Land Transport Authority

CONTRACT T305

CONSTRUCTION OF KATONG PARK STATION AND TUNNELS FOR THOMSON EAST COAST LINE

METHOD STATEMENT FOR K-CELL TEST FOR PRELIMINARY TEST PILES

TEC

Shanghai Tunnel Engineering Co (Singapore) Pte Ltd

A				
-	Issued for LTA's Approval	**SAMBO E&C**	**THAM KOK WENG**	**YOON SUK IL**
Issue	Description	Prepared by	Checked by	Approved by
Document No. **T305/MS/0008/A**			**Date Submitted: 06/06/2016**	

METHOD STATEMENT

No. MS-20160601-RV00

CONSTRUCTION OF KATONG PARK STATION AND TUNNELS FOR THOMSON-EAST COAST LINE(CONTRACT T305)

BORED PILE TESTING WORKS

PROPOSED METHOD STATEMENT FOR INSTALLATION AND LOAD TESTING OF PRELIMINARY TEST PILES(PTP-01)

Date	Prepared for	Attention
1th June 2016	**SAMBO E&C**	Choi Byoung Jin

KFLT-Cell Pte Ltd
19 Jalan Tukang Singapore 139965
Telephone : (+65)6324 9080
Fax : (+65)6324 9081
E-mail : ksi0319@naver.com

TABLE OF CONTENTS

APPENDIX

1.0 BACKGROUND

As shown in Figure 1.1, both test piles for Thomson-Eastern Coast Line T305 (hereafter referred as Project) are very closely located to high traffic main road and densely populated residential area and also both testing sites are quite narrow and space-constrained. In selecting the test method, these fore-mentioned factors are important and needed to be considered with utmost priority.

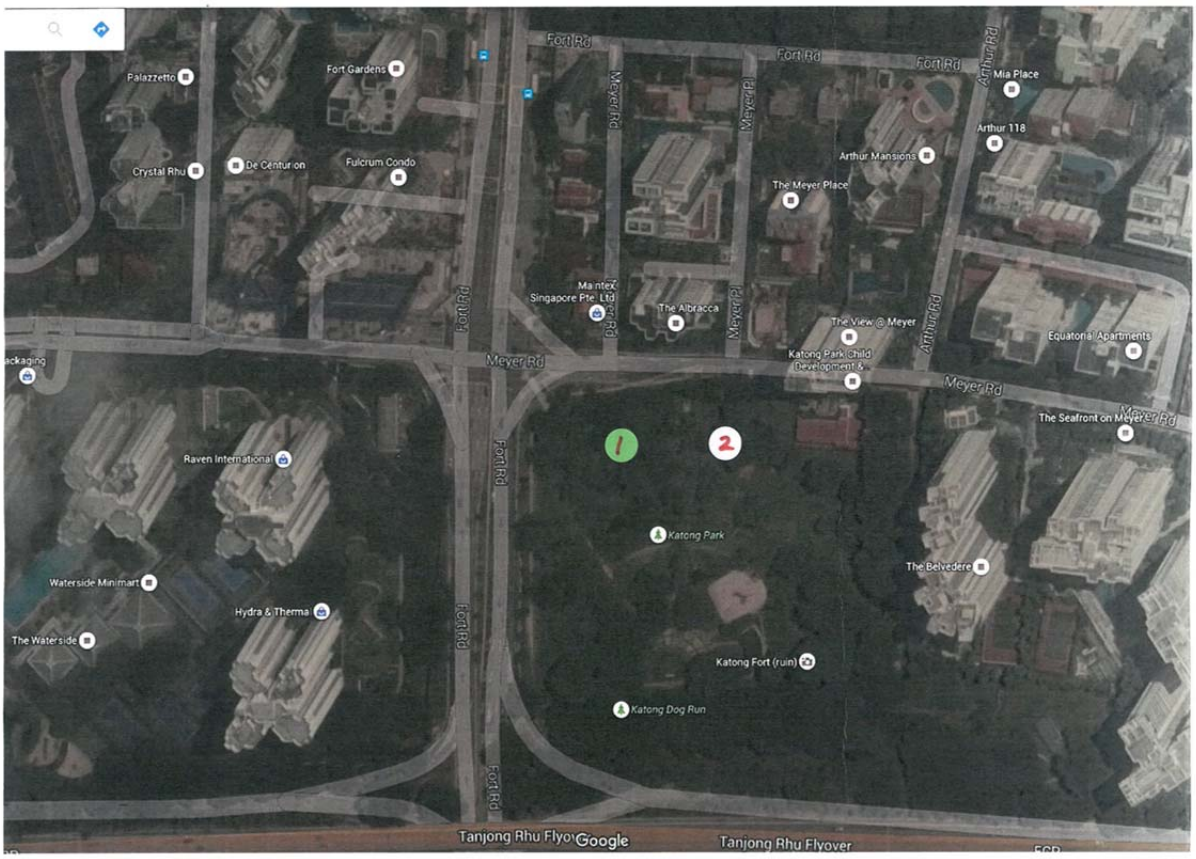


Figure 1.1 Layout of the Site

A comparison matrix in figure 1.2 is showing some of features, advantages & disadvantage of each different test methods that available in Singapore. According to the table, it is clearly judged that the bi-directional test method is most suitable for this project as it well practicable at even narrow space with minimal risks whereas, conventional kentledge type which involves piling-up the concrete block to the height is found to be not suitable for the project in terms of safety and constructability at such limited allowable space along the road way and residential area.

ITEM	Kentledge Test Method	Bidirection Test Method		Statnamic Test Method
		K-Cell Method	O-Cell Method	
Cross-Sectional View				
Photoes				Infeasible
Preliminary Load Test	Feasible	Feasible	Feasible	
Working Load Test	Feasible	Feasible	Feasible	Feasible
Features	● Most conventional method and easy to adopt ● Difficult for Test load higher than 4000ton	● Deciding the location of test device on test pile is critical	● Deciding the location of test device on test pile is critical	● Measuring strain of pile head arise from blast loading
Advantages	● Most conventional method and easy to adopt ● Same direction with loading of upper structure	● A completed equipment set, safe, adoptable at narrow space ● No connection of hydraulic hose is required hence easy to secure space for concrete casting	● Safe method, adoptable at narrow space ● High International reputation	● Test period is very short
Disadvantages	● Relatively unsafe, large space is required ● Inpracticable if bearing capacity of soil is not sufficient	● Cost is bit high for Test load less than 1000ton	● Cost is bit high for Test load less than 1000ton ● On-site Fabrication is required	● Risks associated with blasting works ● Traffic and pedestrian control for 10m radious around the test is required
Remark				

Figure 1.2 Comparison Table

2.0 INTRODUCTION

K-cell is used in Bored pile and Barrette for ultimate load test / working load test. This method shall also be used in conducting the compression load test for piles as required for this project.

2.1 PURPOSE OF THIS TEST

The purpose of this test is as follows:

A. Bi-directional Pile load test
   - Evaluation of the skin friction at the pile element from the K-Cell to pile top or cut off level
   - Evaluation of the bearing capacity (skin friction plus end bearing) at the pile element from the K-Cell to pile toe
   - Drawing Equivalent top-loaded & settlement chart and evaluation of the chart

B. Load Transfer distribution test
   - Drawing chart of load distribution according to depth
   - Calculation Unit Skin friction as the stratums
   - Calculation Unit End bearing of the pile toe.

2.2 TEST LOCATION

The test location was shown in Figure 2.1.

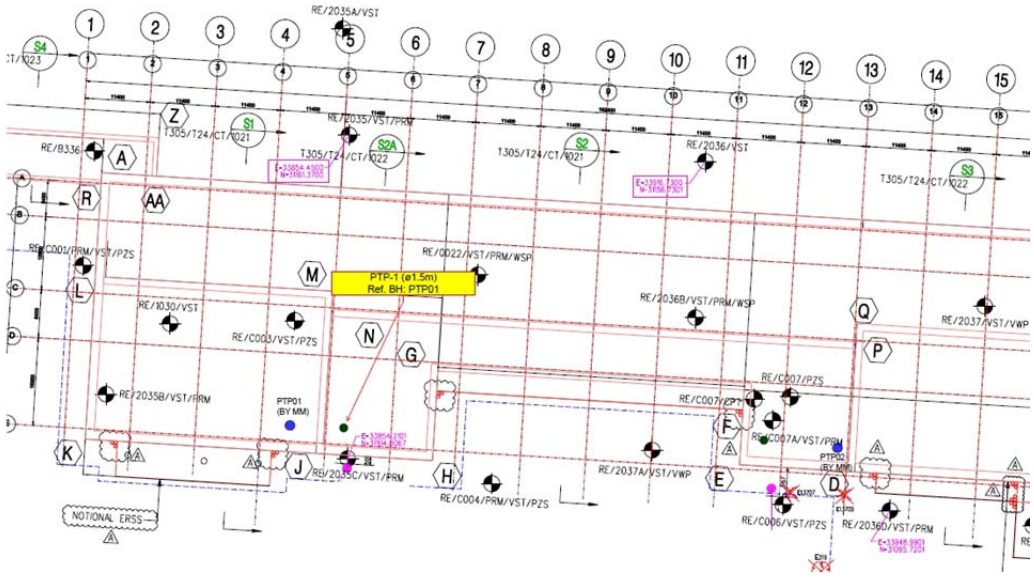


Figure 2.1 Construction Site Location

2.3 TEST PILE REQUIREMENT

Test Pile requirement as follows:

BORED PILE

Items	PTP 01(BORED PILE)
Test Type	Preliminary Test
Pile Reference	-
Pile Size	D1,500
Borehole Reference	PTP01
Ground Level	102.00 mRL
Toe level	39.00 mRL
Cut off level	102.00 mRL
Designed Working Load(WL)	14,800 kN
Test load(2.5×WL)	37,000 kN
Available Equivalent top load test capacity	40,000 kN

3.0 TEST PILE CONSTRUCTION PROCEDURE

K-cell instrumentation will be connected with the approved level by the consultant to the rebar cage. (See attached Figures 1 and 2 of the typical installation sequence, Appendix A). KFLT (Korea Foundation Load Test) personnel will supervise all the operations of the K-cell. Piling contractor shall ask/coordinate KFLT with regards to the reinforcement cage to avoid unnecessary conflict/damages.

Concrete spacers or Steel spacers will be placed at horizontally 2.0m from center cage face and 4.0m center to center vertically during lowering the cage till its designated sitting position at the pile toe ensuring the verticality of K-cell attached to the rebar cage.

Lapping the cage to another cage is repeated with the same procedures as the first and rested on the guide wall until all the cages together with the K-cell are lowered to the required depth.

After steel cage installation together with the attached K-cell, introduce sufficient lengths of tremie pipes with guide funnel to prepare for the tremie concrete casting.

Pile concreting should be extended above the ground at least 500mm for the connection & monitoring of all the instrumentation used from K-cell. Sufficient concrete flow hole provided. (Refer to Appendix A & B – K-cell and instrumentation positioning for the tremie pipe diameter).

Approved supplier will supply the approved design Tremie Concrete to ensure the flow of concrete around the K-cell.

The experienced cube person will perform the slump test as well as the making of concrete cube to test in the laboratory. Cube test result will be provided for the test report after the Ultimate load test has been done using K-cell.

3.1 K-CELL INSTALLED ON TEST PILE

K-cell assembly (Refer to Appendix B and Appendix D on Instrumentation Elevation placement for K-CELL size) shall be attached to the rebar cage of Test Pile on site. K-cell shall follow the approved design calculation & elevation level by the consultant, Appendix C.

K-cell shall be fabricated in the factory and deliver on site. The Reinforcement terminated from top & bottom in the area of K-cell shall be bolted & supervise by the K-cell personnel to ensure all works are properly done.

3.2 K-CELL AND INSTRUMENTATION POSITIONING

The following table summarizes the details of the test piles and instrumentation:

Items	PTP 01
Test pile properties	Bored Pile
Test type	Preliminary Test
Pile size(D)	1,500mm
Designed load(WL)	14,800 kN
Test load(2.5×WL)	37,000 kN
Platform elevation	102.000 mRL
Testing elevation	102.000 mRL
Pile design cut-off level	102.000 mRL
Concrete cast elevation	102.000 mRL
Water table elevation	
Pile toe elevation proposed	39.000 mRL
Concrete cover	75mm
Size and numbers of vertical rebar	28H40+28H20
Size of link reinforcement	H13-300
Test Pile Instrumentation	
K-cell assembly Break Zone elevation	43.500 mRL
Resistance of upward above K-cell	19,262 kN
Resistance of downward blow K-cell	19,439 kN
K-cell quantities and diameters	2nos.OD425mm
Telltale casing on upper plate of K-cell	3 nos.
Extensometer of K-Cell	3 nos.
Telltale casing of pile toe	3 nos.
Displacement transducer of rebar cage top	2 nos.
Strain gauges	4nos.x 23 Layer = 92 nos.

