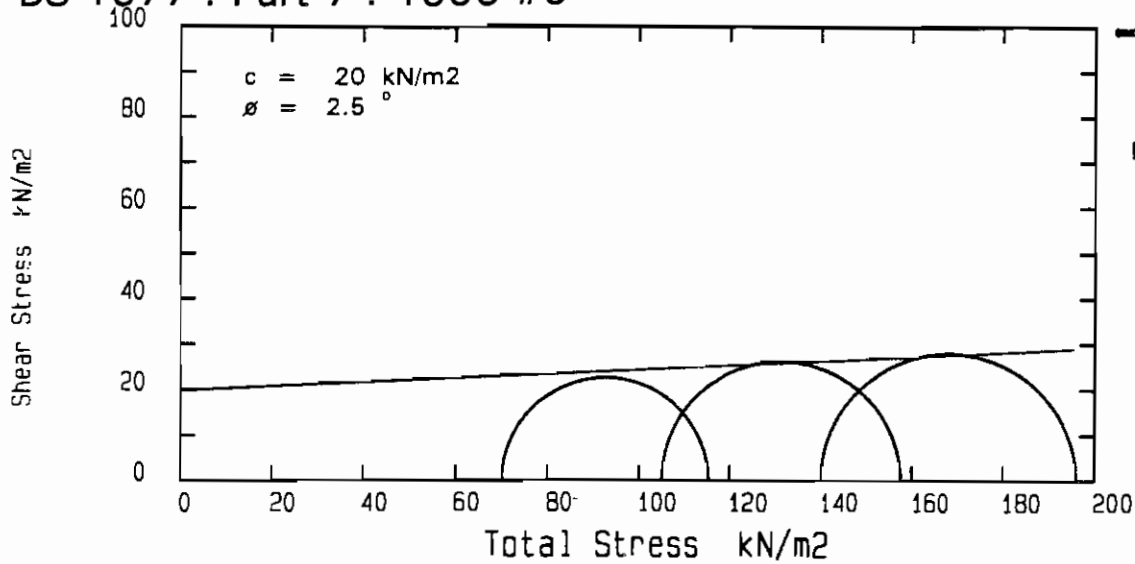


Project : New Upper Changi Road, Land Parcel D

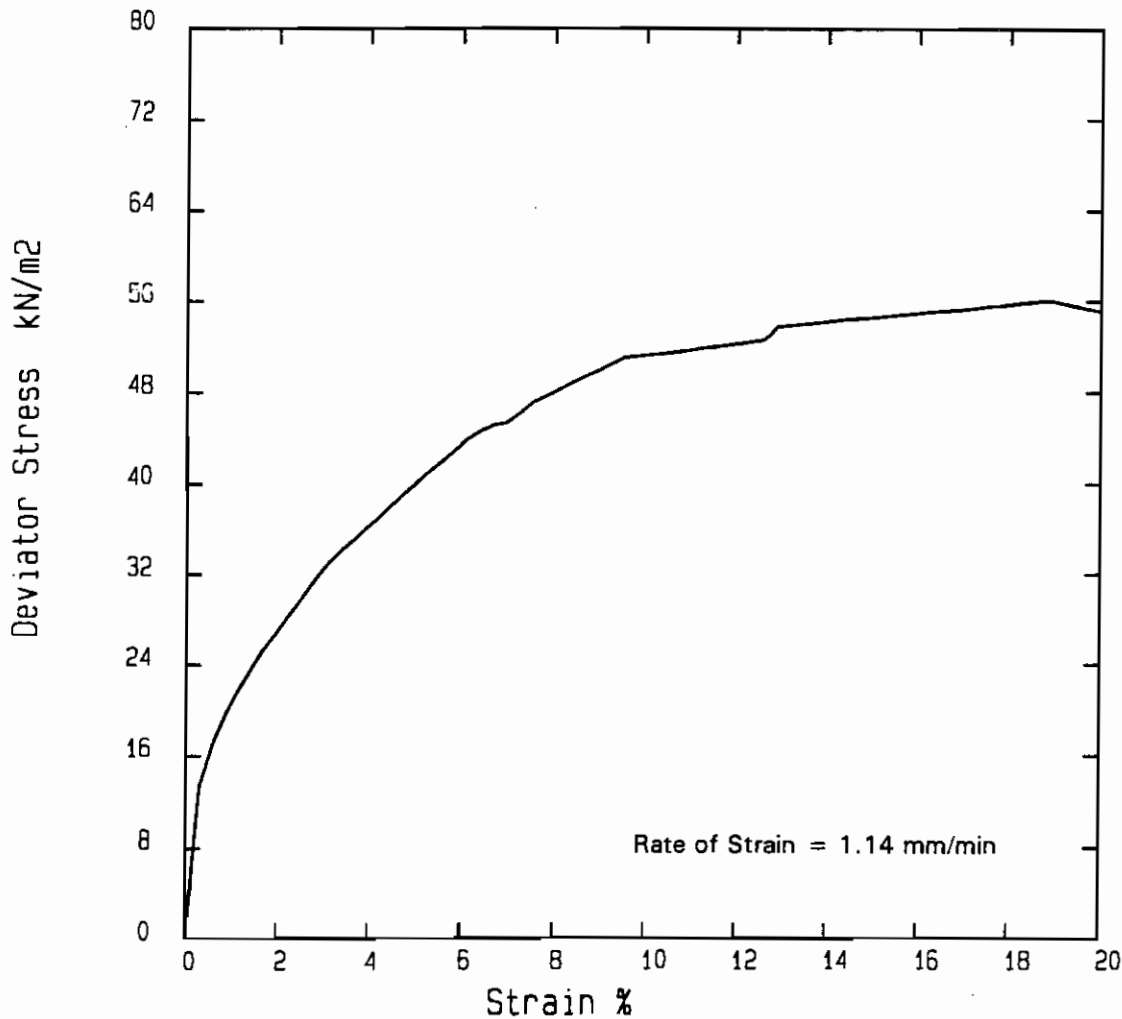
Job No : 0
 Plate :

