FORENSIC SITE INVESTIGATION & INSTRUMENTATION

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DFY Consult & CSL Soil Centralab

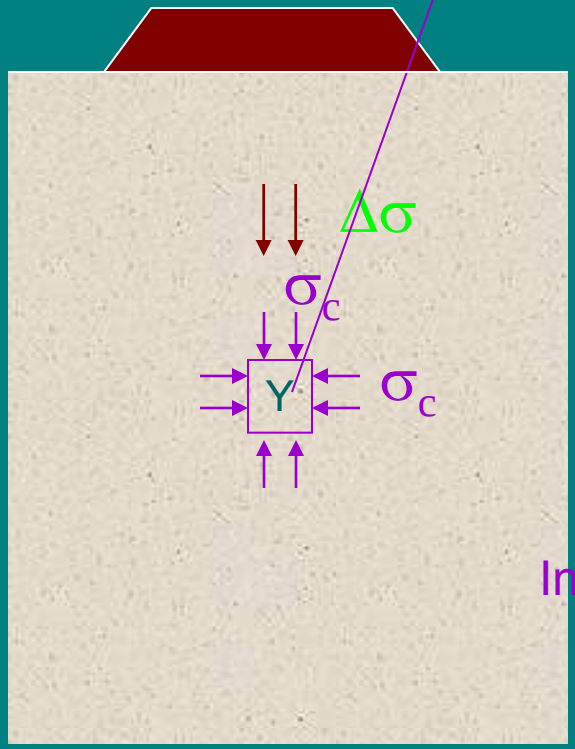

CAUSE, EFFECT OF
FAILURE AND RESULTS OF
INVESTIGATION

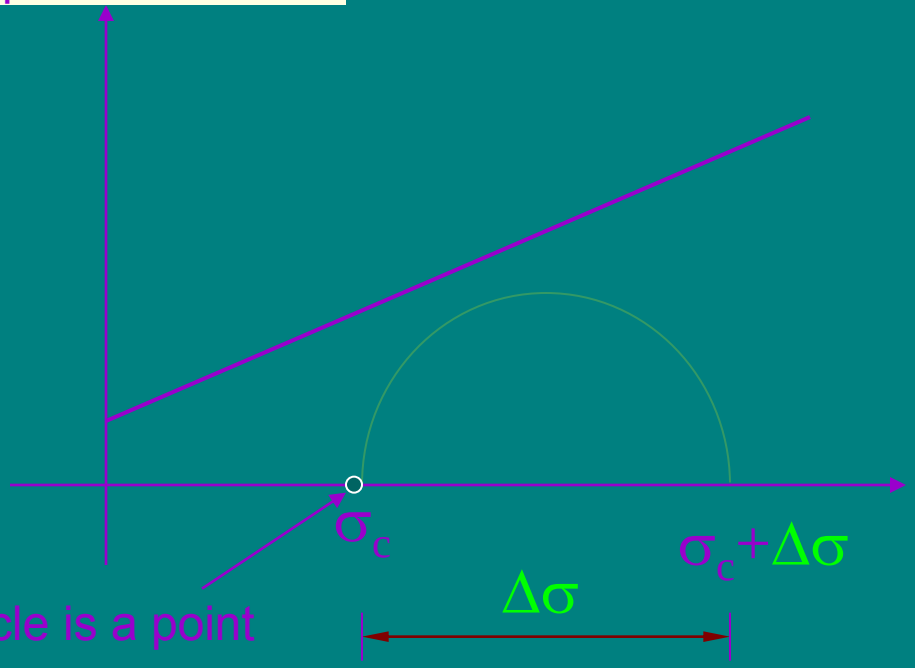
WHAT IS A FAILURE?

Behaviour not in agreement with the expected conditions of stability, or as lacking freedom from necessary repair, or non-compliance with the desired use and occupancy of the completed structure.

Mohr Circles & Failure Envelope

The soil element does not fail if the Mohr circle is contained within the envelope

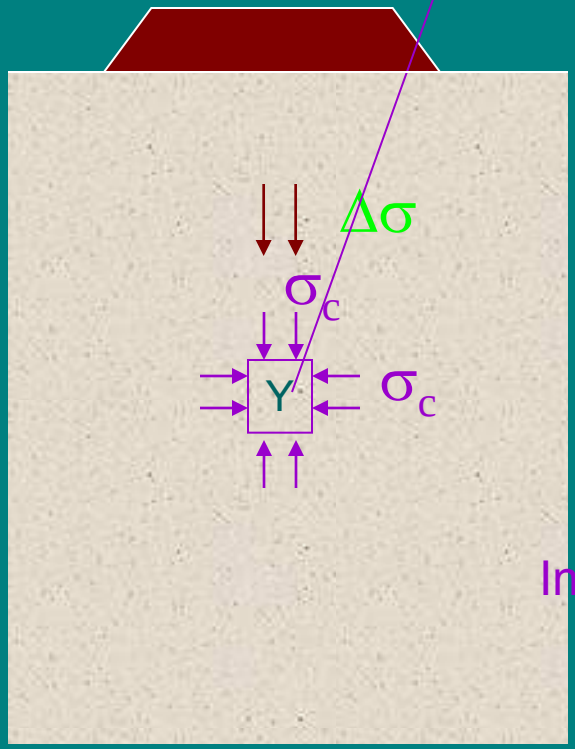


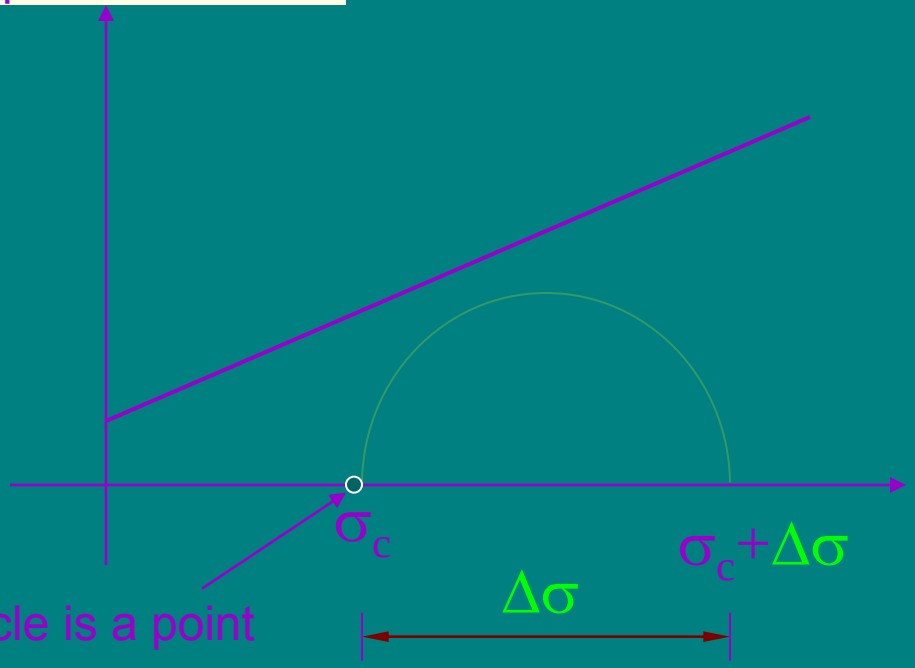


Initially, Mohr circle is a point

Mohr Circles & Failure Envelope

The soil element does not fail if the Mohr circle is contained within the envelope