3.3 K-CELL INSTRUMENTATION

K-cell has been calibrated by the manufacturer prior to shipping. Calibrated certification of K-cell hydraulic jack is provided in Appendix F, while the rest of the vibrating strain gauge, pressure gauge and leveling instruments will be provided on site to check before the commencement of testing.

Telltales for measuring the compression of pile above the K-Cell, the movement of pile toe and the upper movement of pile debonding level have to protrude from top of pile with an extension above ground level. In the case using extensometers in the test pile, the cables of extensometer attached on K-Cell will do as telltales.
The movement of pile head will be measured by the displacement transducers attached on reference beam.

The following table summarizes quantities of telltales and extensometers:

Items	Quantity	Direction of movements
Displacement transducer of Pile Top	2 nos.	↑
Telltale on upper plate of K-cell	3 nos.	↑
Expansion displacement transducer of K-Cell	3 nos.	↕
Telltale of pile toe	3 nos.	↓

In the case using Vibration Wire Strain Gauges (VWSGs) to assess load distribution along the pile shaft above and below the K-cell, the Instrumentation schematic layout can be seen in Appendix E, and further indicated in shop drawing to be submitted separately.

4.0 K-CELL LOAD TEST PROCEDURES

Ultimate load test shall be followed after the required days (3 weeks or 25days) of curing if high grade concrete was used for the concreting as supply by the main contractor discretion, from the tested concrete cubes of 21 days should exceed the required strength of concrete as well as the development of soil bonding to the test pile.

In this test, the Loading Cycle for preliminary will be only 3 Cycle to 250% of Working Load. Unloading will be in 50% decrements following the LTA M&W Specification loading schedule. The Loading Cycle can be found in Appendix G.

Single-level Test Procedure

The K-cell is internally high pressurized. It will create the upward force on the shaft in upper side shear and an equal. Downward force is combined in lower side shear or end bearing.

The K-cell load is determined by relating the applied hydraulic pressure in downward end bearing or side shear which resists downward movement and loads the pipe above the K-cell in upward side shear which resists upward movement (negative shear).

The load shall be removed and the testing has been finished once either one of the following situations occurs:

1) The test load has been applied
2) The maximum travel of the K-cell has been reached (150 mm)
3) The maximum rated K-cell capacity has been reached
4) Ultimate capacity of the pile above or below the K-cell location has been reached.

5.0 FIELD MEASUREMENTS

Measurement before load test

All strain gauges will be measured and recorded immediately **after cage installation but prior to concreting, immediately after concreting** and **prior to load testing.**

Measurement on load testing

In this test, a reference frame will be supported sufficiently far from the test pile center of 3D.

2 nos. LVWDT fixed on reference beam will be used in measuring the top of pile upward vertical movement. Compression movement from K-cell to pile top will be measured by each 3 nos. LVWDT's extend to the top of pile with the telltale & extensometers.

The expansion movement of K-Cell will be measured by 3 nos. extensometer attached K-Cell assembly. Reading of measurement shall be to the nearest 0.01mm division.

On the pile shaft, the distribution of strain & skin friction shall be measured by the Strain Gauges.

Movement measurement shall provide by the following:

1) Movement of Pile Top (measured by LVWDTs attached on reference beam);
2) Pile Compression (measured by telltale rods set from top of K-cell);
3) Upward Movement of K-cell (calculated as Pile compression is added to the movement of Pile TOP);
4) K-cell expansion (measured directly by LVWDTs attached between top and bottom K-cell bearing plates);
5) Downward Movement of K-cell (calculated as measured by expansion transducer minus Upward Movement of K-cell);
6) Downward Movement of Pile Toe (calculated as the movement of pile top is subtracted from the movement measured by telltale road attached near the pile toe);
7) Compression Of pile segment below K-Cell (calculated as Downward Movement of Pile Toe is subtracted from Downward Movement of K-cell)

All the LVWDTs and VWSGs are connected to the Data logger. The logger is connected to a laptop computer. This arrangement allows LVWDTs and strain gauges readings to be recorded simultaneously and stored automatically at 2 minute intervals during the test (depending on the number of instruments being read).

The use of a data logger will allow for greater accuracy than manual readout box methods. All readings are rounded up or down to the nearest 0.01mm for reporting.
Ultimate load test shall be done by a qualified & competent KFLT Engineers.

6.0 TEST RESULT REPORT

After load test completion, the raw data shall be provided. The initial/summary report shall be provided within 7 working days. Full report shall be send within 10 working days.

7.0 QUALITY ASSURANCE

K-cell Installation is to provide and lessen the failure of test requirement in piling works. K-cell has been calibrated by the manufacturer in a maximum capacity and carefully checking prior to shipment.

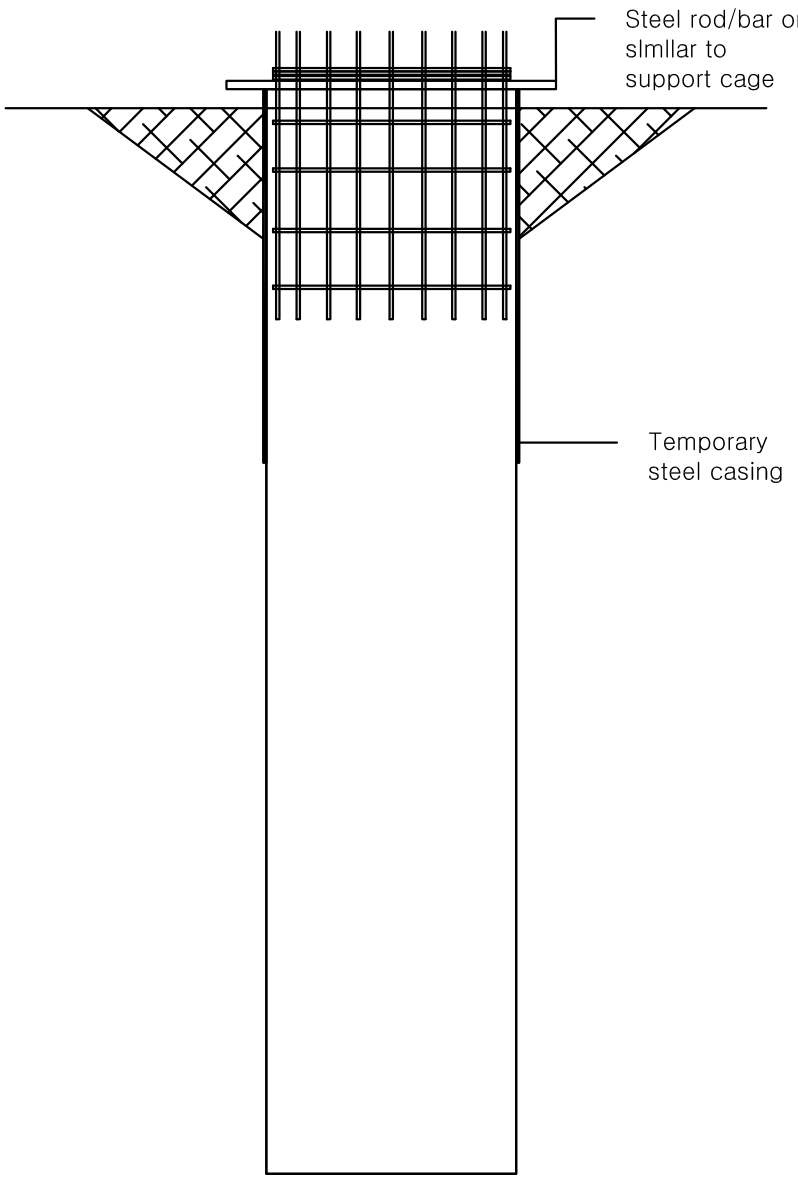
All instruments are certified by the manufacturer in an accurate & functionalities are in good order.

KFLT workmanship will provide the highest quality and experienced personnel deploy on site where assigned to ensure the work has been properly executed.

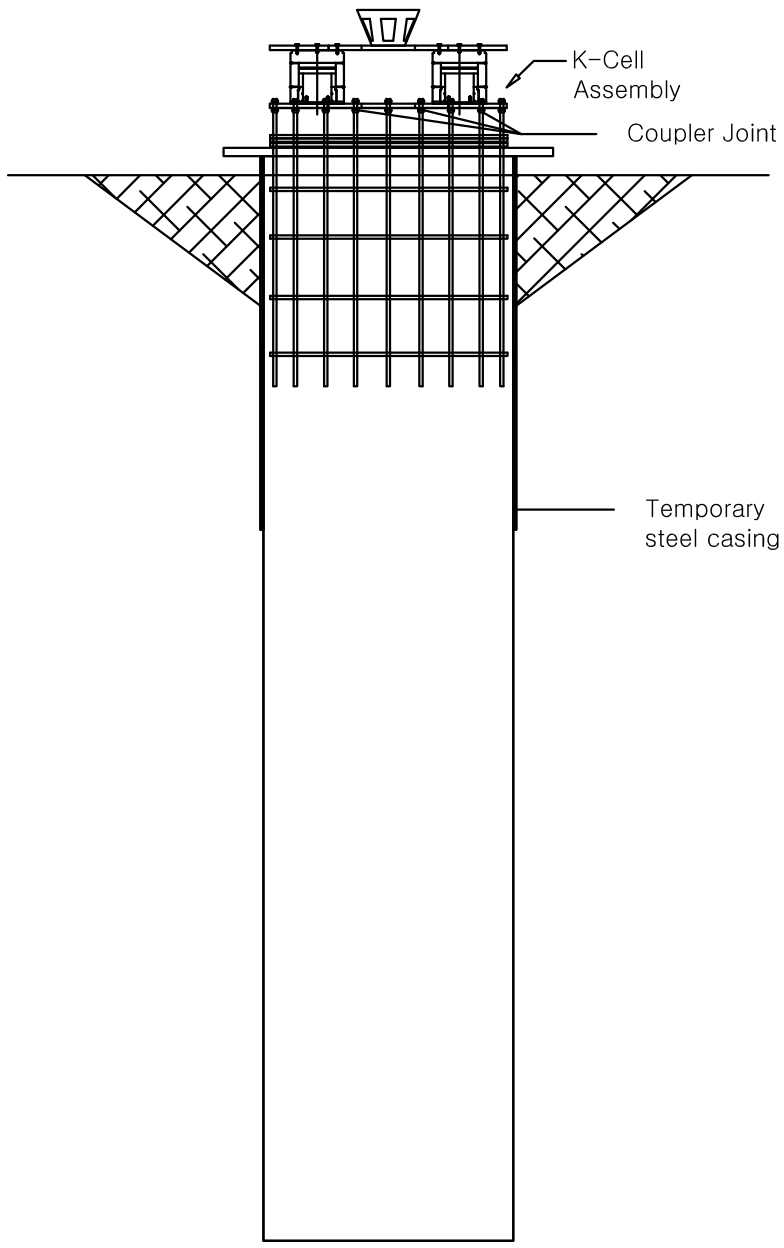
Appendix A

Typical Installation Sequence

①Lower Rebar Cage Install



②K-Cell Join



Project Name : KATONG PARK STATION & TUNNELS FOR THOMSON-EAST COAST LINE(T305)

KFLT-Cell Pte. Ltd

Drawing Title :