Unconsolidated Undrained Triaxial Compression

BS 1377 : Part 7 : 1990 #9



Cell Pressure
 kN/m²
 70
 105
 140



Water Content
 %
 30

Bulk Density
 Mg/m³
 1.93

Sample type UD

Sample Description Soft yellowish gray & reddish orange SILTY CLAY w/traces of f-m sand

Boring No : 22

Sample No: 3

Depth : 4.50-5.20m



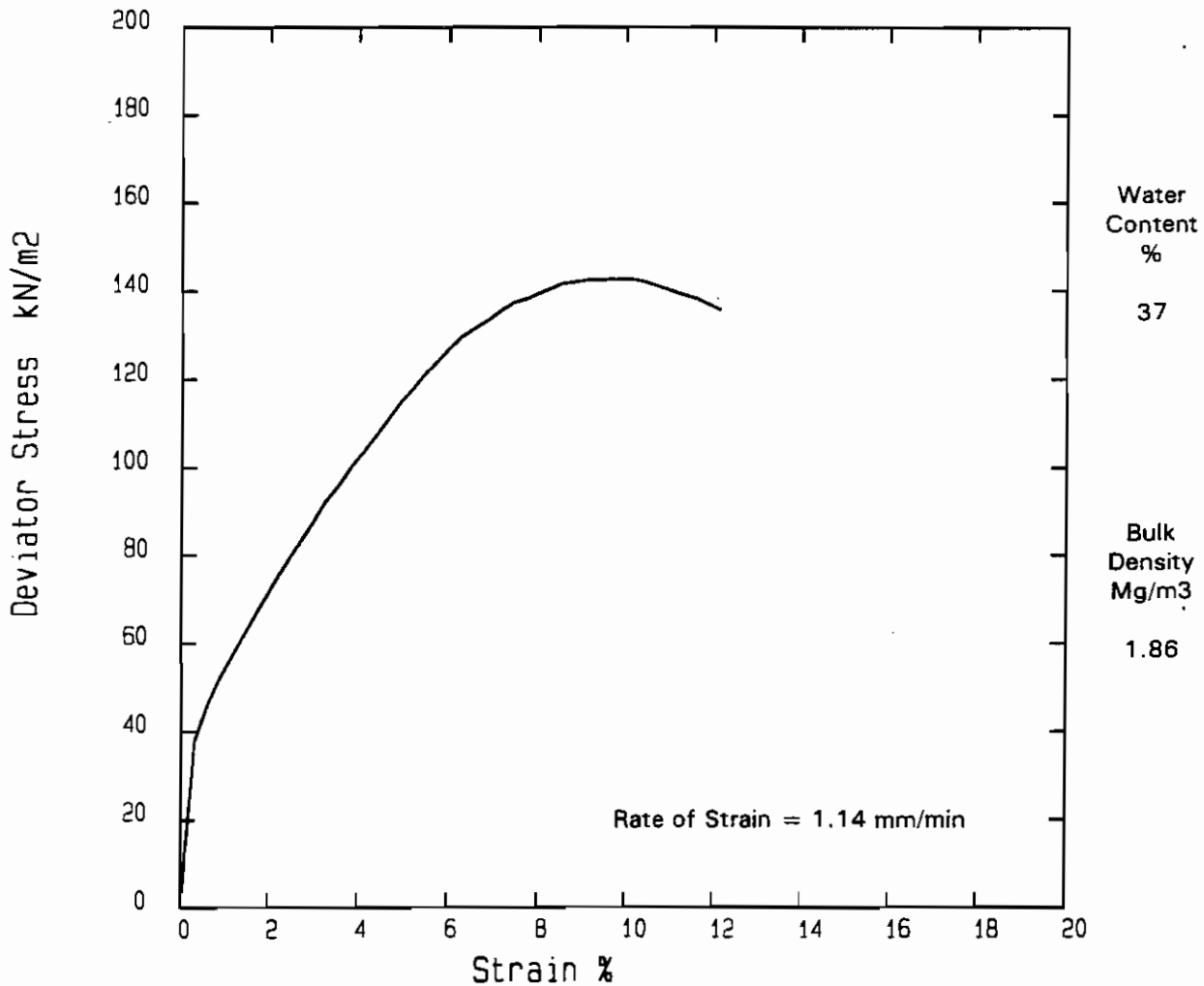
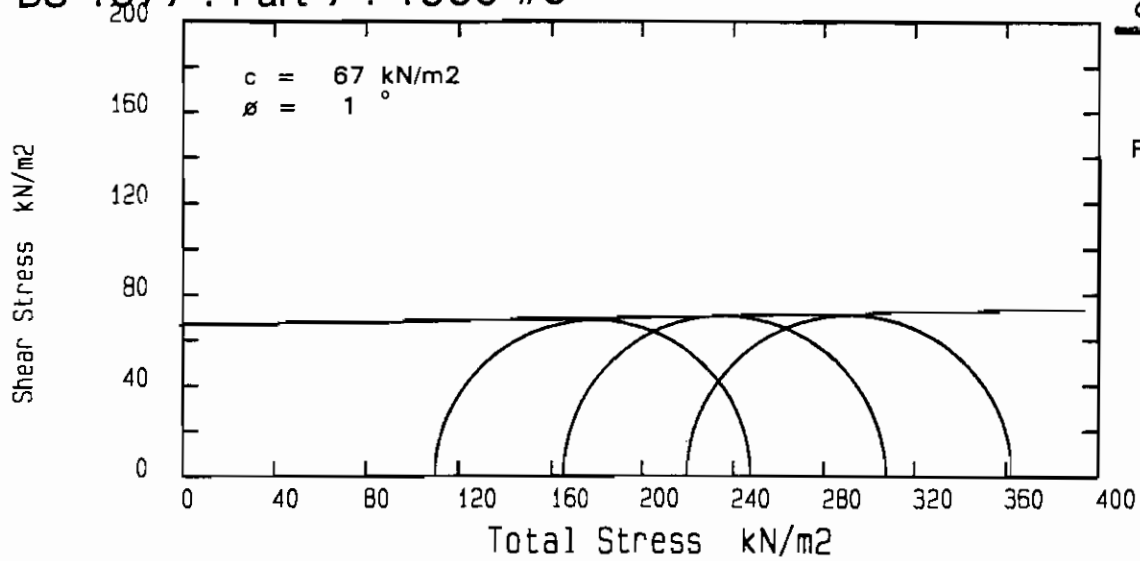
Project : New Upper Changi Road, Land Parcel D