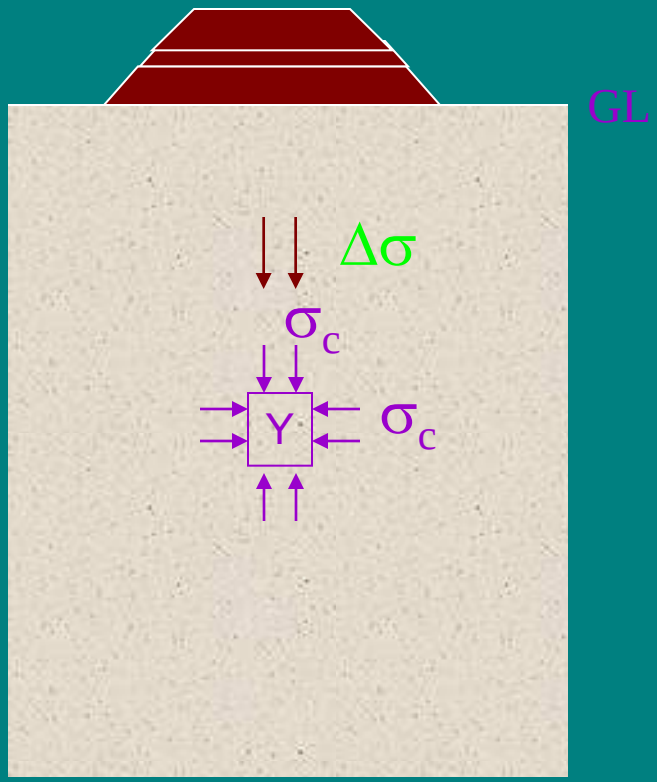


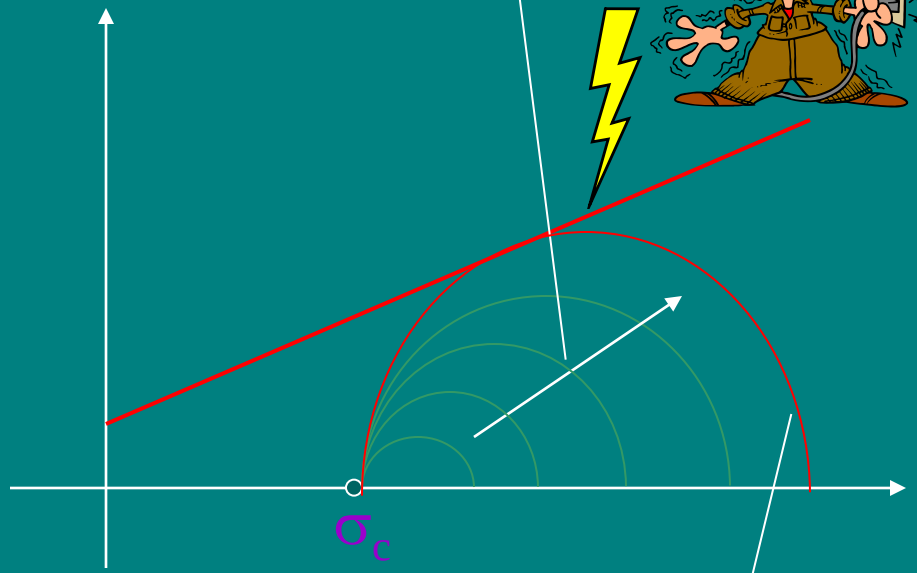


Initially, Mohr circle is a point

Mohr Circles & Failure Envelope

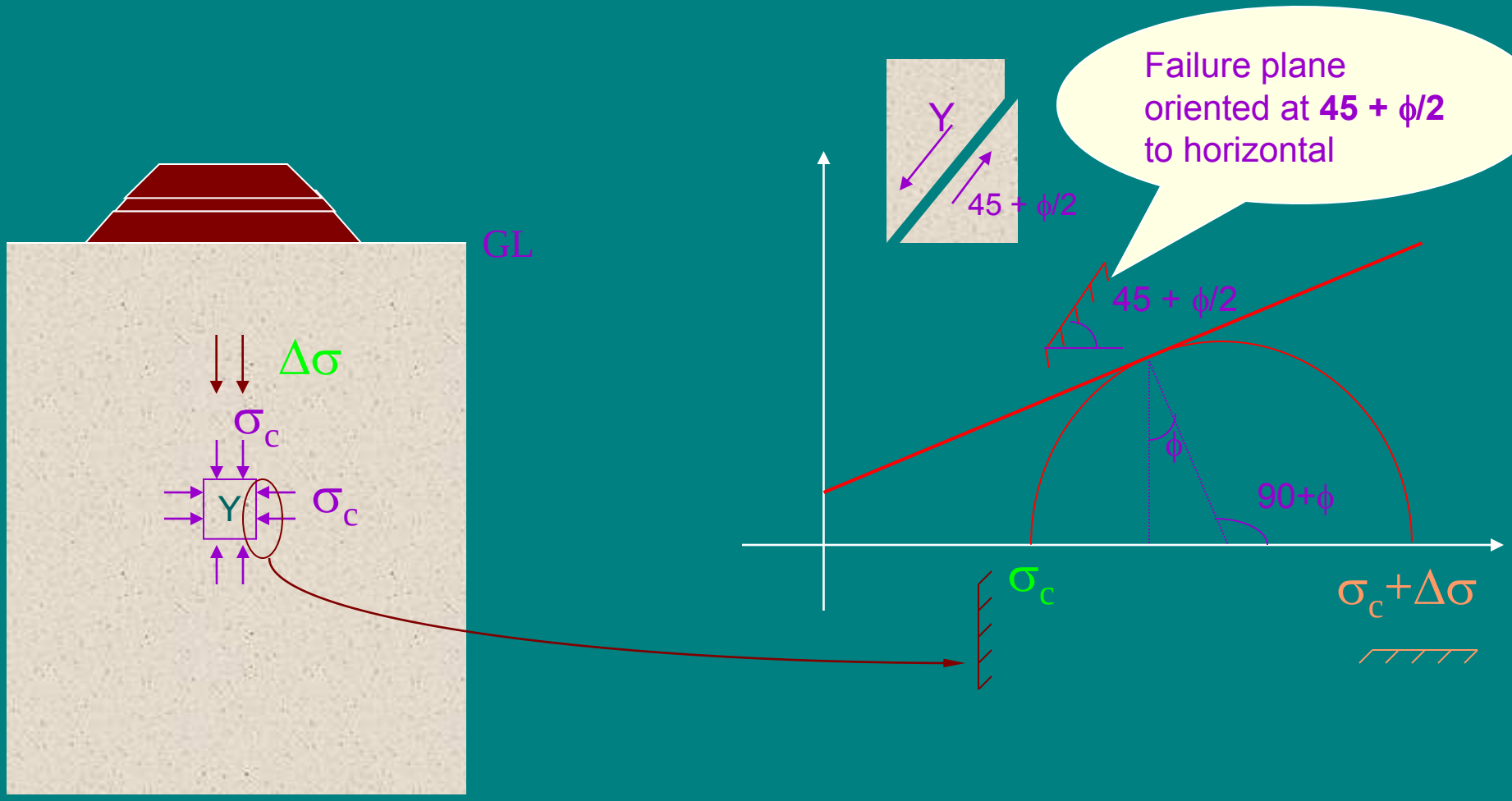
As loading progresses, Mohr circle becomes larger…