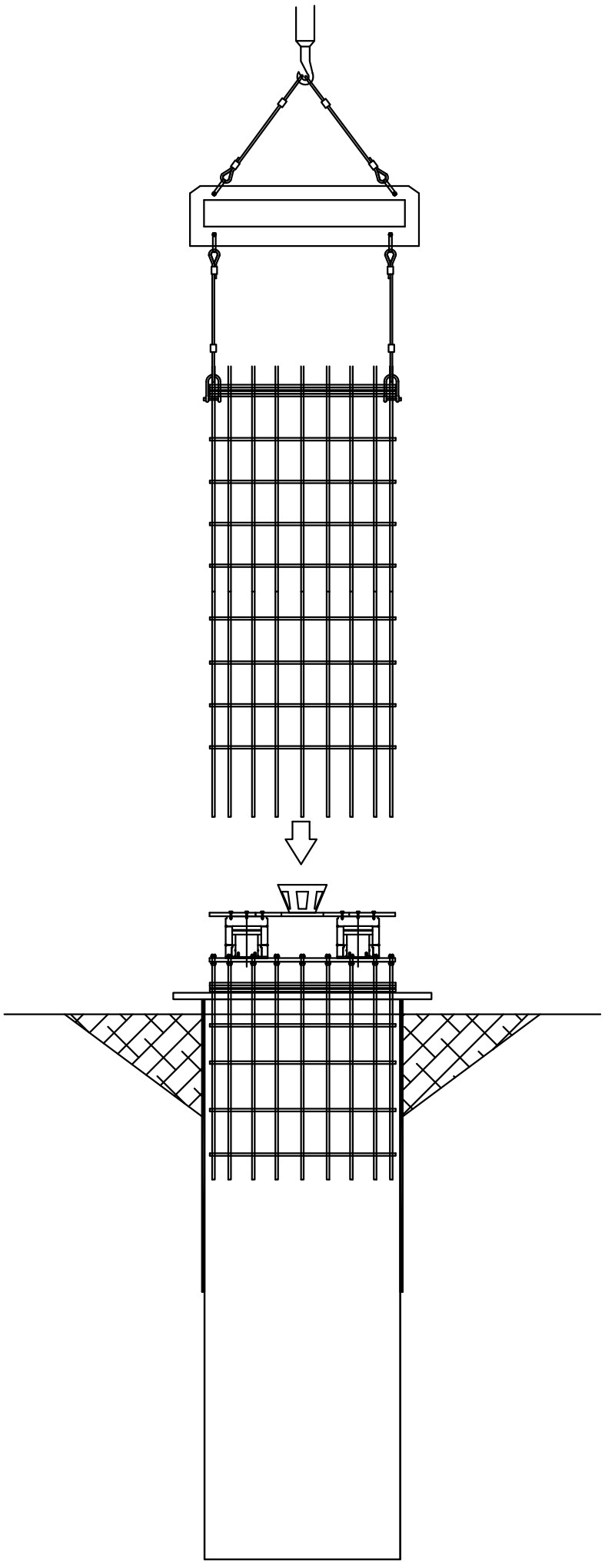
Typicall Installation Sesquence

Fig 1 of 4

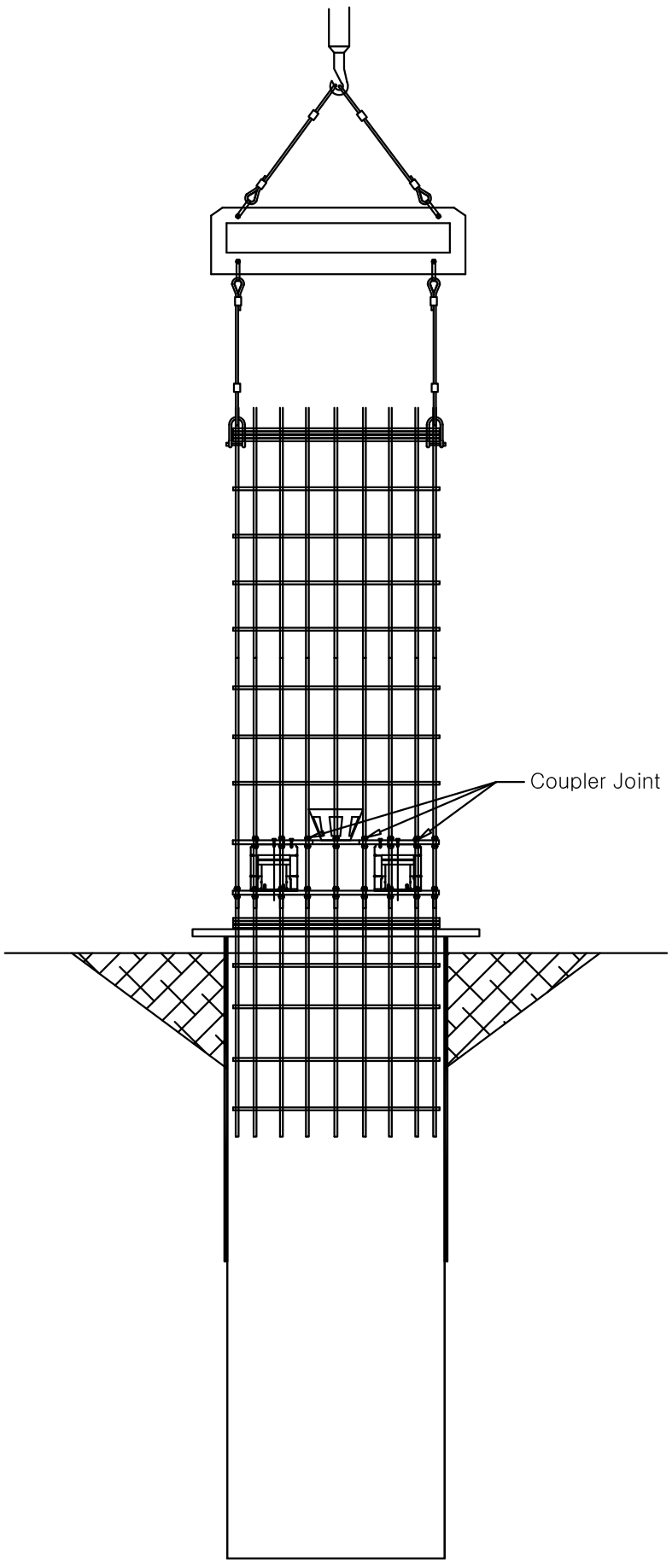
19 Jalan Tukang Singapore 619265
Tel : 6324-9080(Extension 136)
E-mail : ksi0319@naver.com
Fax : 6924-9081

Issue Date :	Drawn By :	Check By :
30th Apr 2016	SOE. T. H. A.	KIM. S. I.

③Upper Rebar Cage Join (1)



④Upper Rebar Cage Join (2)



Project Name : KATONG PARK STATION & TUNNELS FOR THOMSON-EAST COAST LINE(T305)

KFLT-Cell Pte. Ltd

Drawing Title :

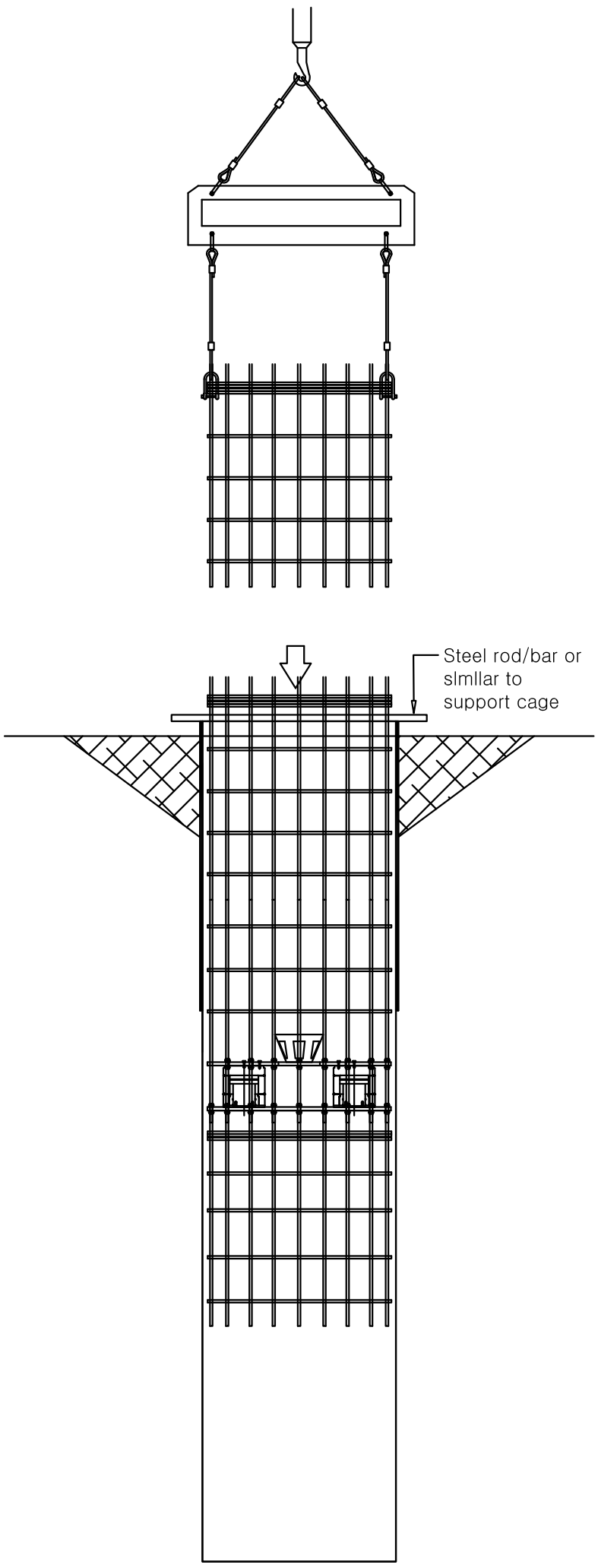
Typicall Installation Sesquence

Fig 2 of 4

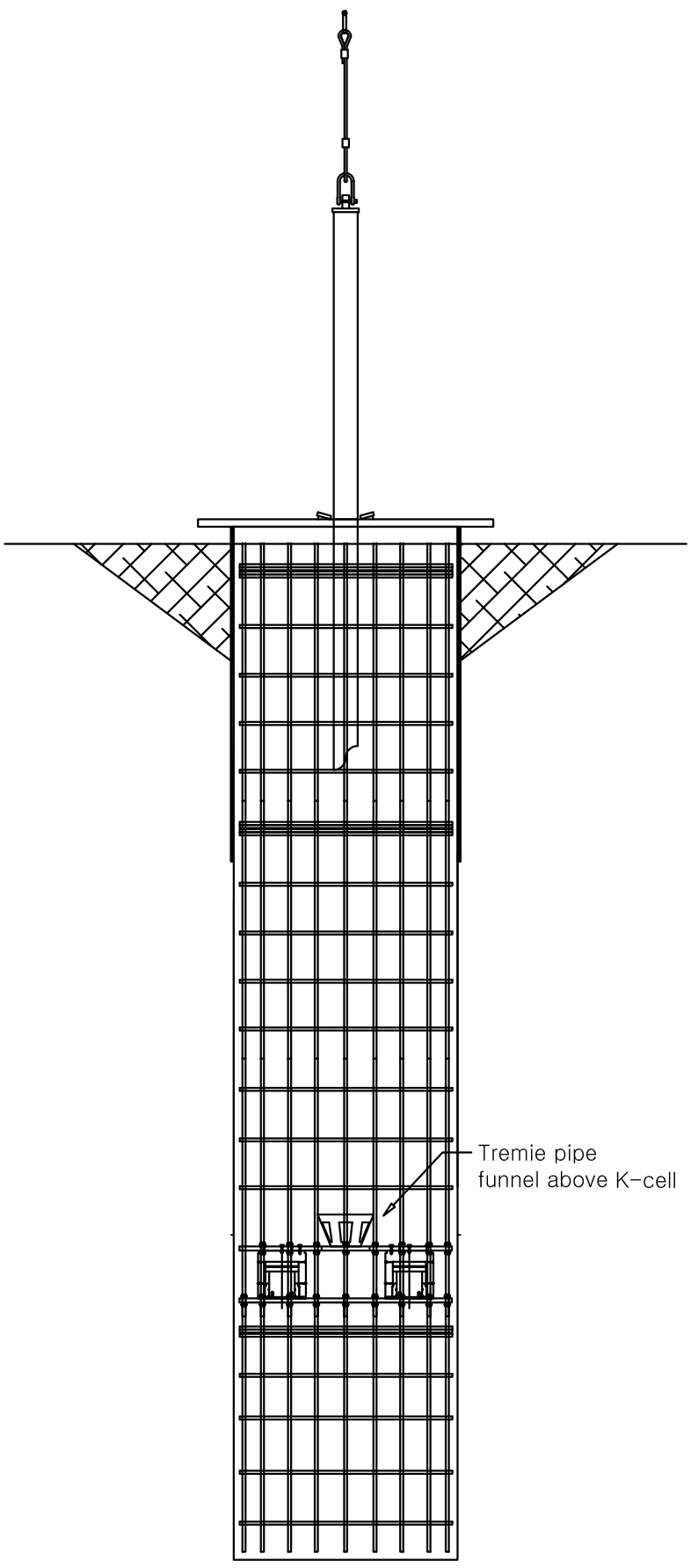
19 Jalan Tukang Singapore 619265 E-mail : ksi0319@naver.com
Tel : 6324-9080(Extension 136) Fax : 6924-9081

Issue Date :	Drawn By :	Check By :
30th Apr 2016	SOE. T. H. A.	KIM. S. I.