Job No : 0

Plate :

Unconsolidated Undrained Triaxial Compression

BS 1377 : Part 7 : 1990 #9



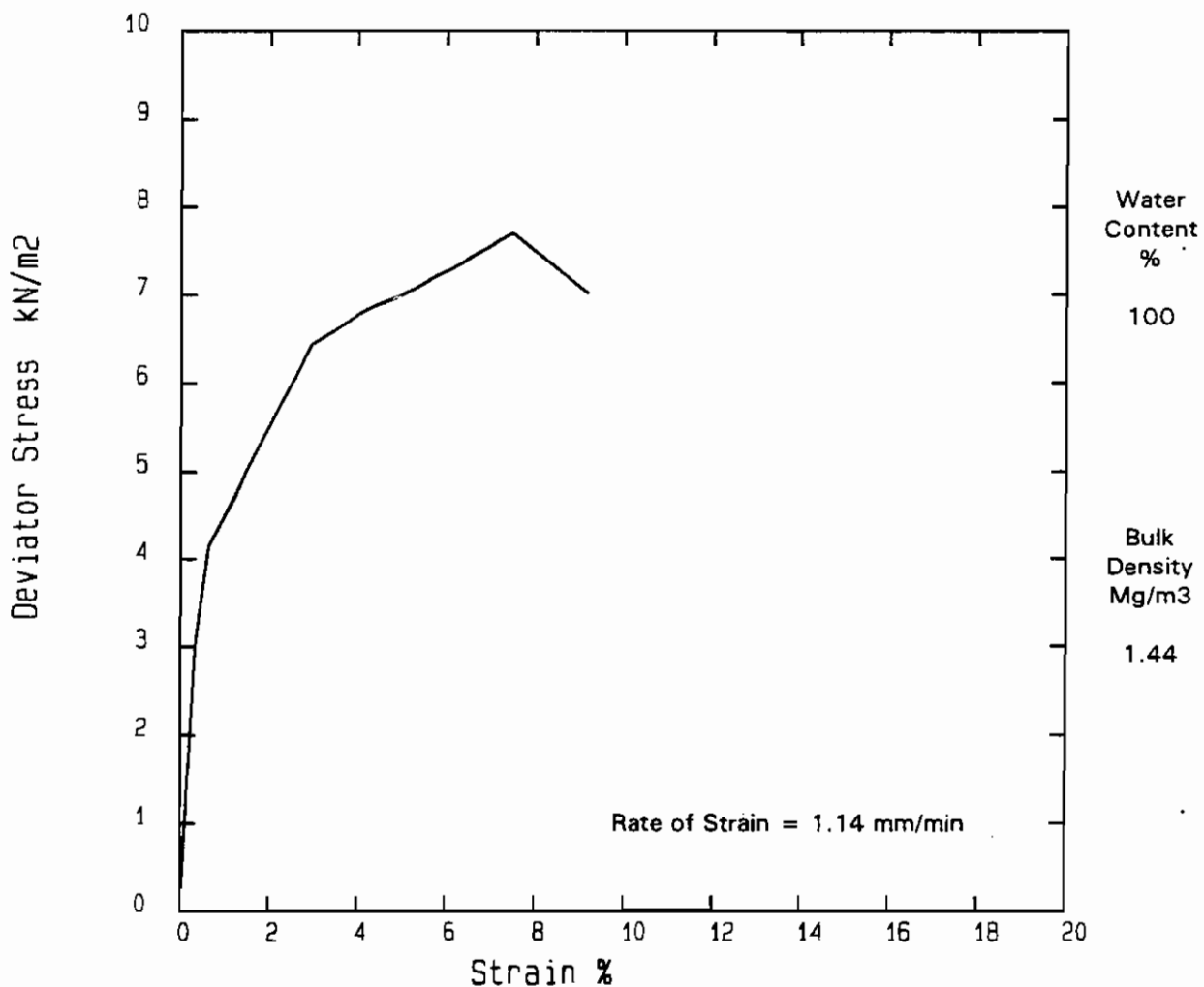
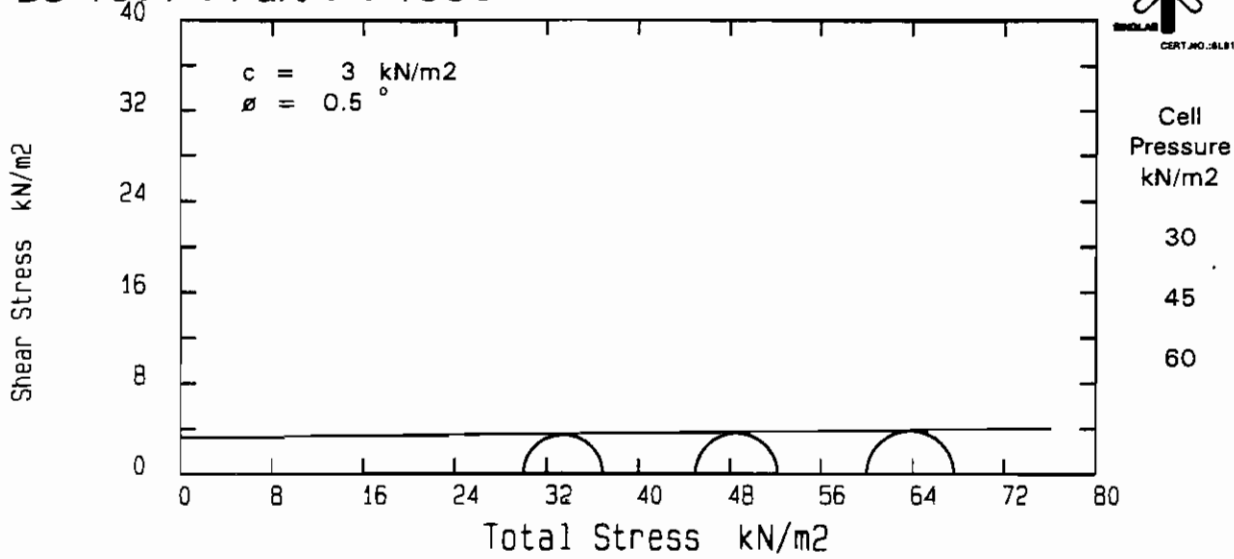
Sample type UD
 Sample Description Stiff light bluish gray & reddish orange SILTY CLAY
 Boring No : 22 Sample No: 4 Depth : 6.00-6.90m



Project : New Upper Changi Road, Land Parcel D

Job No : 0
 Plate :