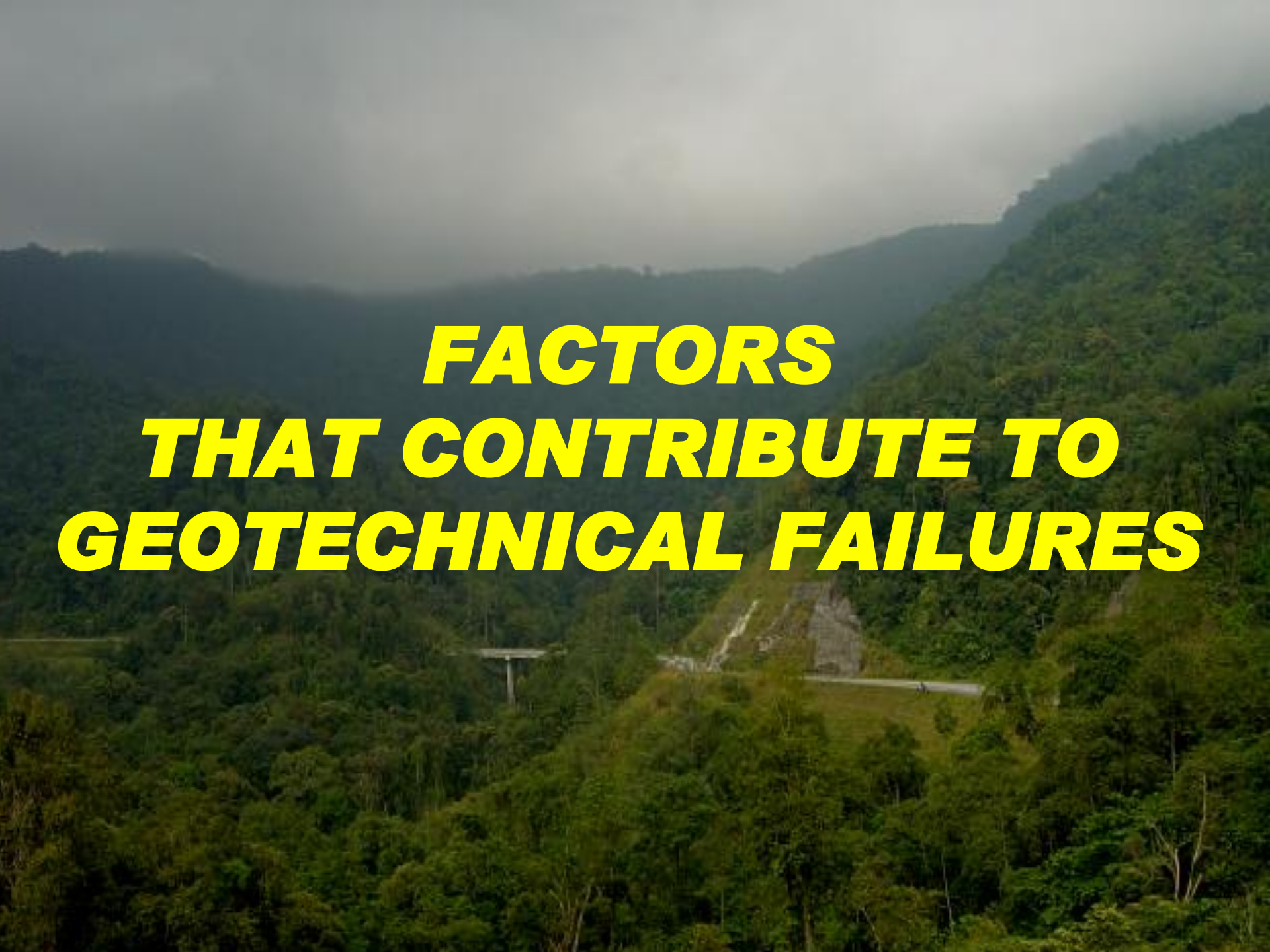


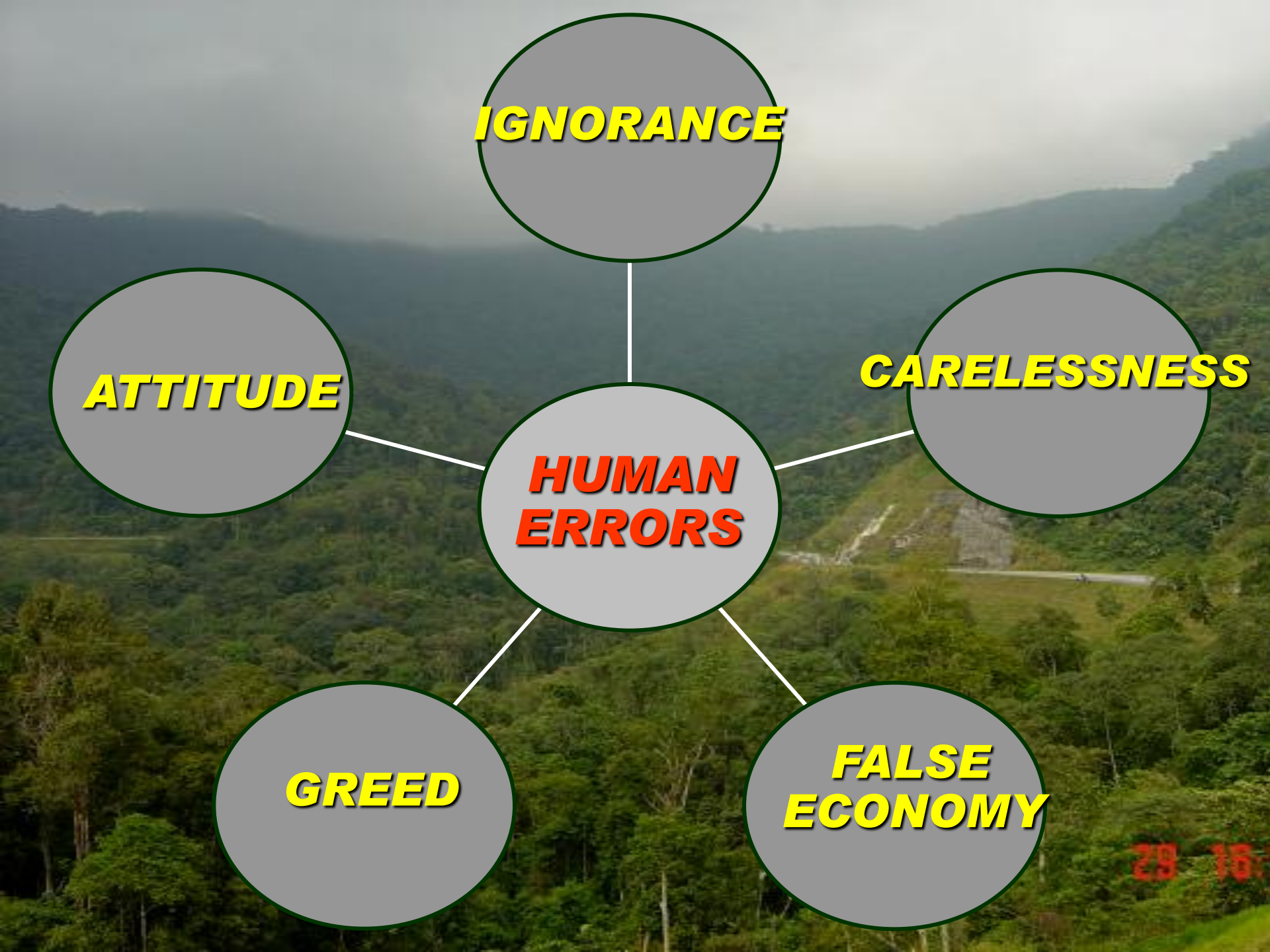


.. and finally failure occurs when Mohr circle touches the envelope

Orientation of Failure Plane




FACTORS
THAT CONTRIBUTE TO
GEOTECHNICAL FAILURES


IGNORANCE
ATTITUDE
CARELESSNESS
HUMAN ERRORS
GREED
FALSE ECONOMY

IGNORANCE

Frequent human ignorance

- Incompetent staff or personnel incharge of site investigation, design, preparation of working drawing and specification of works.
- Absence of proper site investigation.
- Failure to understand or making wrong interpretation of geotechnical investigation results.
- Assumption of vital responsibility by man without the necessarily professional know-how.

IGNORANCE

Frequent human ignorance

- Lack of proper coordination between the various parties.
- Job performed by incompetent contractor.
- Job supervised by personnel lacking intelligence, training or experience.
- Faulty design practice or failure to comply with codes requirement or poor drafting.
- Changing someone else's design without the knowledge of the original designer nor understanding the original designer's assumptions.

CARELESSNESS

- Design oversight which includes a number of errors that occur frequently.
- Carelessness on the part of the contractor and site supervisors.

FALSE ECONOMY

- Economic consideration is certainly a requirement, apart from engineering and safety considerations, in making an engineering decision.

- However, one should not bias a decision based on false economy.

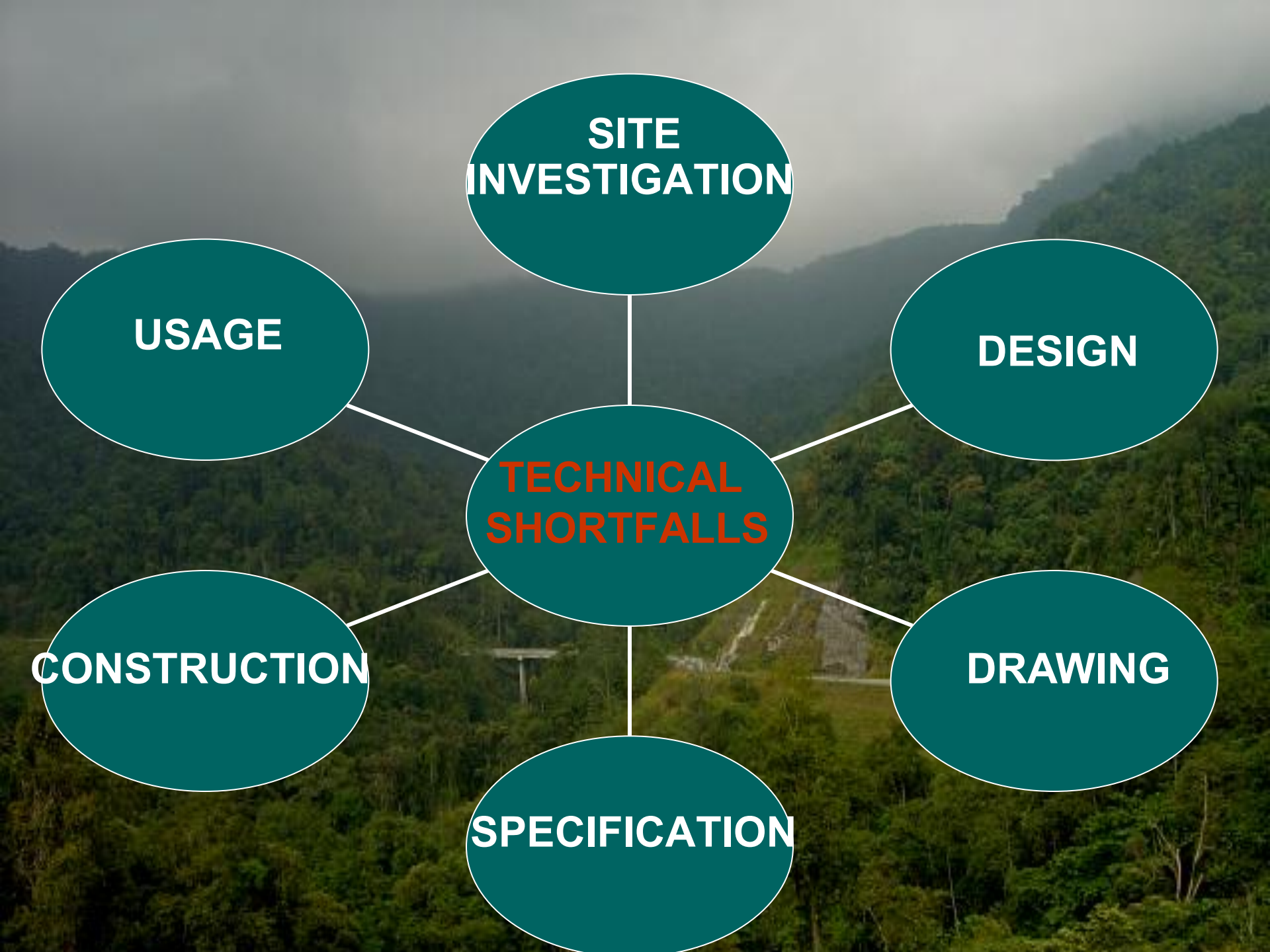
GREED

- It is certainly not wrong to covet richness, but one should not be greedy and try to accumulate wealth through illicit means.