⑤Upper Rebar Cage Join (3)



⑥Tremie Pipe Install



Project Name : KATONG PARK STATION & TUNNELS FOR THOMSON-EAST COAST LINE(T305)

KFLT-Cell Pte. Ltd

Drawing Title :

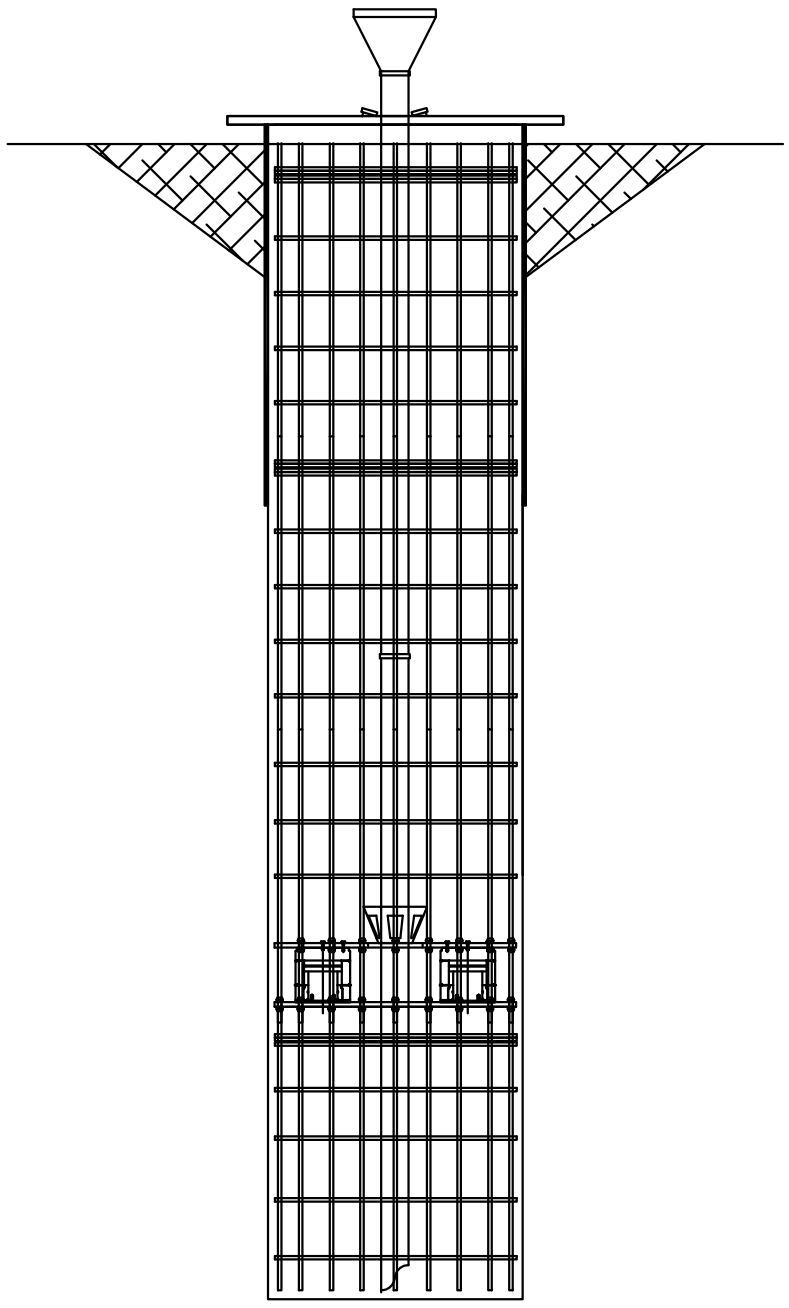
Typicall Installation Sesquence

Fig 3 of 4

19 Jalan Tukang Singapore 619265 E-mail : ksi0319@naver.com
Tel : 6324-9080(Extension 136) Fax : 6924-9081

Issue Date :	Drawn By :	Check By :
30th Apr 2016	SOE. T. H. A.	KIM. S. I.

⑦Concrete Pure Ready



Project Name : KATONG PARK STATION & TUNNELS FOR THOMSON-EAST COAST LINE(T305)

KFLT-Cell Pte. Ltd

Drawing Title :

Typicall Installation Sesquence

Fig 4 of 4

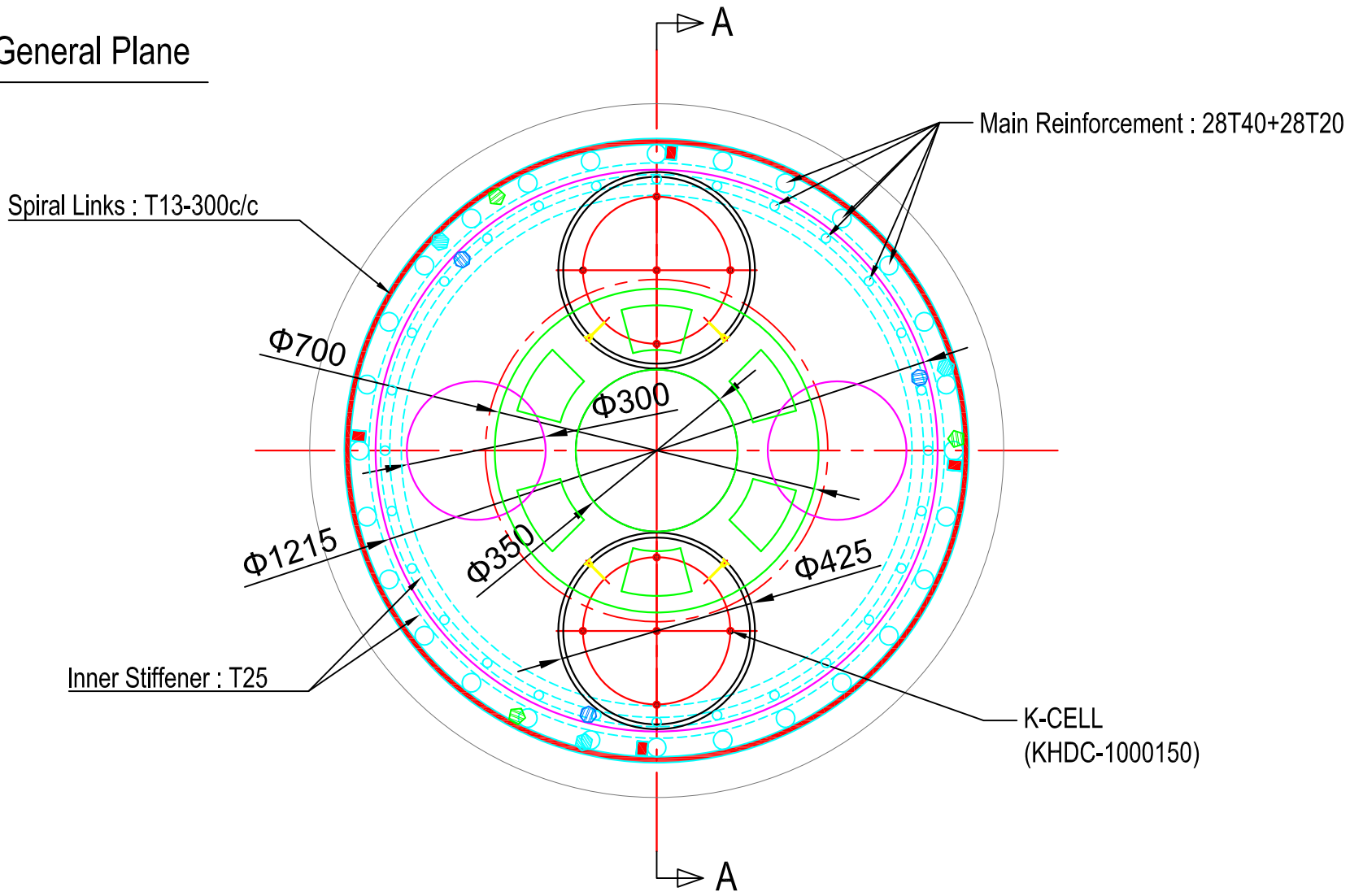
19 Jalan Tukang Singapore 619265 E-mail : ksi0319@naver.com
Tel : 6324-9080(Extension 136) Fax : 6924-9081

Issue Date :	Drawn By :	Check By :
30th Apr 2016	SOE. T. H. A.	KIM. S. I.

Appendix B

K-CELL Assembly Illustration

General Plane



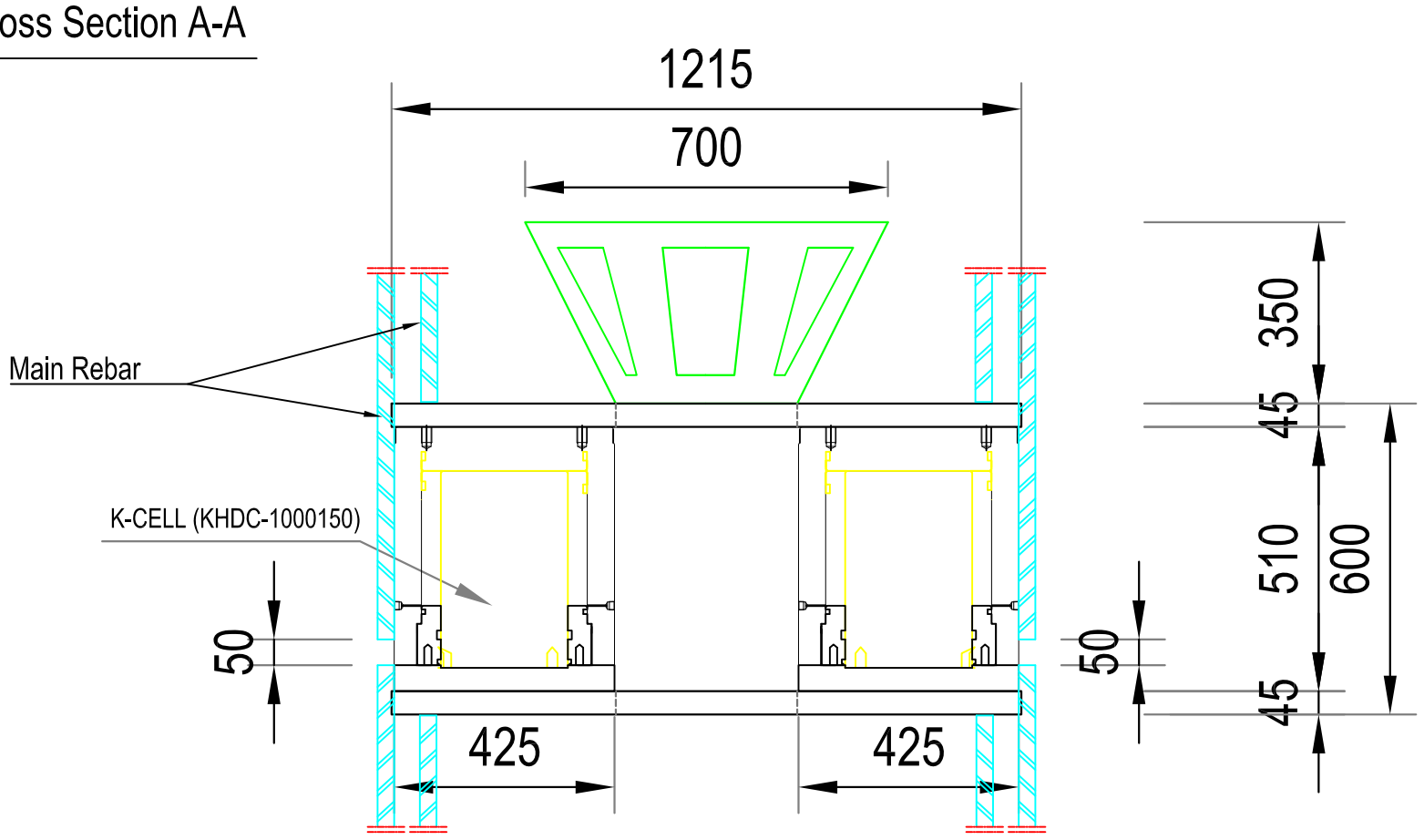
Rod Extensometers of Upper (no) : 3

Rod Extensometers of Pile Toe (no) : 3

Extensometers of K-CELL (no) : 3

Strain Gauge as layer (no) : 4

Cross Section A-A



Project Name : CONSTRUCTION OF KATONG PARK STATION & TUNNEL FOR THOMSON-EAST COAST LINE(T305)