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Sample type UD
 Sample Description Very soft greenish gray marine CLAY w/organic & ferrous stains
 Boring No : 27 Sample No: 1 Depth : 1.50-2.30m

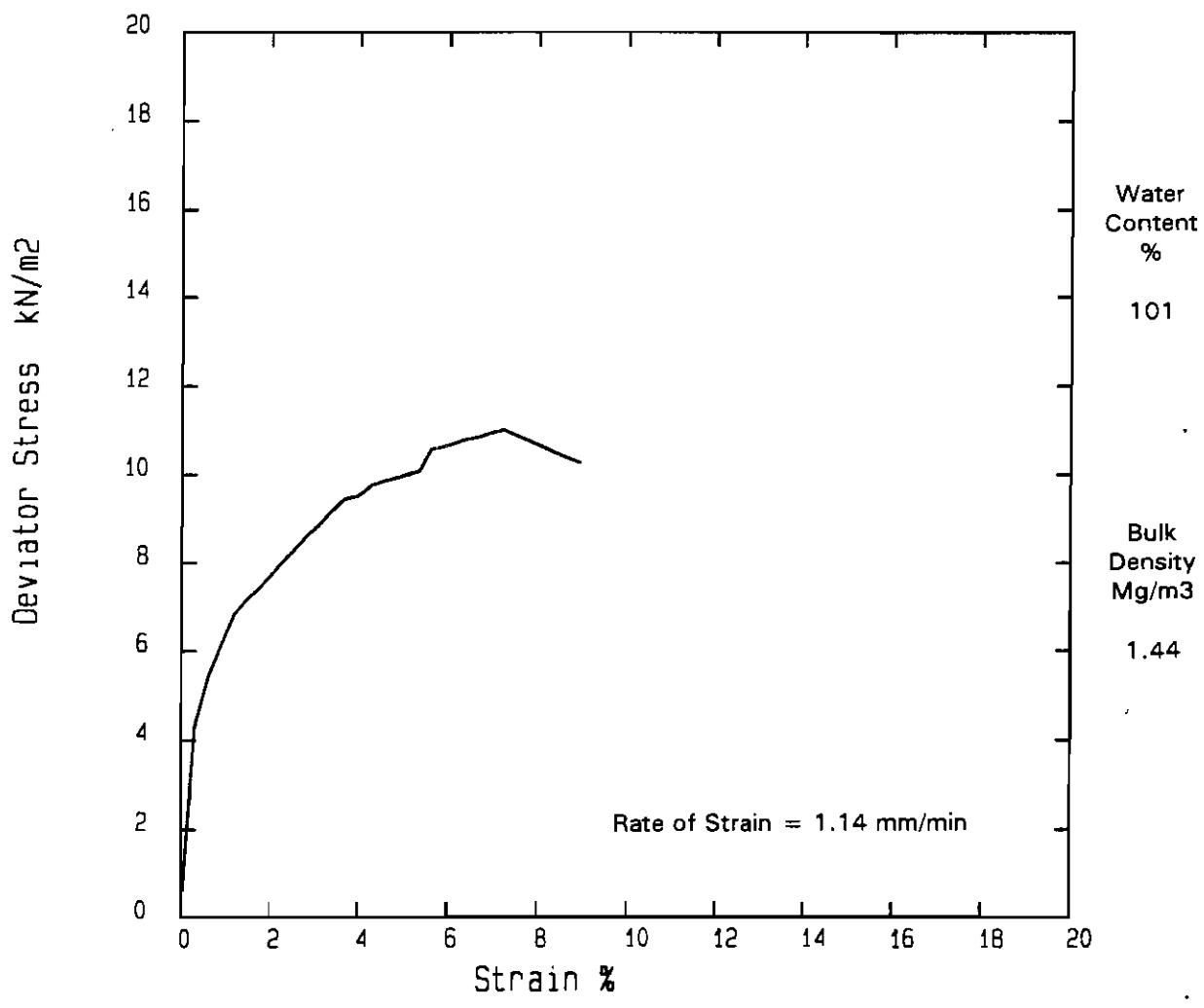
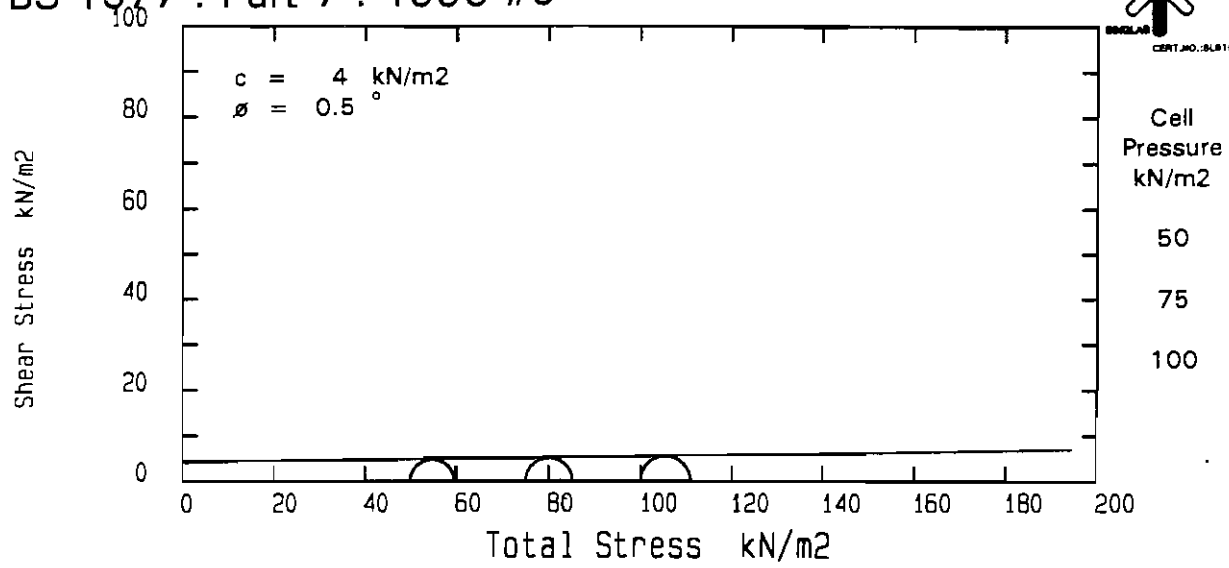