- All practice by contractor can be checked through proper and honest supervisions.

ATTITUDE

- Attitude plays an important role in determining the performance of a person and the quality of his work.
- His work will invariably be careless and error prone, which can trigger many problems.
- If construction failures are to be averted, it is necessary among others, for the engineers and the contractors to have the right work attitude.
- The government “Look East Policy” is part of a strategy to instill a sense of discipline and dedication among the citizen of this country, particularly the government servants, to help cultivate the right attitude towards work.


SITE INVESTIGATION
USAGE
DESIGN
TECHNICAL SHORTFALLS
CONSTRUCTION
DRAWING
SPECIFICATION

CAUSE AND EFFECT

- Activities and their effect on foundation, settlement, slope stability and vibration

REPORT

- Installation record
- Data sheet
- Direct plots

Garbage In Garbage Out

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SITE WORKSHEET

IE

PREINSTALLATION ASSEMBLY AND CHECKING

tube no	reduced level (m) from	reduced level (m) to	tube length (m)	magnet reference no	magnet design level (m)	position of magnet from bottom of tube (m)
1			3 m			
2			3			
3			3			
4			3			
5			3			
6			0.5m			
assembled and check by			HAKIM		date	23/01/2002

INSTALLATION

borehole backfill			chainage	198.88	offset (m)	
water	cement	bentonite	orientation of inclo keyways			OK
	1	4	other information			
volume (m^3)						

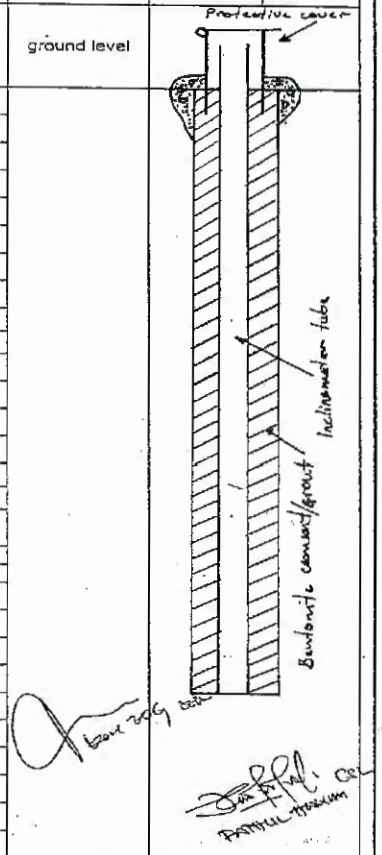
COMMISSIONING

date		RL of top of tube (m)		Reading by	
magnet reference no		read switch probe reading (m)		installed RL of magnets (m)	diffrence to design RL (m)
inclinometer base data file name		INC - 01		date	29/01/2002
witnessed/approved by Engineer					

PC GEO-MANAGEMENT SDN BHD (325469-A)
6B Jalan Anggerik Vanilla M 31/M
Kota Kemuning, Seksyen 31
Kota Alam, Selangor D.E.
Tel: 03-5240863, 5240864
Fax: 03-5240862

INSTALLATION DIAPHGRAM

start date	23/01/2002	ground level (m)	16.541 m
depth (m)	description	casing dia. (mm)	100
0	ground level		



finish date	23/01/2002	driller name	
final depth	15.0		
total casing length (m)	15.20	total casing depth (m)	15.0

INCLINOMETER EXTENSOMETER

project		inclinometer/ extensometer ref. no	date/time installed	5:00 pm 23/01/2002
contract no		INC - 01 EXT - 4	installed by	Hakim / Azlee

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SITE WORSHEET

SP1

PREINSTALLATION ASSEMBLY AND TESTING

piezometer type	Casagrande	test date	15/01/2002	1st standpipe length (m)
serial no	-	test by	Hanis	10.50
remarks	Reference Level from JKR Assume Level = 10.00.			

SITE INFORMATION

ground surface conditions	SLOPE
remarks	-

INSTRUMENT LOCATION

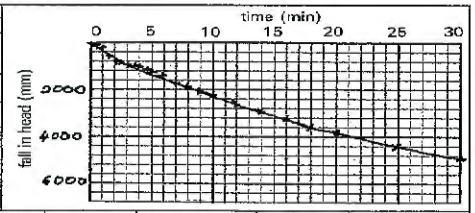
chainage	198.940
offset	2nd Berm N/B.

INSTALLATION IN SAND POCKET

piezometer depth	(m)	10.0	piezometer level (m)	8.677 m	
backfilling materials		from depth (m)	to depth (m)	volume (m^3)	
sand pocket		10.50	9.50	0.002	
bentonite plug		9.50	8.50	0.002	
bentonite grout		8.50	0.0	0.170	
grout mix details		1 : 4	total standpipe length (m)	10.5m	

FALLING HEAD TEST

date of test	18/01/2002
time of test	11 00 a.m.
remarks	Base Reading = 1.160 m



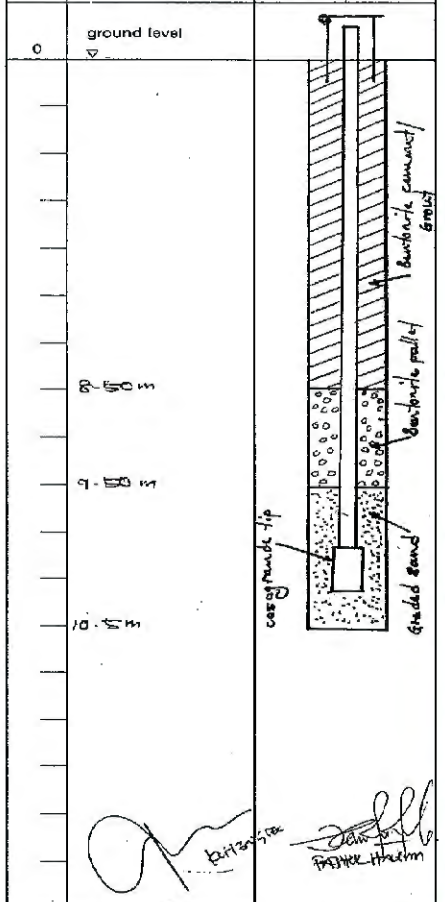
time (min)	fall in head (mm)	time (min)	fall in head (mm)	time (min)	fall in head (mm)
0	0.0	4.0	1120 mm	12.0	2590 mm
0.5	150	4.5	1260	14.0	2930
1.0	260	5.0	1300	16.0	3250
1.5	595	6.0	1510	18.0	3530
2.0	670	7.0	1700	20.0	3780
2.5	750	8.0	1890	25.0	4390
3.0	870	9.0	2080	30.0	4900
3.5	985	10.0	2260		

date protective cover installed	25/02/02	final RL of standpipe top (m)	
witnessed/approved by Engineer			

PC GEO-MANAGEMENT SDN BHD (335499-A)
68 Jalan Anggerik Vanilla M 31/M
Kota Kemuning 40460 Shah Alam, Selangor D.E.
Tel: 03-5240869, 03-5240879, Durian Tunggal
Fax: 03-5240864

BOREHOLE (all depths from ground level)

start date	15/01/2002	ground level (m)	18.746 m
depth (m)	description	casing dia (mm)	100



finish date	16/01/2002	driller's name	S & Foundation
final depth (m)	10.50		
total casing length (m)	10.70	total casing depth (m)	10.50

STANDPIPE PIEZOMETER

contract no		piezometer ref no	SP-01 BH-1
		date/time installed	11:30 am 16/01/2002
		installed by	Halim / Hanis

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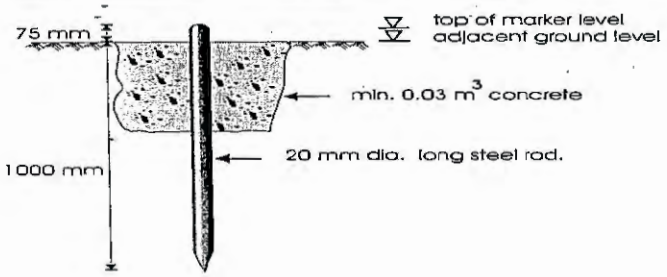
SITE WORKSHEET