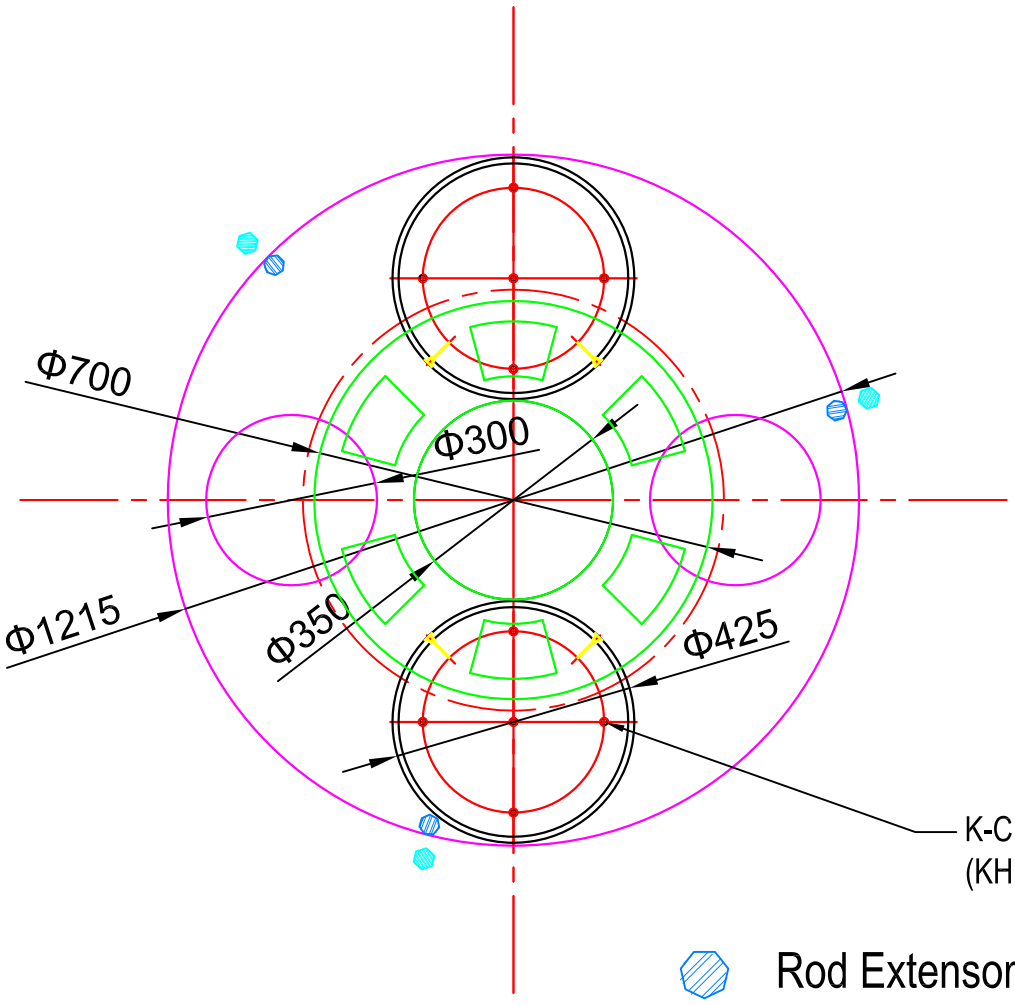
KFLT-Cell Pte. Ltd

19 Jalan Tukang Singapore 619265
Tel : 6324-9080(Extension 136)
E-mail : ksi0319@naver.com
Fax : 6924-9081

Drawing Title : K-CELL ASSEMBLY DRAWING
FOR PRELIMINARY LOAD TEST FOR PTP01
Φ1,500mm (10MN X 2 nos.)

Issue Date :	Drawn By :	Check By :
28th Apr 2016	SOE. T. H. A.	KIM. S. I.

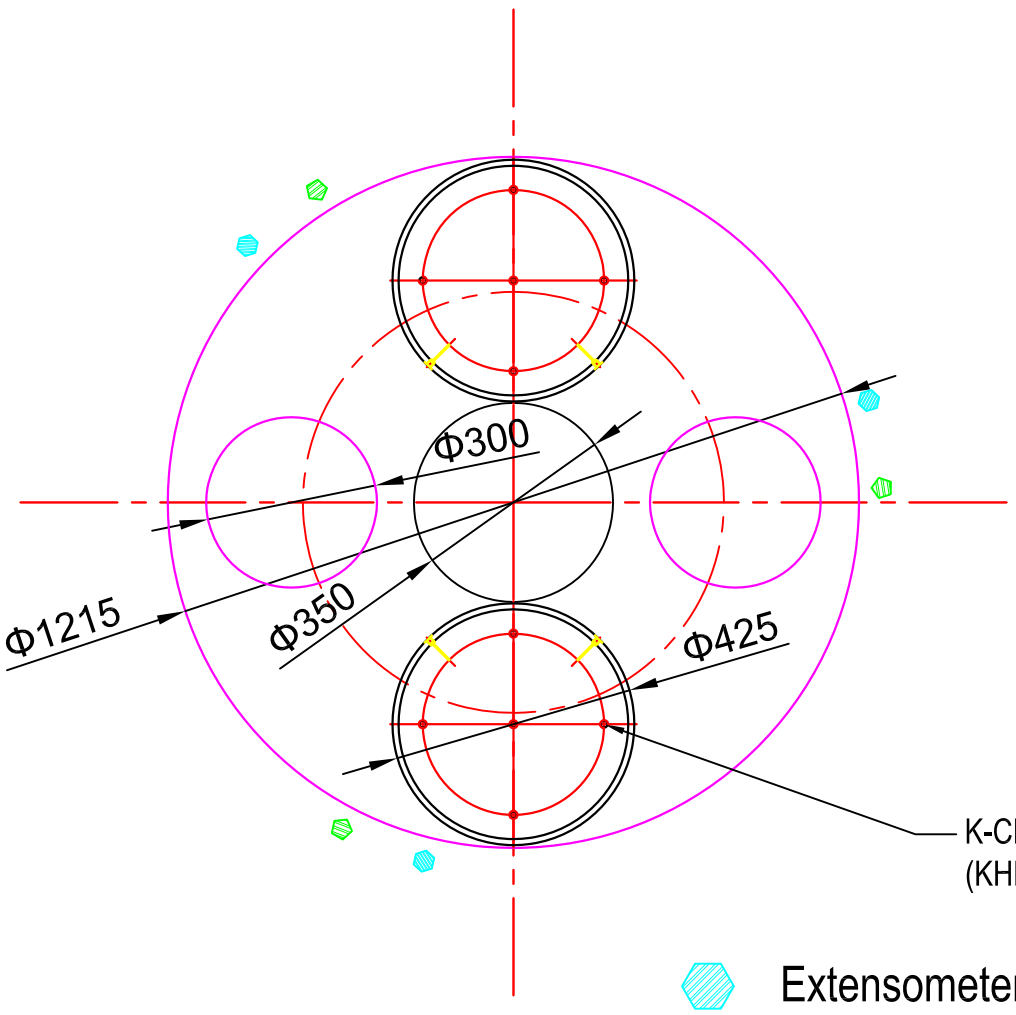
Upper Plate



Rod Extensometers of Upper (no) : 3

Extensometers of K-CELL (no) : 3

Lower Plate



Extensometers of K-CELL (no) : 3

Rod Extensometers of Pile Toe (no) : 3

Project Name : CONSTRUCTION OF KATONG PARK STATION & TUNNEL FOR THOMSON-EAST COAST LINE(T305)

KFLT-Cell Pte. Ltd

19 Jalan Tukang Singapore 619265 E-mail : ksi0319@naver.com
Tel : 6324-9080(Extension 136) Fax : 6924-9081

Drawing Title :

PLANE OF UPPER AND LOWER PLATE
FOR PRELIMINARY LOAD TEST FOR PTP01

Issue Date :	Drawn By :	Check By :
28th Apr 2016	SOE. T. H. A.	KIM. S. I.

Appendix C

K-CELL Level Calculation and Soil Log

CONSTRUCTION OF KATONG PARK STATION & TUNNELS FOR THOMSON-EAST COAST LINE(T305)

Reference Number : PTP-01 (Borehole No. PTP01)

Date : 2016-06-01

Bored Pile Requirements :		
Working Load - Compression	14,800	kN
Required Design Factor of Safety	2.5	
Required Geotechnical Capacity	37,000	kN

Pile Type	BORED PILE	
Size	1,500 mm	
Ground Level	102.00	mRL
Cut-off Level	102.00	mRL
Toe Level	39.000	mRL

Depth (GL. -m)		Elevation Level (mRL)		Thickness (m)	GEOC	SPT		Skin friction or End bearing	Ks or Kb	Unit Skin Friction/Unit End bearing	Ultimate Skin Friction/ End bearing	Buoyant Weight	Ultimate Skin Friction of Upward	Ultimate Bearing Capacity of Downward	
From	To	From	To			N Value	PE.(cm)			(kN/m^2)	(kN)	(kN)	(kN)	(kN)	
0.00	2.00	102.00	100.00	2.00	-	N.A.	300	Skin Fric.			0	47	47	37,332	
2.00	9.00	100.00	93.00	7.00	FILL	7	300	Skin Fric.	2.5	17.5	577	164	788	37,332	
9.00	18.00	93.00	84.00	9.00	M	1	300	Skin Fric.	2.5	10.0	424	211	1,423	36,754	
18.00	21.00	84.00	81.00	3.00	E	1	300	Skin Fric.	2.5	0.0	0	70	1,493	36,330	
21.00	24.00	81.00	78.00	3.00	F2	0	300	Skin Fric.	2.5	49.6	701	70	2,264	36,330	
24.00	36.00	78.00	66.00	12.00	M	0	300	Skin Fric.	2.5	20.0	1131	281	3,676	35,629	
36.00	39.20	66.00	62.80	3.20	E	3	300	Skin Fric.	2.5	0.0	0	75	3,751	34,498	
39.20	42.00	62.80	60.00	2.80	F1	18	300	Skin Fric.	2.5	82.9	1094	66	4,911	34,498	
42.00	48.00	60.00	54.00	6.00	F1	1	300	Skin Fric.	2.5	93.9	2655	140	7,706	33,404	
48.00	51.00	54.00	51.00	3.00	O(B)	100	280	Skin Fric.	2.5	250.0	3534	70	11,311	30,748	
51.00	57.00	51.00	45.00	6.00	O(B)	85	300-250	Skin Fric.	2.5	212.5	6008	140	17,459	27,214	
57.00	57.50	45.00	44.50	0.50	O(A)	100	220	Skin Fric.	2.5	250.0	589	12	18,060	21,206	
57.50	58.00	44.50	44.00	0.50	O(A)	100	220	Skin Fric.	2.5	250.0	589	12	18,661	20,617	
58.00	58.50	44.00	43.50	0.50	O(A)	100	220	Skin Fric.	2.5	250.0	589	12	19,262	20,028	K-Cell
58.50	63.00	43.50	39.00	4.50	O(A)	100	220-180	Skin Fric.	2.5	250.0	5301	105	24,668	19,439	
63.00		**39.00**				100		End Bearing		8,000	14,137	1,474		14,137	

			Allowable Geotecnical Capacity, Qa			
Pile length above K-Cell	58.50	m	**1. (Qb + Qs)/(1.5X1.35)**	=	**18,435**	**kN**
Pile Length below K-Cell	4.50	m	**2. (Qb/1.7 + Qs/1.4)/(1.5)**	=	**16,589**	**kN**
Total Pile Length	63.00	m	**3. Qs/1.5**	=	**15,463**	**kN**
Total Skin Resistance, Qs	23,194	kN	**Qt/Qa (min)**	=	**2.50**	
Total Base Resistance, Qb	14,137	kN	**Qt/Qa (max)**	=	**2.10**	

Resistance Required Above and Below	18,500	kN	K-cell Assembly	10,000kN X 2 nos. =	20,000	kN
Estimate soil resistance above K-Cell Level	**19,262**	kN OK!	Gross available test capacity for testing above K-Cell level		20,000	kN
Estimate soil resistance below K-Cell Level	**19,439**	kN OK!	Gross available test capacity for testing below K-Cell level		20,000	kN
Total bearing capacity of the pile	**38,700**	kN	Available - Equivalent top load test capacity		40,000	kN

PROJECT NO:	SIL/S7578/16/SI
LOCATION:	Katong Park

BOREHOLE NO:	PTP01
NORTHING:	
EASTING:	
REDUCED LEVEL:	Existing G.L

IN-SITU TESTS DATA

SPT N VALUE: 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100

SPT(N)/mm	REDUCED LEVEL(m)	DEPTH (m)	SAMPLE TYPE	THICKNESS (m)	GEOLOGICAL CLASSIFICATION	DESCRIPTION
		1				Soft Reddish Brown Mottled Light Grey Slightly Gravelly Sandy SILT with hardcore and tree roots (MADE GROUND)
	-2.00	2		2.00	MG	
4/300		3	SPT1			Very Loose To Loose Light Grey and Dark Brown Slightly Gravelly Fine To Coarse grained Silty SAND (Reclaim SAND)
		4				
		5				
10/300		6	SPT2			
		7				
		8				
0/300	-9.00	9	SPT3	7.00	MG	
		10				Very Soft Bluish Grey Marine CLAY with shell fragments and traces of sand Marine Member (KALLANG FORMATION)
		11				
1/300		12	SPT4			
		13				
		14				
1/300		15	SPT5			
		16				
		17				
1/300	-18.00	18	SPT6	9.00	M	
		19				Very Soft Brownish Dark Grey Peaty CLAY with decayed wood and organic matter Transitional/Estuarine Member (KALLANG FORMATION)
		20				

SPT1:3.00-3.45m 1/0/1/1/1/1

SPT2:6.00-6.45m 1/3/2/3/2/3

SPT3:9.00-9.45m 0/0/0/0/0/0

SPT4:12.00-12.45m 0/0/0/0/0/1

SPT5:15.00-15.45m 0/0/0/0/0/1

SPT6:18.00-18.45m 0/0/0/0/0/1

Ground Water Observation	Time	BH Depth	CS Depth	Water Depth
Boring Type: Rotary	08:30	68.00	15.00	3.20
DIAMETER(mm): 100.0	17:30	81.50	15.00	6.80