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Sample type UD
 Sample Description Very soft greenish gray marine CLAY
 Boring No : 27 Sample No: 2 Depth : 3.00-3.40m

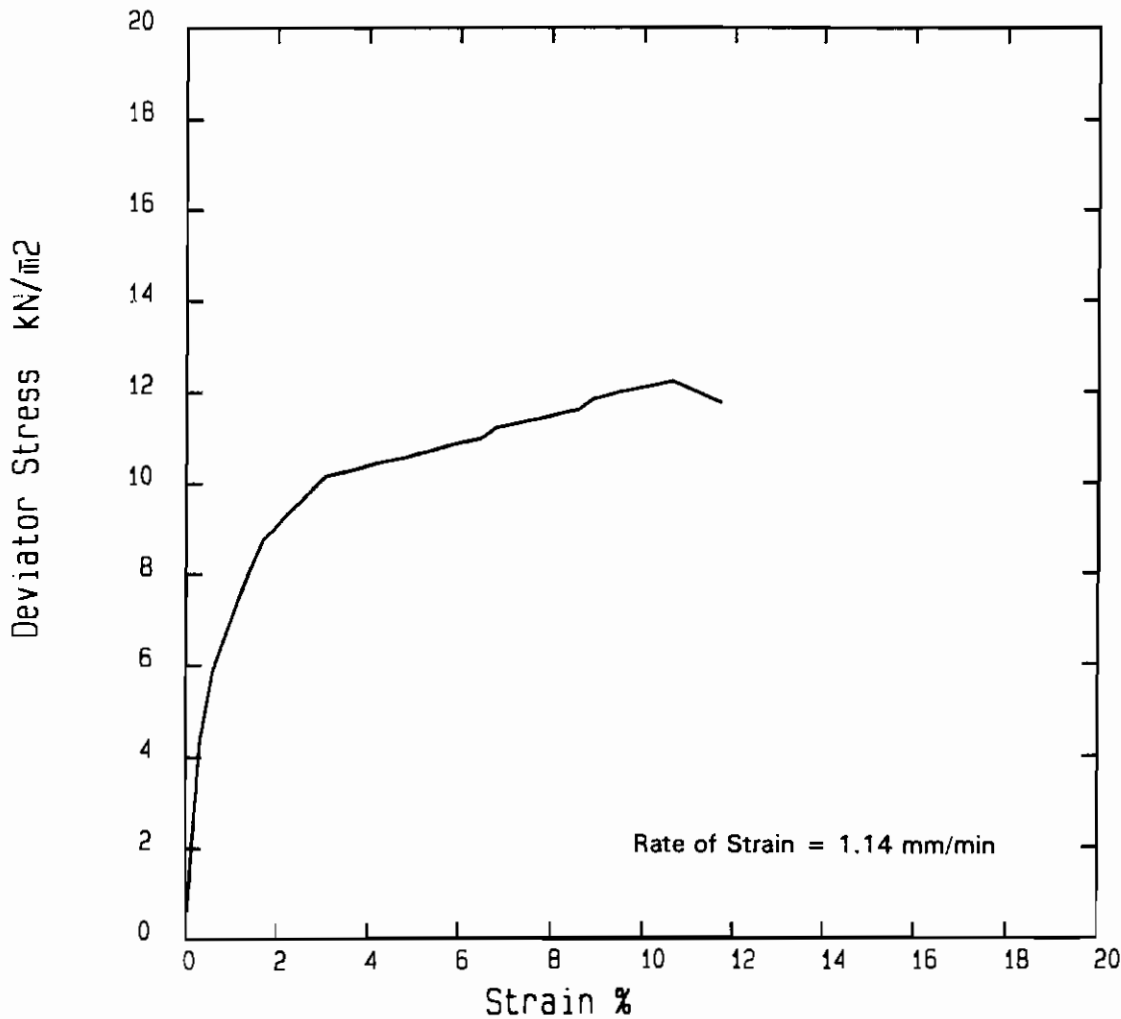
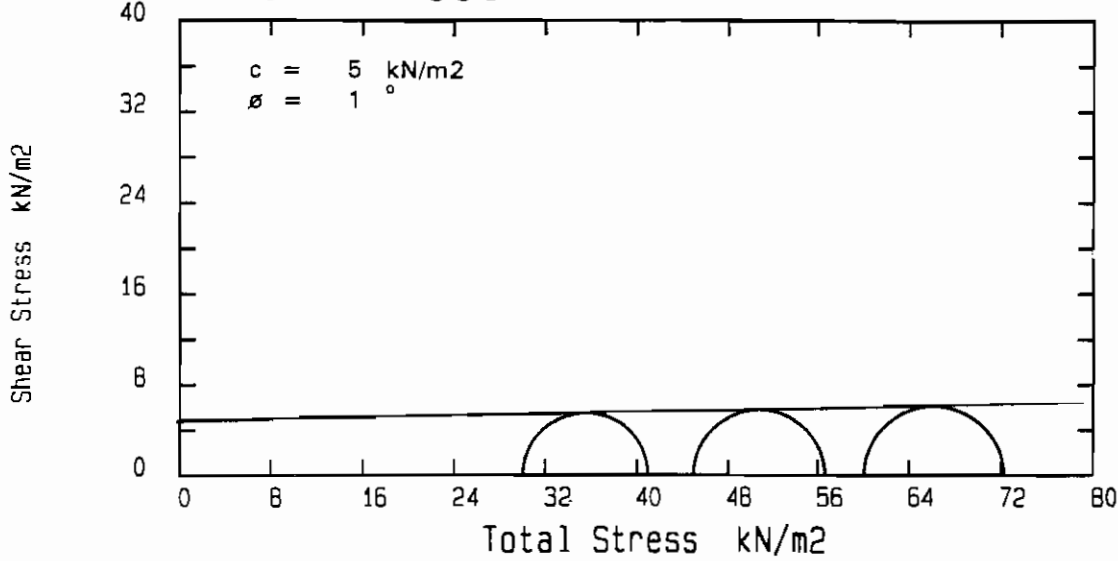