SHM

TYPICAL INSTALLATION DETAILS



marker reference no	location: chainage (m)	location: offset (m)	date installed	top of marker level (m)	adjacent ground level (m)	remarks
G1	CH 199.06		15.1.2002	13.891 m		
G2	CH 199.02		15.1.2002	16.080		
G3	CH 198.98		15.1.2002	19.098		
G4	CH 198.94		17.01.2002	19.017		
G5	CH 198.90		15.1.2002	17.894		
G6	CH 198.86		"	14.865		
G7	CH 198.82		"	11.053		
G8	CH 198.84		"	12.587		
G9	CH 198.88		"	13.706		
G10	CH 198.92		"	13.977PC		
G11	CH 198.96		"	14.066		
G12	CH 198.00		"	14.343		
G13	CH 199.06		"	8.513		
G14	CH 199.02		"	8.295m		
G15	CH 198.98		"	7.973m		
G16	CH 198.94		"	7.795		
G17	CH 198.90		15.1.2002	7.805		
markers installed by		HAKIM		level taken by	HAKIM	

GEO-MANAGEMENT SDN BHD (325A
6B Jalan Anggerik Vanilla M 31/
Kota Kemuning, Seksyen 31
40460 Shah Alam, Selangor D
Tel: 03-5240863, 5240
Fax: 03-5240864

SETTLEMENT HEAVE MARKER	contract name	INS. WORKS AT KMM 199, DURIAN TUNGGAL	sheet no
	location		2

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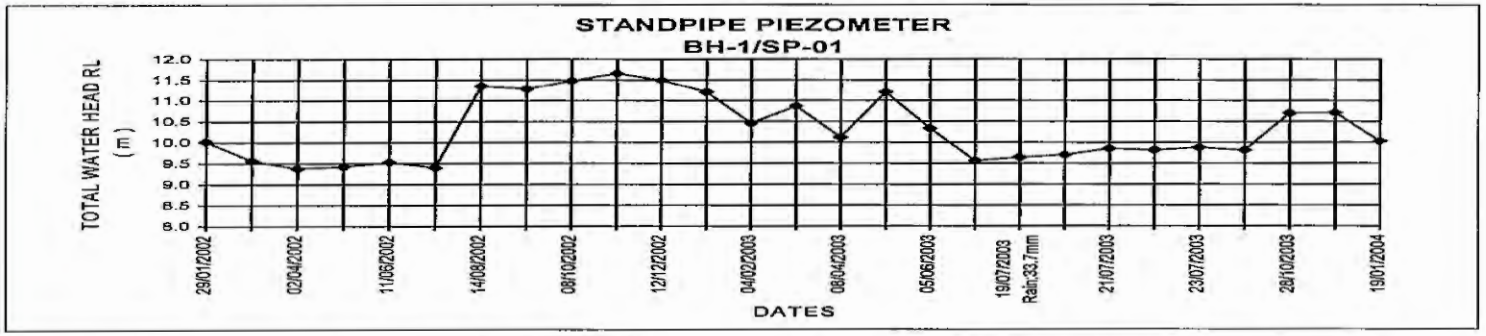
DATASHEET

SP2

DATE INSTALLED	16/01/2002	RL OF TOP OF STANDPIPE AS INSTALLED (m)	19.177
LEVEL OF STANDPIPE AS INSTALLED (m)	8.677	RL OF GROUND ADJACENT TO STANDPIPE AT INSTALLATION (m)	18.746
TOTAL LENGTH OF STANDPIPE INSTALLED (m)	10.50	TOTAL HEAD BASE READING (m)	10.017

DATE	DAY NO	TIME	DIPMETER READING (m)	STANDPIPE TOP RL (m)	ADJACENT GROUND RL (m)	TOTAL WATER HEAD RL (m)	WATER HEAD RELATIVE TO BASE READING (m)
29/01/2002	1	15:15	9.160	19.177	18.746	10.017	0.000
19/02/2002	22	17:02	9.620	19.177	18.746	9.557	0.460
02/04/2002	64	12:35	9.800	19.177	18.746	9.377	0.640
23/04/2002	85	11:42	9.760	19.177	18.746	9.417	0.600
11/06/2002	134	13:38	9.650	19.177	18.746	9.527	0.490
09/07/2002	162	10:59	9.780	19.177	18.746	9.397	0.620
14/08/2002	198	11:10	7.830	19.177	18.746	11.347	-1.330
10/09/2002	225	11:16	7.900	19.177	18.746	11.277	-1.260
08/10/2002	253	10:51	7.700	19.177	18.746	11.477	-1.460
12/11/2002	288	10:35	7.520	19.177	18.746	11.657	-1.640
12/12/2002	318	12:47	7.690	19.177	18.746	11.487	-1.470
07/01/2003	344	14:00	7.980	19.177	18.746	11.197	-1.180
04/02/2003	372	12:45	8.720	19.177	18.746	10.457	-0.440
03/03/2003	399	11:14	8.310	19.177	18.746	10.867	-0.850
08/04/2003	435	11:22	9.060	19.177	18.746	10.117	-0.100
06/05/2003	463	12:05	7.980	19.177	18.746	11.197	-1.180
05/06/2003	493	13:50	8.850	19.177	18.746	10.327	-0.310
18/07/2003	536	11:04	9.618	19.177	18.746	9.559	0.458
19/07/2003 Rain:33.7mm	537	12:24	9.538	19.177	18.746	9.639	0.378
20/07/2003	538	12:35	9.480	19.177	18.746	9.697	0.320
21/07/2003	539	12:55	9.330	19.177	18.746	9.847	0.170
22/07/2003	540	12:25	9.360	19.177	18.746	9.817	0.200
23/07/2003	541	12:12	9.300	19.177	18.746	9.877	0.140
04/08/2003	553	11:54	9.365	19.177	18.746	9.812	0.205
28/10/2003	638	13:34	8.480	19.177	18.746	10.697	-0.680
29/12/2003	700	13:06	8.470	19.177	18.746	10.707	-0.690
19/01/2004	721	12:09	9.150	19.177	18.746	10.027	-0.010



STANDPIPE PIEZOMETER	Project Name	INSTRUMENTATION WORKS AT KM 199 (N/B), DURIAN TUNGGAL				
	Section	-	Chainage	198.94	Piezometer Ref No	BH-1/SP-01

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DATASHEET

SSM

CHAINAGE/OFFSET	[illegible]			[illegible]			[illegible]			[illegible]			[illegible]			[illegible]		
SSM NO	[illegible]			[illegible]			[illegible]			[illegible]			[illegible]			[illegible]		
DATE INSTALLED	15/01/2002			[illegible]			[illegible]			[illegible]			15/01/2002			[illegible]		
BASE READING	[illegible]			17.404			[illegible]			17.772			16.200			[illegible]		

DATE	DAY NO	RL TOP OF ROD (m)	SETTLEMENT (m) Incremental	SETTLEMENT (m) Cumulative	RL TOP OF ROD (m)	SETTLEMENT (m) Incremental	SETTLEMENT (m) Cumulative	RL TOP OF ROD (m)	SETTLEMENT (m) Incremental	SETTLEMENT (m) Cumulative	RL TOP OF ROD (m)	SETTLEMENT (m) Incremental	SETTLEMENT (m) Cumulative	RL TOP OF ROD (m)	SETTLEMENT (m) Incremental	SETTLEMENT (m) Cumulative	RL TOP OF ROD (m)	SETTLEMENT (m) Incremental	SETTLEMENT (m) Cumulative
[illegible]	0	[illegible]	[illegible]	0.000	17.404	0.000	[illegible]	[illegible]	0.000	0.000	17.772	0.000	[illegible]	[illegible]	[illegible]	[illegible]	12.018	[illegible]	0.000
[illegible]	[illegible]	[illegible]	-0.002	-0.005	17.400	[illegible]	-0.004	[illegible]	[illegible]	[illegible]	17.766	-0.006	[illegible]	[illegible]	[illegible]	[illegible]	12.016	[illegible]	[illegible]
[illegible]	42	[illegible]	-0.001	-0.006	[illegible]	[illegible]	0.022	[illegible]	[illegible]	0.000	17.773	0.007	[illegible]	[illegible]	0.008	[illegible]	12.017	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-0.002	[illegible]	[illegible]	0.001	17.770	0.002	[illegible]	[illegible]	[illegible]	-0.002	[illegible]	0.004	[illegible]
[illegible]	58	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.002	[illegible]	[illegible]	[illegible]	[illegible]	0.005	[illegible]	16.210	0.008	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	70	[illegible]	0.004	0.004	[illegible]	[illegible]	0.002	[illegible]	[illegible]	0.006	[illegible]	0.002	[illegible]	[illegible]	0.000	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	238	Damaged			Damaged			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.000	Damaged			Damaged		
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[illegible]	255	[illegible]	[illegible]	[illegible]	[illegible]	-0.012	-0.006	[illegible]	-0.017	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-0.006	[illegible]	[illegible]	[illegible]	[illegible]	-0.002	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-0.008
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.006	[illegible]	[illegible]	-0.008	17.790	0.001	-0.026	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.001
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-0.005	18.297	[illegible]	-0.004	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.002
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-0.008	[illegible]	[illegible]	0.000	[illegible]	[illegible]	[illegible]	16.210	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.008	[illegible]	[illegible]	[illegible]	17.770	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Damaged		
[illegible]	[illegible]	[illegible]	-0.000	[illegible]	[illegible]	[illegible]	-0.012	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	16.210	[illegible]	[illegible]	Damaged		
[illegible]	734	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Damaged		