ATT - ATTEMPT MZ,PS,TW,UD
CR - CORE RUN
MZ - MAZIER SAMPLE
PBT - PERMEABILITY TEST
PKT - PACKER TEST
PMT - PRESSUREMETER TEST
PS - PISTON SAMPLE
PZS - CASAGRANDE PIEZOMETER
SPT - SPT N VALUE
TW - THIN WALL PUSH IN
UD - THICK WALL OPEN DRIVE
VST - VANE SHEAR TEST
WSP - WATER STANDPIPE

CLIENT: Shanghai Tunnel Engineering Co (Singapore) Pte Ltd

PROJECT: SI for Contract T305 - Katong Park Station (Thomson-East Coast Line)

LOG OF BORING

GEOTECHNICAL STUDY-FIELD INVESTIGATIONS

CONTRACTOR: Soil Investigation Pte Ltd

LOGGED BY:	DATE OF FIELD WORK
Khin Maung Aye	20/05/16 - 25/05/16
CHECKED BY	SHEET NO
Than Ho	<1>/<5>

PROJECT NO:	SIL/S7578/16/SI
LOCATION:	Katong Park

BOREHOLE NO:	PTP01
NORTHING:	
EASTING:	
REDUCED LEVEL:	Existing G.L

IN-SITU TESTS DATA	SPT N VALUE (10 20 30 40 50 60 70 80 90 100)	SPT(N)/mm	REDUCED LEVEL(m)	DEPTH (m)	SAMPLE TYPE	THICKNESS (m)	GEOLOGICAL CLASSIFICATION	DESCRIPTION
SPT7:21.00-21.45m 0/0/0/0/0/0	•	0/300	-21.00	21	SPT7	3.00	E	
				22				Very Soft Light Grey Spotted Dark Grey Slightly Fine grained Sandy CLAY with traces of peat Alluvial Member (KALLANG FORMATION)
SPT8:24.00-24.45m 0/0/0/0/0/0	•	0/300	-24.00	23 24	SPT8	3.00	F2	
				25				Very Soft Bluish Grey Marine CLAY Marine Member (KALLANG FORMATION)
SPT9:27.00-27.45m 0/0/0/0/0/0	•	0/300		26 27	SPT9			
				28 29				
SPT10:30.00-30.45m 0/0/0/0/0/0	•	0/300		30	SPT10			
				31 32				
SPT11:33.00-33.45m 0/0/0/0/0/1	•	1/300		33	SPT11			
				34 35				
SPT12:36.00-36.45m 0/0/0/1/1/1	•	3/300	-36.00	36	SPT12	12.00	M	
				37				Soft Brownish Dark Grey Spotted Yellow Peaty CLAY with decayed wood and organic matter Transitional/Estuarine Member (KALLANG FORMATION)
SPT13:39.00-39.45m 1/2/3/6/6/3	•	18/300	-39.20	38 39	SPT13	3.20	E	
				40				Medium Dense Light Grey Silty Medium To Coarse grained SAND Alluvial Member (KALLANG FORMATION)

Ground Water Observation	Time	BH Depth	CS Depth	Water Depth
Boring Type: Rotary	08:30	68.00	15.00	3.20
DIAMETER(mm): 100.0	17:30	81.50	15.00	6.80

ATT - ATTEMPT MZ,PS,TW,UD
CR - CORE RUN
MZ - MAZIER SAMPLE
PBT - PERMEABILITY TEST
PKT - PACKER TEST
PMT - PRESSUREMETER TEST
PS - PISTON SAMPLE
PZS - CASAGRANDE PIEZOMETER
SPT - SPT N VALUE
TW - THIN WALL PUSH IN
UD - THICK WALL OPEN DRIVE
VST - VANE SHEAR TEST
WSP - WATER STANDPIPE

CLIENT:
Shanghai Tunnel Engineering Co (Singapore) Pte Ltd

PROJECT:
SI for Contract T305 - Katong Park Station (Thomson-East Coast Line)

LOG OF BORING
GEOTECHNICAL STUDY-FIELD INVESTIGATIONS

CONTRACTOR:
Soil Investigation Pte Ltd

LOGGED BY:	DATE OF FIELD WORK
Khin Maung Aye	20/05/16 - 25/05/16
CHECKED BY	SHEET NO
Than Ho	<2>/<5>

PROJECT NO:	SIL/S7578/16/SI
LOCATION:	Katong Park

BOREHOLE NO:	PTP01
NORTHING:	
EASTING:	
REDUCED LEVEL:	Existing G.L

IN-SITU TESTS DATA	SPT N VALUE 10	20	30	40	50	60	70	80	90	100	SPT(N)/mm	REDUCED LEVEL(m)	DEPTH (m)	SAMPLE TYPE	THICKNESS (m)	GEOLOGICAL CLASSIFICATION	DESCRIPTION
SPT14:42.00-42.45m 0/0/0/0/0/0	•										0/300	-42.00	41 42	SPT14	2.80	F1	
SPT15:45.00-45.45m 0/0/0/0/0/1	•										1/300		43 44 45 46 47	SPT15			Very Loose Light Grey Clayey Fine To Medium grained SAND Alluvial Member (KALLANG FORMATION)
SPT16:48.00-48.41m 12/13/20/25/28/27										•	100/280	-48.00	48	SPT16	6.00	F1	
SPT17:51.00-51.45m 10/12/14/16/20/20								•			70/300	-51.00	49 50 51	SPT17	3.00	O(B)	Very Dense Bluish Grey Silty Fine To Coarse grained SAND Partially Weathered (OLD ALLUVIUM)
SPT18:54.00-54.39m 10/15/25/28/30/17										•	100/250	-54.00	52 53 54	SPT18	3.00	O(B)	Hard Light Grey Mottled Brown and Yellow Slightly Fine grained Sandy CLAY Partially Weathered (OLD ALLUVIUM)
SPT19:57.00-57.32m 15/10/28/35/37/0										•	100/220	-57.00	55 56 57	SPT19	3.00	O(B)	Hard Brown Mottled Light Grey Slightly Fine grained Sandy CLAY Partially Weathered (OLD ALLUVIUM)
												-60.00	58 59 60		3.00	O(A)	Hard Light Grey Mottled Yellow Slightly Fine grained Sandy CLAY Unweathered (OLD ALLUVIUM)

Ground Water Observation	Time	BH Depth	CS Depth	Water Depth
Boring Type: Rotary	08:30	68.00	15.00	3.20
DIAMETER(mm): 100.0	17:30	81.50	15.00	6.80

ATT - ATTEMPT MZ,PS,TW,UD
CR - CORE RUN
MZ - MAZIER SAMPLE
PBT - PERMEABILITY TEST
PKT - PACKER TEST
PMT - PRESSUREMETER TEST
PS - PISTON SAMPLE
PZS - CASAGRANDE PIEZOMETER
SPT - SPT N VALUE
TW - THIN WALL PUSH IN
UD - THICK WALL OPEN DRIVE
VST - VANE SHEAR TEST
WSP - WATER STANDPIPE

CLIENT:
Shanghai Tunnel Engineering Co (Singapore) Pte Ltd

PROJECT:
SI for Contract T305 - Katong Park Station (Thomson-East Coast Line)

LOG OF BORING
GEOTECHNICAL STUDY-FIELD INVESTIGATIONS

CONTRACTOR:
Soil Investigation Pte Ltd

LOGGED BY:	DATE OF FIELD WORK
Khin Maung Aye	20/05/16 - 25/05/16
CHECKED BY	SHEET NO
Than Ho	<3>/<5>

PROJECT NO:	SIL/S7578/16/SI
LOCATION:	Katong Park

BOREHOLE NO:	PTP01
NORTHING:	
EASTING:	
REDUCED LEVEL:	Existing G.L

IN-SITU TESTS DATA	SPT N VALUE 10	20	30	40	50	60	70	80	90	100	SPT(N)/mm	REDUCED LEVEL(m)	DEPTH (m)	SAMPLE TYPE	THICKNESS (m)	GEOLOGICAL CLASSIFICATION	DESCRIPTION
SPT20:60.00-60.30m 11/14/35/45/20/0										•	100/180		61	SPT20			Very Dense Light Bluish Grey Silty Fine To Medium grained SAND Unweathered (OLD ALLUVIUM)
SPT21:63.00-63.32m 14/11/25/35/40/0										•	100/220	-63.00	62 63	SPT21	3.00	O(A)	
SPT22:66.00-66.38m 14/11/25/27/28/20										•	100/260		64 65 66	SPT22			Hard Light Grey Mottled Brown and Yellow Slightly Fine grained Sandy CLAY Unweathered (OLD ALLUVIUM)
SPT23:69.00-69.30m 15/10/35/35/30/0										•	100/200		67 68 69	SPT23			
SPT24:72.00-72.23m 25/0/40/55/5/0										•	100/160	-72.00	70 71 72	SPT24	9.00	O(A)	
SPT25:75.00-75.26m 18/7/30/55/15/0										•	100/170		73 74 75	SPT25			Very Dense Light Grey Silty Fine To Medium grained SAND Unweathered (OLD ALLUVIUM)
SPT26:78.00-78.29m 12/13/35/60/5/0										•	100/160	-78.00	76 77 78	SPT26	6.00	O(A)	
													79 80				Very Dense Light Grey Mottled Yellow Slightly Gravelly Fine To Coarse grained Silty SAND Subangular To Subrounded Unweathered (OLD ALLUVIUM)

Ground Water Observation	Time	BH Depth	CS Depth	Water Depth
Boring Type: Rotary	08:30	68.00	15.00	3.20
DIAMETER(mm): 100.0	17:30	81.50	15.00	6.80

ATT - ATTEMPT MZ,PS,TW,UD
CR - CORE RUN
MZ - MAZIER SAMPLE
PBT - PERMEABILITY TEST
PKT - PACKER TEST
PMT - PRESSUREMETER TEST
PS - PISTON SAMPLE
PZS - CASAGRANDE PIEZOMETER
SPT - SPT N VALUE
TW - THIN WALL PUSH IN
UD - THICK WALL OPEN DRIVE
VST - VANE SHEAR TEST
WSP - WATER STANDPIPE

CLIENT:
Shanghai Tunnel Engineering Co (Singapore) Pte Ltd

PROJECT:
SI for Contract T305 - Katong Park Station (Thomson-East Coast Line)

LOG OF BORING
GEOTECHNICAL STUDY-FIELD INVESTIGATIONS

CONTRACTOR:
Soil Investigation Pte Ltd

LOGGED BY:	DATE OF FIELD WORK
Khin Maung Aye	20/05/16 - 25/05/16
CHECKED BY	SHEET NO
Than Ho	<4>/<5>

PROJECT NO:	SIL/S7578/16/SI
LOCATION:	Katong Park

BOREHOLE NO:	PTP01
NORTHING:	
EASTING:	
REDUCED LEVEL:	Existing G.L

IN-SITU TESTS DATA	SPT N VALUE (10 20 30 40 50 60 70 80 90 100)	SPT(N)/mm	REDUCED LEVEL(m)	DEPTH (m)	SAMPLE TYPE	THICKNESS (m)	GEOLOGICAL CLASSIFICATION	DESCRIPTION
SPT27:81.00-81.24m 14/11/30/65/5/0	•	100/150	-81.50	81	SPT27	3.50	O(A)	
				82				
				83				
				84				
				85				
				86				
				87				
				88				
				89				
				90				
				91				
				92				
				93				
				94				
				95				
				96				
				97				
				98				
				99				
				100				

Ground Water Observation	Time	BH Depth	CS Depth	Water Depth
Boring Type: Rotary	08:30	68.00	15.00	3.20
DIAMETER(mm): 100.0	17:30	81.50	15.00	6.80

ATT - ATTEMPT MZ,PS,TW,UD
CR - CORE RUN
MZ - MAZIER SAMPLE
PBT - PERMEABILITY TEST
PKT - PACKER TEST
PMT - PRESSUREMETER TEST
PS - PISTON SAMPLE
PZS - CASAGRANDE PIEZOMETER
SPT - SPT N VALUE
TW - THIN WALL PUSH IN
UD - THICK WALL OPEN DRIVE
VST - VANE SHEAR TEST
WSP - WATER STANDPIPE

CLIENT:
Shanghai Tunnel Engineering Co (Singapore) Pte Ltd

PROJECT:
SI for Contract T305 - Katong Park Station (Thomson-East Coast Line)

LOG OF BORING
GEOTECHNICAL STUDY-FIELD INVESTIGATIONS

CONTRACTOR:
Soil Investigation Pte Ltd

LOGGED BY:	DATE OF FIELD WORK
Khin Maung Aye	20/05/16 - 25/05/16
CHECKED BY	SHEET NO
Than Ho	<5>/<5>