Project : New Upper Changi Road, Land Parcel D

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Unconsolidated Undrained Triaxial Compression

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Sample type UD

Sample Description Very soft greenish gray marine CLAY w/organic stains

Boring No : 31

Sample No: 1

Depth : 1.50-2.40m



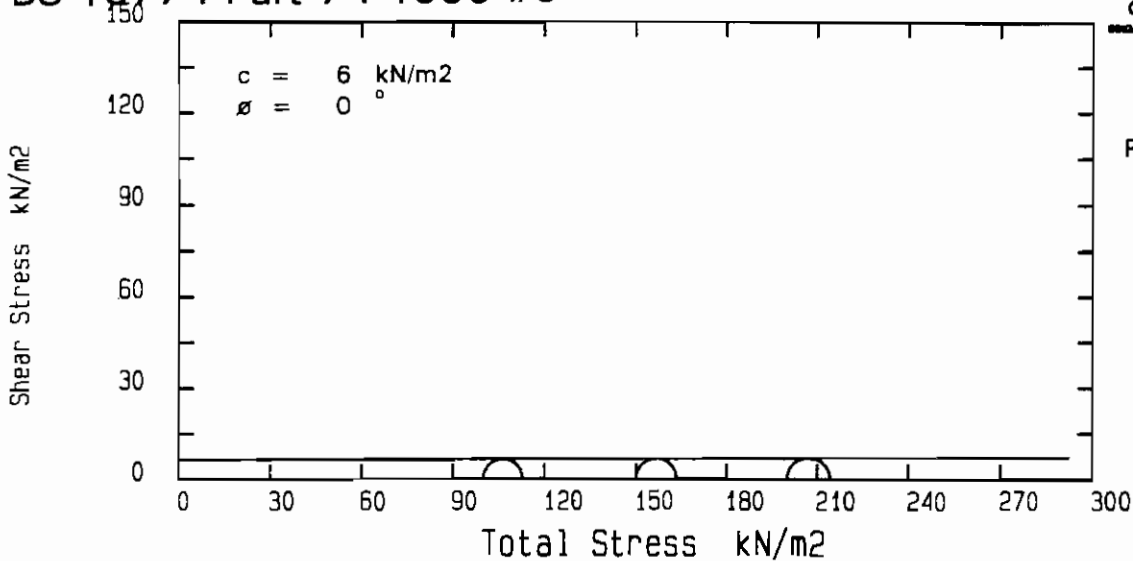
Project : New Upper Changi Road, Land Parcel D