SURFACE SETTLEMENT MARKER	Project Name:	INSTRUMENTATION WORKS AT KM 199 , DURIAN TUNGGAL

DATE STARTED: 9.9.09

DATE COMPLETED: 9.9.09

BORING METHOD: rotary wash boring

BOREHOLE DIAMETER: 110mm

CASING DEPTH / DIAMETER: 100mm

LOG BY: Mohd Nizam Anuar

REMARKS:

SAMPLE / TEST LEGEND
- UP thin walled piston
- UT thin walled
- UD open drive
- DS SPT split spoon
- MZ mazier sample
- C rock coring
- BS bulk disturbed
- OS small disturbed
- WS ground water
- V vane shear test
- P pressuremeter

DATE AND DEPTH OF BORING (m): 09.09.09 — 17.00

DEPTH TO WATER (m): 3.50

SAMPLES	DEPTH (m)	SYMBOL	OBSERVATIONS	REDUCED LEVEL (m)	STRATA DEPTH (m)	STRATA THICKNESS (m)	STRATA DESCRIPTION
	0.00-1.50				1.50	1.50	Wash Bore
P-1 DS-1	1.50-1.95		2/2-2-2-2 N=8 R=0.28/0.45m			1.50	Firm, yellowish red SILT
P-2 DS-2	3.00-3.45		2/1-2-2-2 N=7 R=0.35/0.45m		3.00	1.50	Firm, yellowish red, light yellow SILT
P-3 DS-3 VS-1	4.50-4.95 5.00	V	2/1-1-1-1 N=4 R=0.30/0.45m Peak=18.0kPa Rem=8.5kPa		4.50	1.00	Soft, yellowish red, yellowish brown, light grey SILT
UD-1	5.50-6.50		R=0.95/1.00m		5.50	1.00	Top : Soft, yellowish yellow SILT Bottom : Soft, yellowish red, light grey SILT
P-4 DS-4	6.50-6.95		3/4-4-8-7 N=23 R=0.40/0.45m		6.50	1.50	Very stiff, light grey, yellowish red, light yellow SILT
P-5 DS-5	8.00-8.45		4/3-4-5-5 N=17 R=0.25/0.45m		8.00	1.50	Very stiff, light grey, yellowish red, light yellow SILT
P-6 DS-6	9.50-9.95		7/5-6-6-5 N=22 R=0.27/0.45m		9.50	1.50	Very stiff, light grey, light yellow SILT
P-7 DS-7	11.00-11.38		30/20-11-19/0.075m N=50/0.225m R=0.12/0.375m		11.00	1.50	Hard, light yellow SILT
P-8 DS-8	12.50-12.90		17/10-11-21-8/0.025m N=50/0.25m R=0.10/0.40m		12.50	1.50	Hard, yellowish light grey SILT
P-9 DS-9	14.00-14.30		24/22-28/0.075m N=50/0.15m R=0.11/0.30m		14.00	1.50	Hard, yellowish light grey SILT
P-10 DS-10	15.50-15.65		20-30/0.075m N=50/0.075m R=0.08/0.15m		15.50	1.65	Hard, dark grey gravelly SILT
P-11 DS-11	17.00-17.15		23-27/0.075m N=50/0.075m R=0.09/0.15m		17.15		END OF BOREHOLE DEPTH : 17.15m

'N' VALUE: 10 20 30 40

LEGEND

soil centralab sendirian berhad

CONTRACT NAME: SI WORKS FOR LPT PHASE 2 PKJ 5A

BOREHOLE RECORD

BOREHOLE NO.: BH-8

GROUND LEVEL (m):

CHAINAGE / OFFSET (m): 54242

COORDINATES:

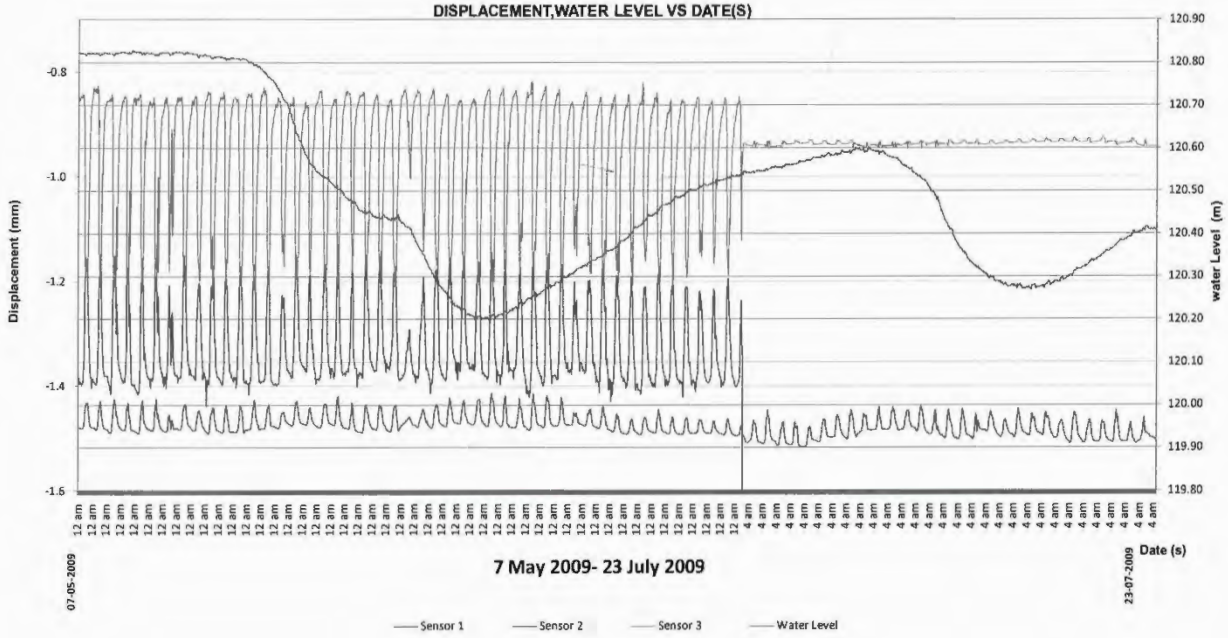
FORM: B1

PAGE: 1

PEMBANGUNAN SISTEM PEMANTAUAN CERUN DI KM 8.25,
JALAN JELAWANG-GUA MUSANG.

IPI 2 & VWP 4

DISPLACEMENT,WATER LEVEL VS DATE(S)



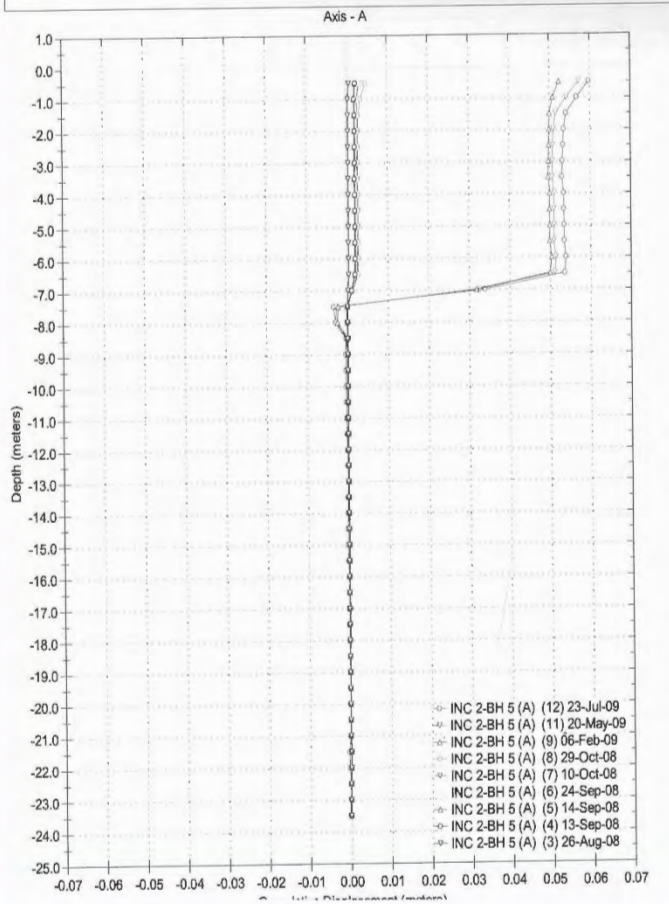
RST Instruments Ltd.