Appendix D

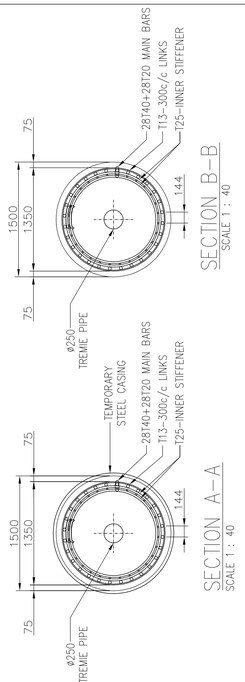
Instrumentation Elevation of Test Pile

BAR BENDING SCHEDULE FOR PTP-01

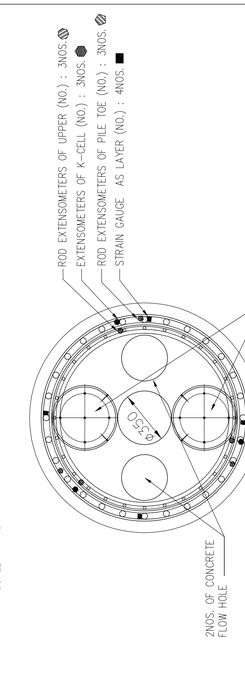
PER : 1 PANEL

Member	Bar mark	Type and Size	Total Nos.	Length of each bar mm	Shape Code	Bar Shape	A	B	C	D	E	Kg/m	Total(Kg)
MAIN BARS	1	T40	112	12000	20	A	12000	40	1800	–	–		
	1a	T40	28	4500	20	A	4500	–	–	–	–		
	1b	T40	28	8750	20	A	8750	–	–	–	–		
	1c	T40	28	10700	20	A	10700	40	1800	–	–	9.865	19872
	4	T20	28	12000	20	A	12000	20	900	–	–		
	4a	T20	84	11100	20	A	11100	20	900	–	–		
	4b	T20	28	7850	20	A	7850	–	–	–	–		
	4c	T20	28	9800	20	A	9800	20	900	–	–		
	4d	T20	28	4500	20	A	4500	–	–	–	–	2.466	4657
SPIRAL LINK	11	T13	210	4255	77	A, B, D	1350	300	–	–	–	1.042	931
SPIRAL LINKS LAPPING	–	T13	74	585	67	A	585	–	–	–	–	1.042	45
INNER STIFFENER	12	T25	22	4200	77	A, B, D	1240	300	–	–	–		
	12a	T25	22	3850	77	A, B, D	1150	300	–	–	–	3.854	683
REST BAR	14	T20	35	4500	77	A, B, D	1350	200	–	–	–	2.466	388
LIFTING & HANGING HOOK	13	T25	42	1500	32	D	700	160	–	–	–	3.854	243
HANGING BAR	15	T25	4	3000	20	A	3000		–	–	–	3.854	46
												TOTAL WEIGHT IN KGS	26865

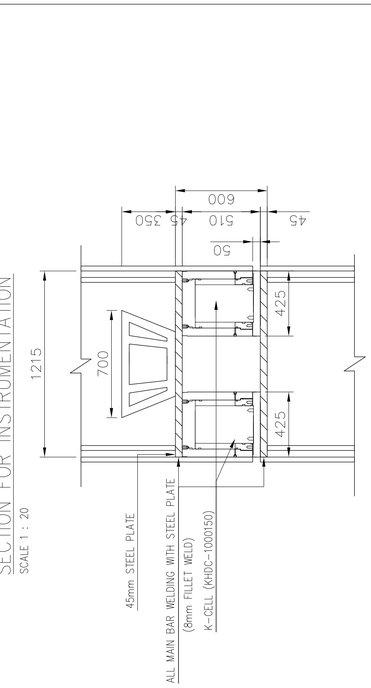
NOTE : TOTAL NO. FOR LINKS LAPPING : (APPROXIMATE ONLY)
TOTAL SPIRAL LINKS LENGTH/12000=NO. OF LINKS LAPPING (T13 LINK-45ø)



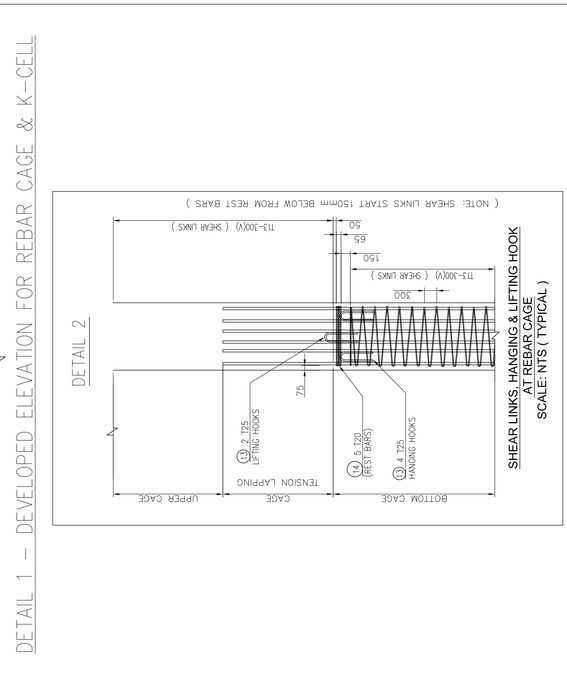
SECTION A-A
SCALE 1 : 40



SECTION B-B
SCALE 1 : 40

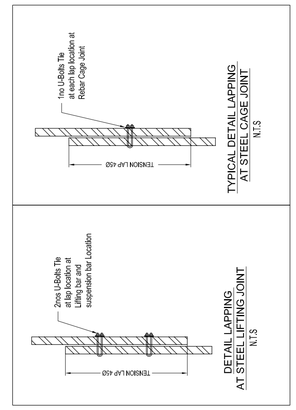


SECTION FOR INSTRUMENTATION
SCALE 1 : 20

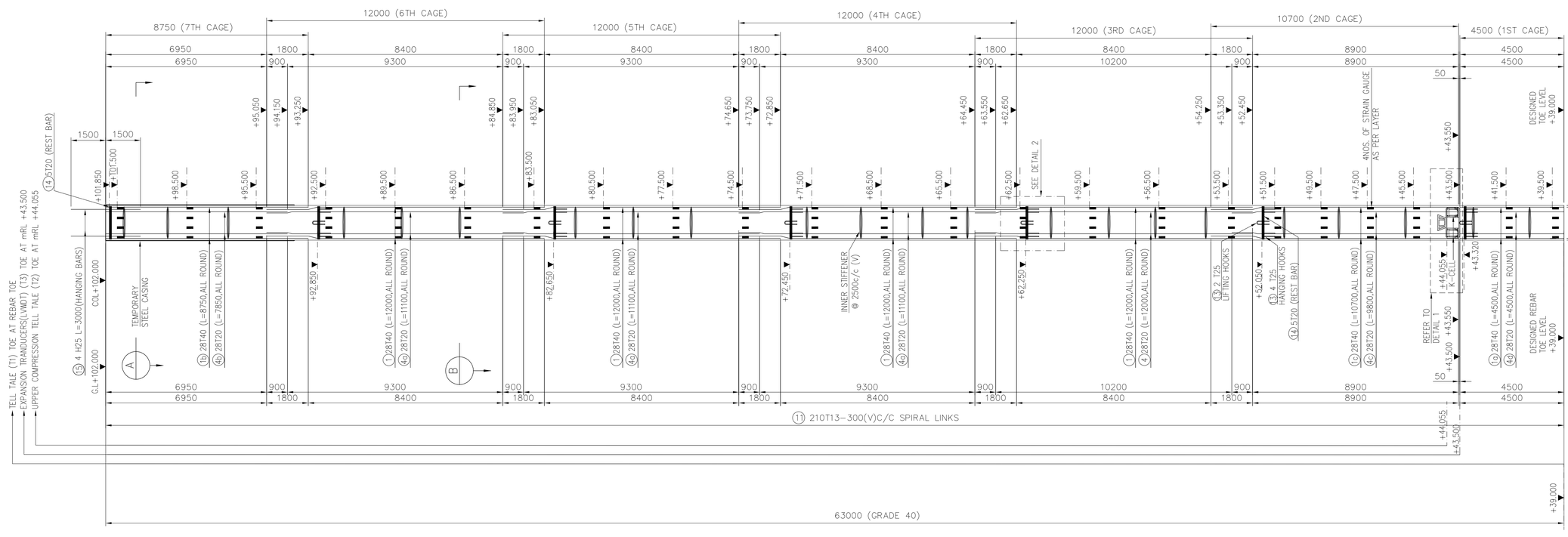


DETAIL 2

SHEAR LINKS, HANGING & LIFTING HOOK AT REBAR CAGE
SCALE: NTS (TYPICAL)



DETAIL 1 – DEVELOPED ELEVATION FOR REBAR CAGE & K-CELL



0 0.5 1 1.5 2 3 4 5 Metres
Scale 1:100

0 0.4 0.8 1.2 1.6 2.0 Metres
Scale 1:40

0 0.2 0.4 0.6 0.8 1.0 Metres
Scale 1:20

NOTES:

ATTACHED REFERENCE FILE

Rev.	Date	Drawn By	Description	Designed by	Chk'd	App'd
–	01.06.2016	SD	FIRST SUBMISSION	SD	JK LEE	BJ CHOI

Qualified Person Endorsement :

LTA Endorsement :

Main Contractor :
上海隧道工程股份(新加坡)有限公司 SHANGHAI TUNNEL ENGINEERING CO (SINGAPORE) PTE LTD

Contractor's Consultant :
MEINHARDT INFRASTRUCTURE
10 Sin Ming Lane, #08-13 Midview City
Singapore 573960
Tel: (65)63779700 Fax: (65)63779733

Sub Contractor :
SAMBO E & C CO. LTD. (Singapore BR)
ENGINEERING & CONSTRUCTION
19 JALAN TUKANG
SINGAPORE 619265
Tel: 65-63249080 Fax: 65-63249081
E-mail : sambo2@singnet.com.sg

Project Title :
CONTRACT T305
CONSTRUCTION OF KATONG PARK STATION & TUNNELS FOR THOMSON-EAST COAST LINE

Designed	Checked	Approved
SD	JK LEE	BJ CHOI
Scale	Drawn	Date
AS SHOWN	SD	MAY 2016

Land Transport Authority

Drawing Title :
TE24 KATONG PARK STATION
REINFORCEMENT DETAILS
(TEST BORED PILE-PTP01)

Drawing No. : M/T305/T24/TP0001
Rev. : –
Sheet : 1 of 1
CAD File Name : MT305T24-TP0001-.dgn
A1

CONSTRUCTION OF KATONG PARK STATION & TUNNELS FOR THOMSON-EAST COAST LINE(T305)

Test Location : **PTP-01**

Depth of K-Cell below Pilling Platform Level : 58.500 m

K-Cell elevation : 43.500 mRL

Reference Borehole : **PTP01**

Strain gauge Instrumentation : 23 levels of 4nos.(Total 92nos.) Vibrating Wire Strain Gauges