Job No : 0

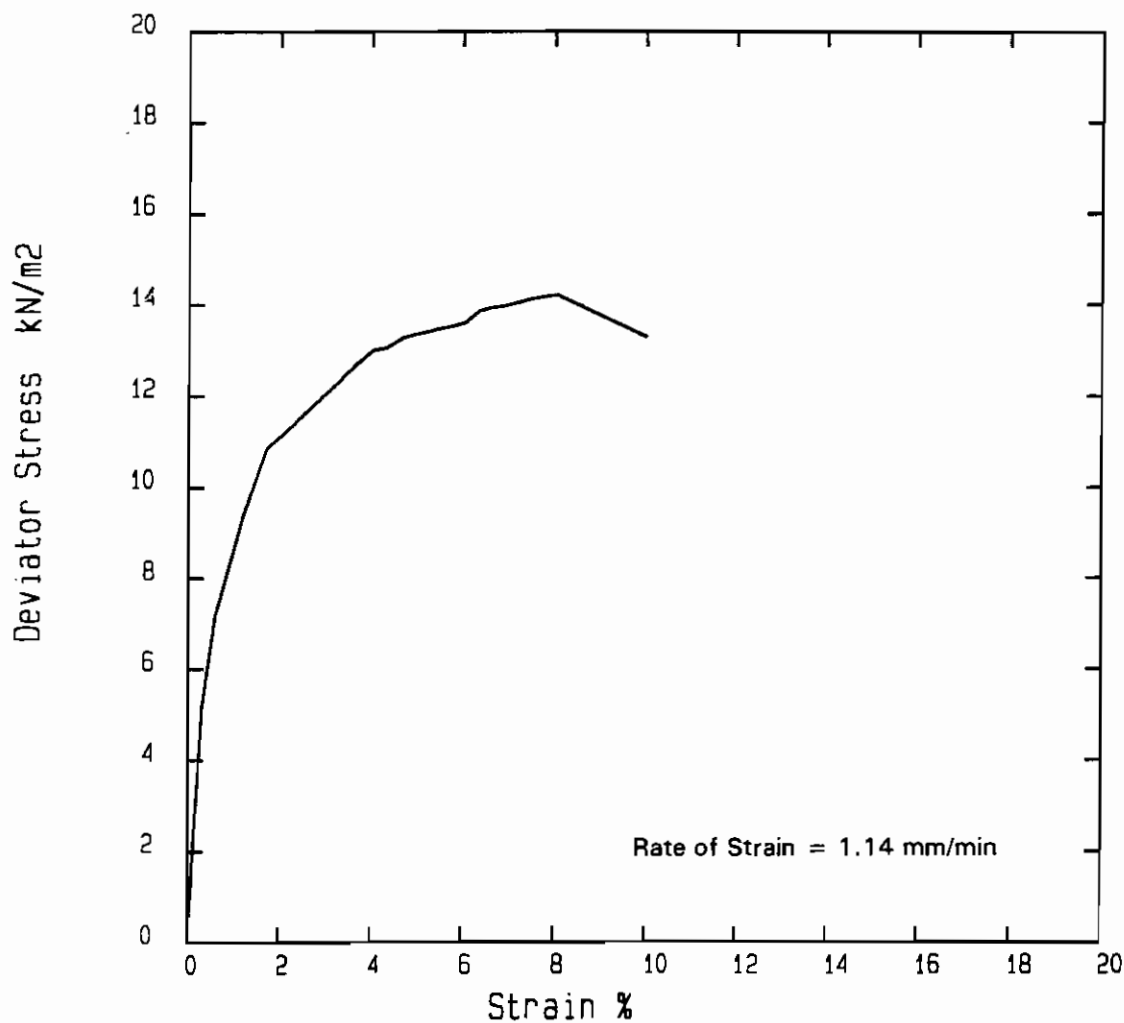
Plate :

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Cell Pressure
 kN/m²
 100
 150
 200



Water Content
 %
 88

Bulk Density
 Mg/m³
 1.49

Sample type UD

Sample Description Very soft greenish gray marine CLAY w/organic stains

Boring No : 31

Sample No: 3

Depth : 4.50-5.50m



Project : New Upper Changi Road, Land Parcel D

Job No : 0

Plate :