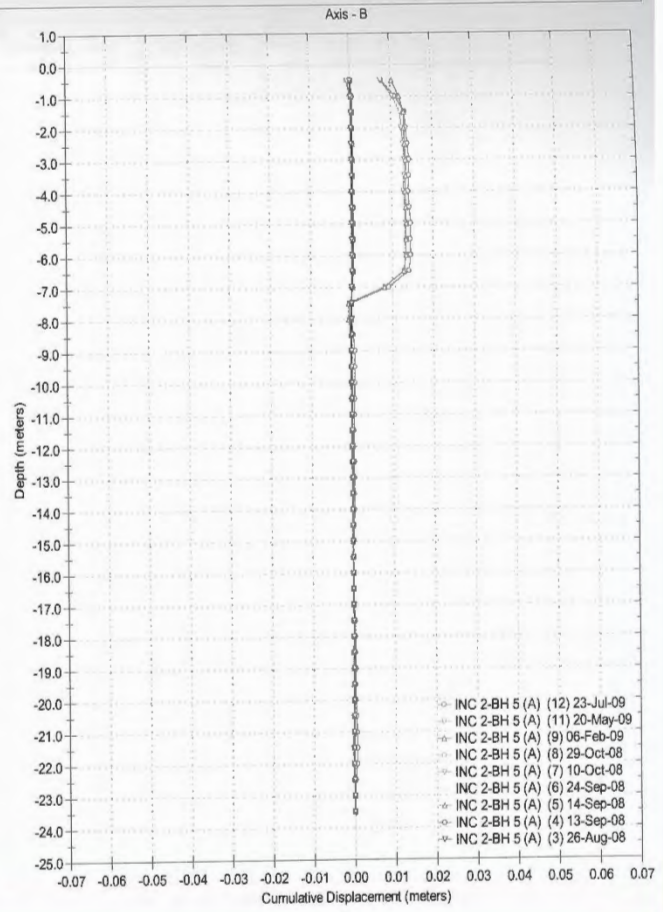
CUMULATIVE DISPLACEMENT

Inclinalysis

Borehole : INC 3 - BH 5 (A)
Project : JELAWANG - GUA MUSANG
Location :
Northing :
Easting :

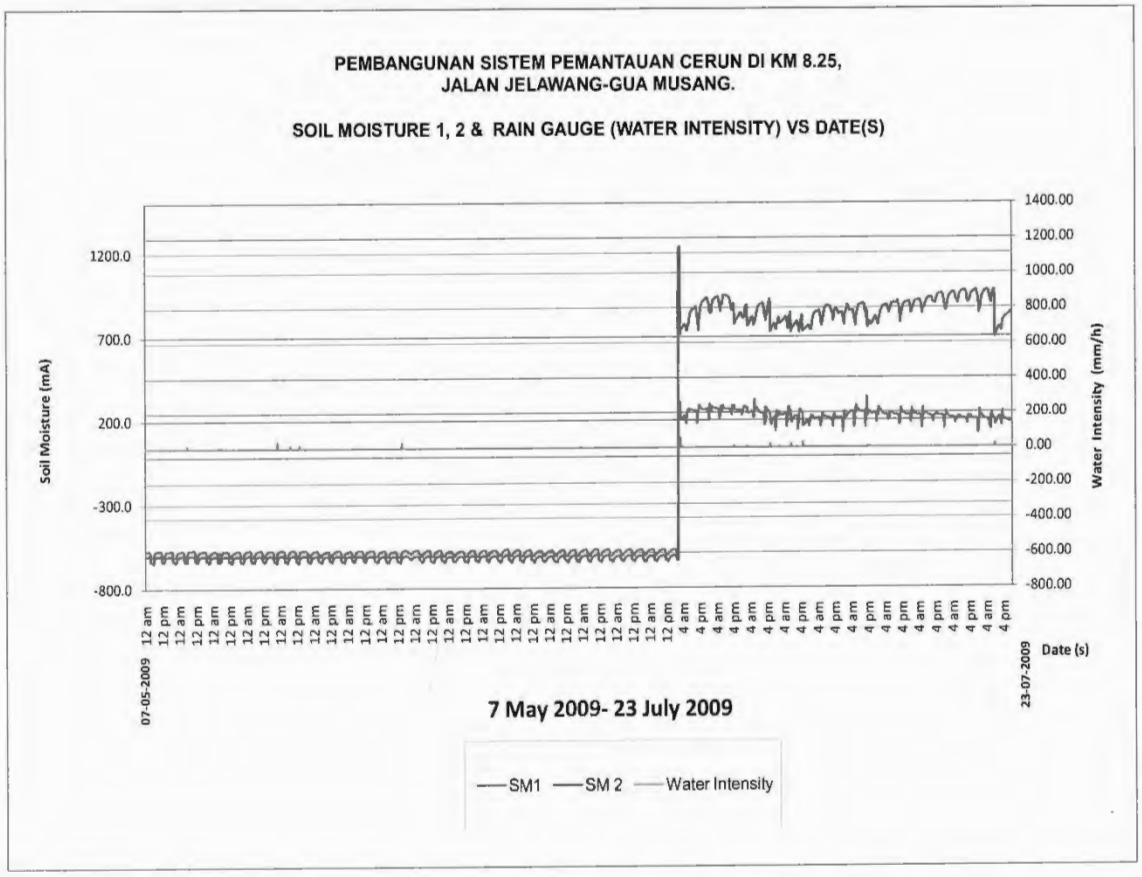
Spiral Correction : N/A
Collar Elevation :
Borehole Total Depth : 23.5 meters
North Groove Azimuth :
Base Reading : 2008 Aug 23 13:38





PEMBANGUNAN SISTEM PEMANTAUAN CERUN DI KM 8.25,
JALAN JELAWANG-GUA MUSANG.

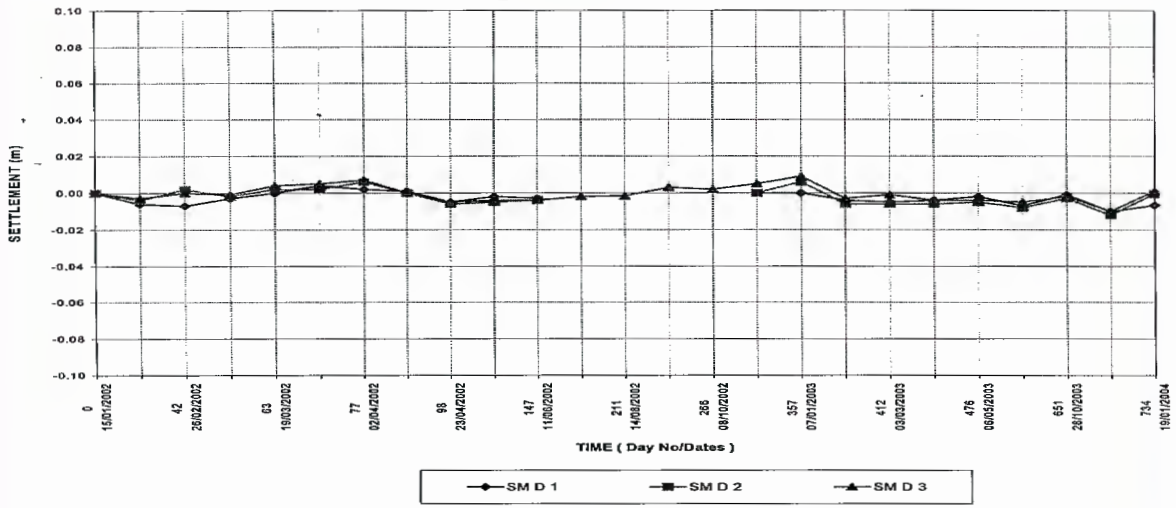
SOIL MOISTURE 1, 2 & RAIN GAUGE (WATER INTENSITY) VS DATE(S)



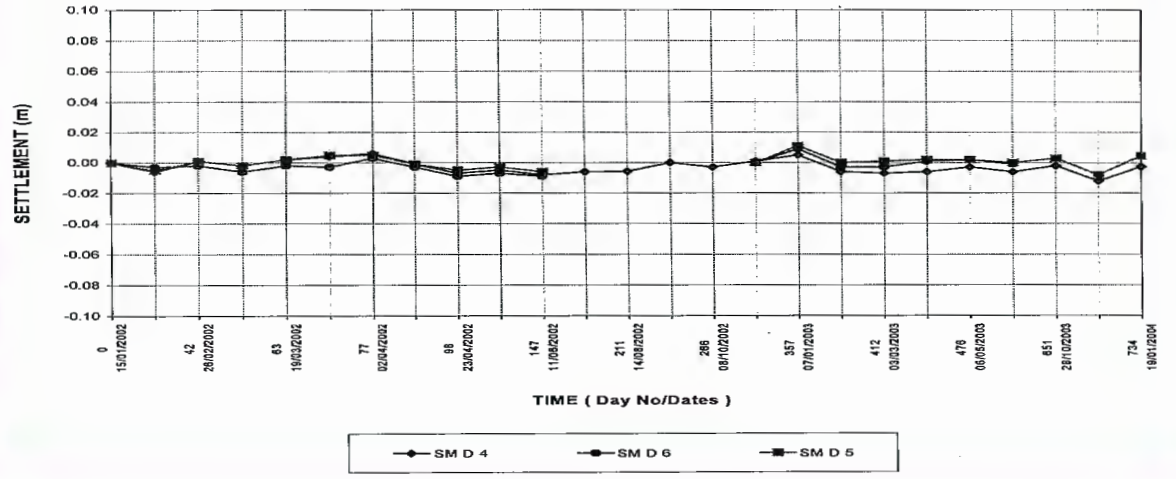
INSTRUMENTATION WORKS AT KM 199 (NB), DURIAN TUNGGAL

(SURFACE SETTLEMENT MARKER)

SETTLEMENT VS TIME



SETTLEMENT VS TIME



ANALYSIS

- Asaoka Plot (1978)
- Matsuo Plot (1977)
- Varnes (1978)

Independent monitoring

MACKINTOSH PROBE

HUMAN ERRORS

- Drop height less than 280mm resulting in higher blow counts;
- Applying force to hammer (exerting) resulting in less blow counts;
- Penetration depth not marked correctly;
- Wrong counting.

MACKINTOSH PROBE

INSTRUMENTAL ERRORS

- Driving rod bent giving more blow counts;
- Stopper blow lost or damaged; torn or worn out threads on coupling;

For stiffer soils (normally residual soil), a different method of consistency definition is used taken from American practice which is based on SPT “N” value. The defined range of Cu is also given:

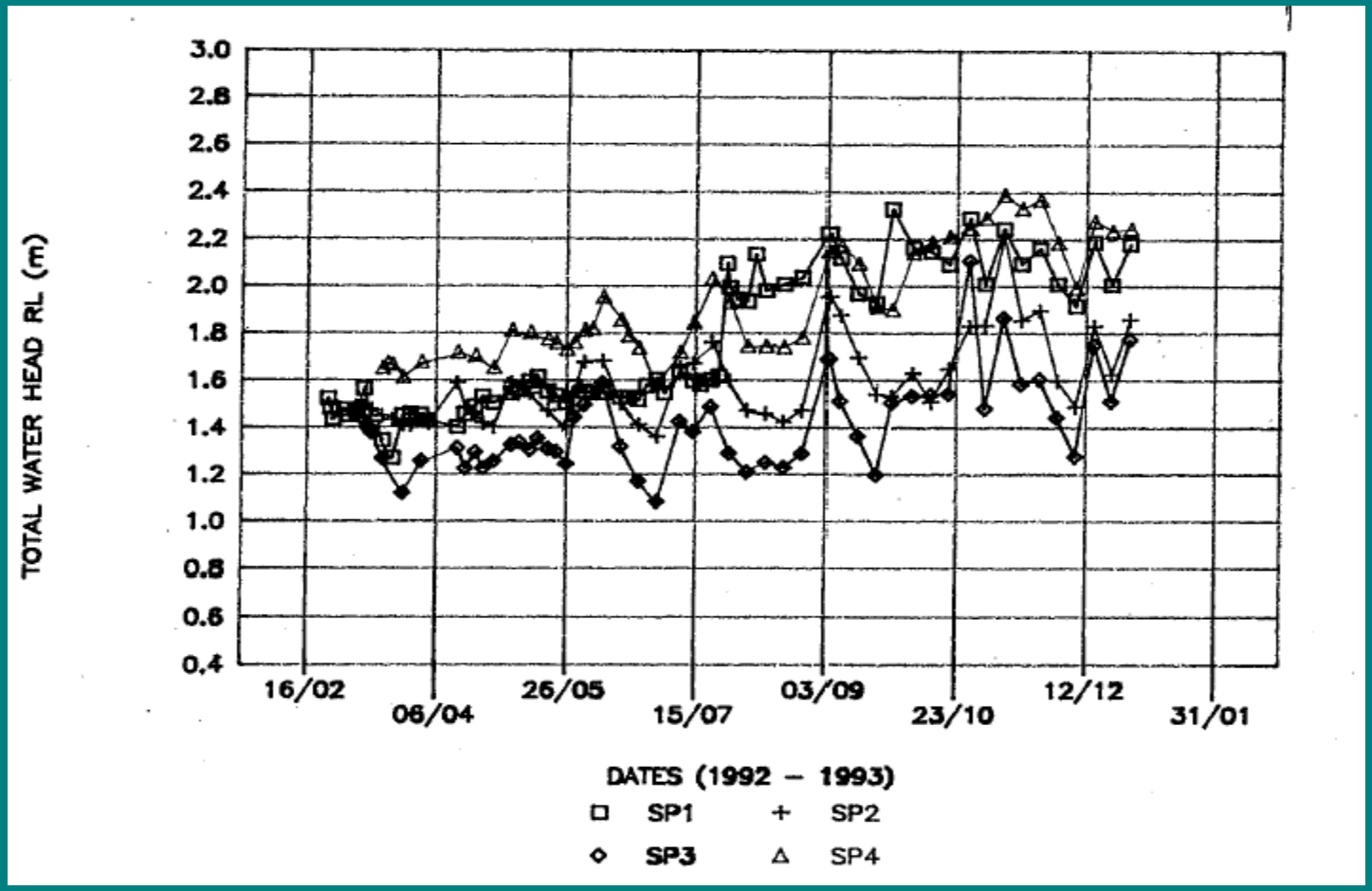
Consistency	SPT “N” Values	Cu Range (kPa)
Very soft	0 - 2	0 -12.5
Soft	2 - 4	12.5 - 25
Medium stiff	4 - 8	25 - 50
Stiff	8 -15	50 -100
Very stiff	15 - 30	100 - 200
Hard	30 and greater	200 and greater

For granular (coarse) soils the following method of relative density is used:

Relative Density	SPT "N" Values
Very loose	0 – 4
Loose	4 – 10
Medium dense	10 – 30
Dense	30 – 50
Very dense	50 and greater

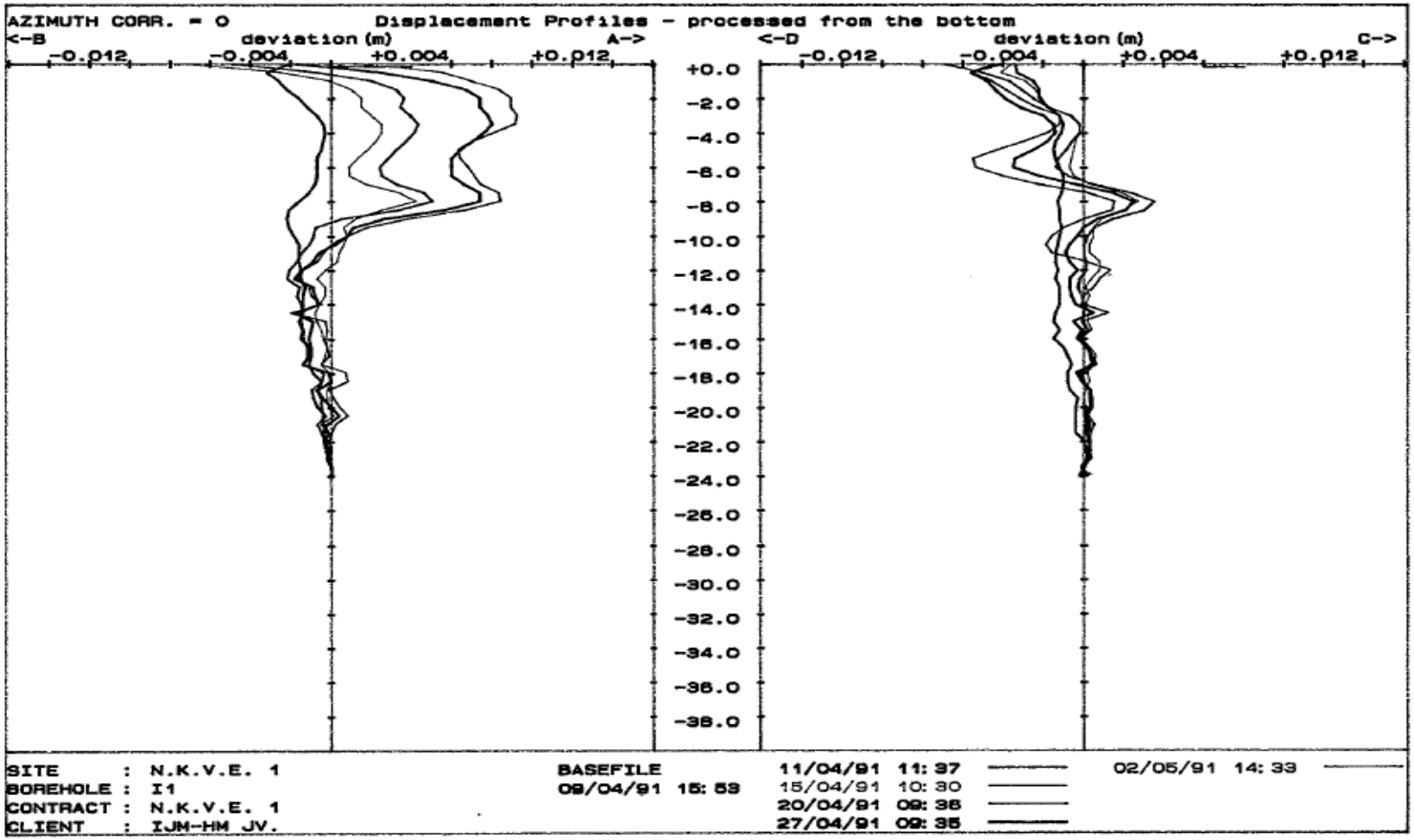
Data collection, processing and presentation

Standpipe Piezometer



Data collection, processing and presentation

Inclinometer



Thank You