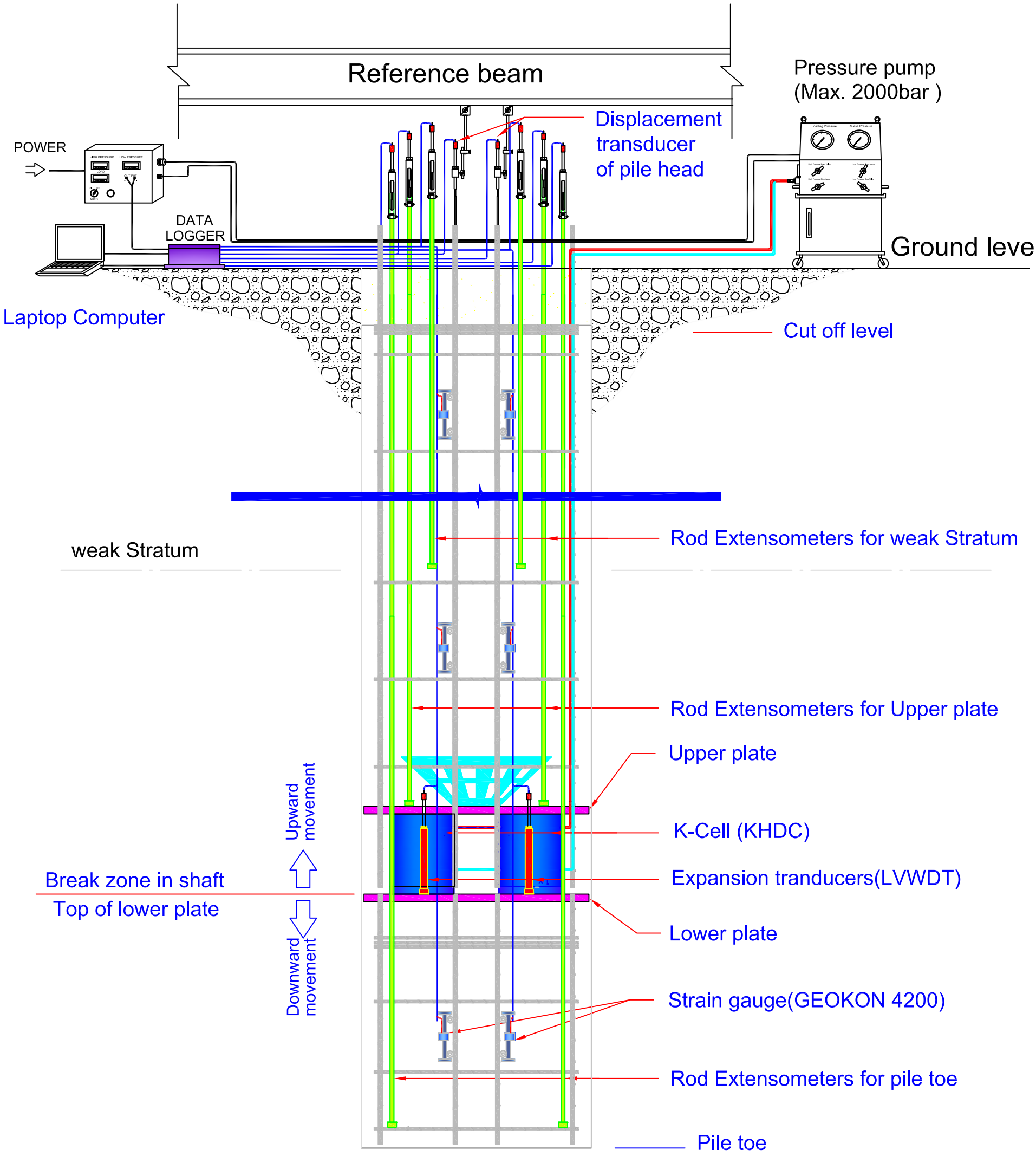
K-Cell Instrumentation : 2 numbers of 10MN capacity Cells (diameter 425mm)

Gauge Type	Quantity	Description	Depth (m)	mRL	Distance (m)
NA		Piling plateform level	**0.000**	102.000	
Vibrating Wire Strain Gauge	4	SG Level 23	0.500	101.500	3.00
Vibrating Wire Strain Gauge	4	SG Level 22	3.500	98.500	3.00
Vibrating Wire Strain Gauge	4	SG Level 21	6.500	95.500	3.00
Vibrating Wire Strain Gauge	4	SG Level 20	9.500	92.500	3.00
Vibrating Wire Strain Gauge	4	SG Level 19	12.500	89.500	3.00
Vibrating Wire Strain Gauge	4	SG Level 18	15.500	86.500	3.00
Vibrating Wire Strain Gauge	4	SG Level 17	18.500	83.500	3.00
Vibrating Wire Strain Gauge	4	SG Level 16	21.500	80.500	3.00
Vibrating Wire Strain Gauge	4	SG Level 15	24.500	77.500	3.00
Vibrating Wire Strain Gauge	4	SG Level 14	27.500	74.500	3.00
Vibrating Wire Strain Gauge	4	SG Level 13	30.500	71.500	3.00
Vibrating Wire Strain Gauge	4	SG Level 12	33.500	68.500	3.00
Vibrating Wire Strain Gauge	4	SG Level 11	36.500	65.500	3.00
Vibrating Wire Strain Gauge	4	SG Level 10	39.500	62.500	3.00
Vibrating Wire Strain Gauge	4	SG Level 9	42.500	59.500	3.00
Vibrating Wire Strain Gauge	4	SG Level 8	45.500	56.500	3.00
Vibrating Wire Strain Gauge	4	SG Level 7	48.500	53.500	2.00
Vibrating Wire Strain Gauge	4	SG Level 6	50.500	51.500	2.00
Vibrating Wire Strain Gauge	4	SG Level 5	52.500	49.500	2.00
Vibrating Wire Strain Gauge	4	SG Level 4	54.500	47.500	2.00
Vibrating Wire Strain Gauge	4	SG Level 3	56.500	45.500	2.00
NA		Break zone	58.500	43.500	
Vibrating Wire Strain Gauge	4	SG Level 2	60.500	41.500	2.00
Vibrating Wire Strain Gauge	4	SG Level 1	62.500	39.500	0.50
NA		Toe	63.000	39.000	

Instrument for measuring displacementes	From Elevation (mRL)	To Elevation (mRL)	Length (m)	Quantity	Remarks
Telltale Rod on Pile Top	102.000	102.000	0.0	2	Telltale rod
Telltale Casing and Rod on Upper plate	44.055	102.000	57.9	3	Telltale rod
Extension meter(GK 4450)	43.500	43.500	-	3	Displacement transduceer
Telltale Casing and Rod at Pile Toe	39.000	102.000	63.0	3	Telltale rod

Appendix E

Schematic Layout Showing K-CELL Arrangement



Project Name : KATONG PARK STATION AND TUNNELS FOR THOMSON-EAST COAST LINE(T305)

KFLT-Cell Pte. Ltd

Drawing Title :

Schematic Layout
Showing K-Cell Arrangement

19 Jalan Tukang Singapore 619265 E-mail : ksi0319@naver.com
Tel : 6324-9080(Extension 136) Fax : 6924-9081

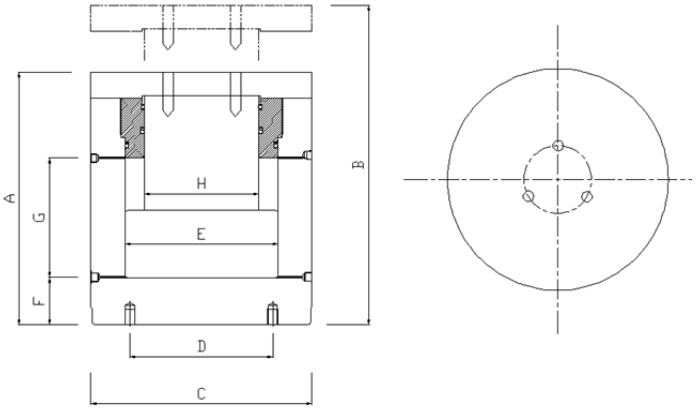
Issue Date :	Drawn By :	Check By:
30th April 2016	SOE. T.	KIM. S. I.

Appendix F

Brochures and K-cell Hydraulic Jack Certification

(All Update Calibration Certificates shall be submitted prior to testing)

DOUBLE ACTION CYLINDER(HIGH)



- Capacity : 6MN ~ 20MN
- Stroke : 100mm~200mm
- Using Pressure : 1500kgf/cm^2(Max 1800 kgf/cm^2)
- Faster Retraction under hydraulic power
- Removable plunger caps

How to understand Model No.

K H DC – 1000 150

- Stroke 150mm
- Capacity 1000 tonf(10MN)
- Double-Action Cylinder
- High pressure
- KFLT-CELL

Specifications

Model	Cylinder Capacity (MN)	Stroke (mm)	Cylinder Effective Area (cm^2)	Oil Capacity (cc)	Retracted Height A	Extended Height B	Cylinder Out Dia. C	Bolt Circle Dia. D	Piston Rod Dia. E	Base to Inlet Port F	Port & Port G	Cylinder Bore Dia. H
KHDC-600100	6	100	415.3	4152.7	435	535	334	230	230	96.5	208.5	165
KHDC-600150	6	150		6229.0	485	635					258.5	
KHDC-800100	8	100	551.3	5512.7	465	565	385	275	265	111.5	213.5	200
KHDC-800150	8	150		8269.0	510	660					263.5	
KHDC-1000100	10	100	683.1	6831.5	465	565	425	325	295	111.5	213.5	220
KHDC-1000150	10	150		10247.2	510	660					263.5	
KHDC-1100100	11	100	754.4	7543.9	470	570	450	328	310	111.5	213.5	220
KHDC-1100150	11	150		11315.8	520	670					263.5	
KHDC-1200100	12	100	854.8	8848.7	485	585	485	328	330	117.5	213.5	220
KHDC-1200150	12	150		12822.9	535	685					263.5	
KHDC-1500100	15	100	1017.4	10173.6	520	620	528	360	360	129.5	228.5	260
KHDC-1500150	15	150		15260.4	570	720					278.5	
KHDC-2000100	20	100	1352.0	13519.7	585	685	600	450	415	142	258	320
KHDC-2000150	20	150		20279.5	635	785					308	

Pressure Gauge

Calibration Report No : CM-39029/1

SETSCO

SETSCO SERVICES PTE LTD

18 Teban Gardens Crescent
Singapore 608925
Tel : (65) 6566 7777
Fax: (65) 6566 7718
Website: www.setsco.com
Business Reg. No. 196900269D

(This Report is issued subject to the terms & conditions set out below)

Your Ref : -

Our Ref : CM-39029/KTI/1

Date : 16/04/2014

CALIBRATION REPORT ON PRESSURE GAUGE

Issued To : KFLT-CELL PTE LTD
19 JALAN TUKANG
SINGAPORE 619265
Attn : MR CHUNG

Description	: PRESSURE GAUGE	**Ambient Temperature**	: 20 ± 3 °C
Manufacturer	: WIKA	**Relative Humidity**	: 53 ± 5 % r.h.
Norminal Gauge Size	: 100 (mm)	**Date Received**	: 7 April 2014
Serial No.	: 33258213	**Receiving Condition**	: Satisfactory
Range	: 0 to 100 (MPa)	**Date of Calibration**	: 16 April 2014
Scale Interval	: 2 (MPa)	**Recommended Due**	: 16 April 2015

Calibration Location : Setsco Services Pte Ltd; Mechanical Calibration Laboratory (2nd Level)
The instrument was calibrated under the conditions stated above.

Method of Calibration
The method of calibration is generally stated in SETSCO Procedure MTD/CAL-05:2012 and BS EN 837-1:1998 as a guide.
The true force method was used to effect the calibration.

Reference Instrument Traceability : NMC-Singapore
The following reference instruments are traceable to National Standard.

No.	Description	Serial No.	Calibration Certificate	Calibration Date	Due Date
1	DIGITAL PRESSURE GAUGE	3118006	SK-21378/1	03/12/2013	03/12/2014

As Found Results

Applied Pressure (MPa)	Indicated Pressure (MPa)			
	Increasing		Decreasing	
	Mean Reading	Error	Mean Reading	Error
0.0	0.0	0.0	0.0	0.0
20.0	19.7	-0.3	20.3	0.3
40.0	39.7	-0.3	40.3	0.3
60.0	59.7	-0.3	60.3	0.3
80.0	79.5	-0.5	80.3	0.3
100.0	99.3	-0.7	-	-

Accuracy of the instrument was found within ± 1.0 % of maximum scale value.

Expanded Uncertainty = 0.3 (MPa) ; Coverage : k - factor = 2.05

Remarks:
1. If the pressure instrument is dismantled, or subject to major repairs or adjustment, or if there is any reason to doubt the accuracy of its results, it shall be re-calibrated.
2. The user should determine the suitability of the pressure instrument for its intended use.
3. The expanded uncertainty of measurement is at confidence level of approximately 95%.
4. No adjustment was made on the instrument.

KARTHI
Calibration Officer

RAJ KUMAR
Assistant Engineer (Calibration & Measurement)
Mechanical Technology Division

ilac-MRA ACCREDITED LABORATORY SAC-SINGLAS

The results reported herein have been performed in accordance with the laboratory's terms of accreditation under the Singapore Accreditation Council - Singapore Laboratory Accreditation Scheme LA-1994-0068-A, LA-1987-0001-B, LA-1993-0067-G, LA-1993-0051-C, LA-1998-0144-D, LA-2000-0181-F, LA 2012-0519-E, LA 1993-0051-C-1

Pressure Gauge

Calibration Report No : CM-39029/2

SETSCO SERVICES PTE LTD
18 Teban Gardens Crescent
Singapore 608925
Tel : (65) 6566 7777
Fax: (65) 6566 7718
Website: www.setsco.com
Business Reg. No. 196900269D

(This Report is issued subject to the terms & conditions set out below)

Your Ref : - Our Ref : CM-39029/KTI/2 Date : 16/04/2014

Page : 1 of 1

CALIBRATION REPORT ON PRESSURE GAUGE

Issued To : KFLT-CELL PTE LTD
19 JALAN TUKANG
SINGAPORE 619265
Attn : MR CHUNG

Description	: PRESSURE GAUGE	**Ambient Temperature**	: 20 ± 2 °C
Manufacturer	: CEJN	**Relative Humidity**	: 53 ± 5 % r.h.
Norminal Gauge Size	: 100 (mm)	**Date Received**	: 7 April 2014
Serial No.	: 1765	**Receiving Condition**	: Satisfactory
Range	: 0 to 300 (MPa)	**Date of Calibration**	: 16 April 2014
Scale Interval	: 2 (MPa)	**Recommended Due**	: 16 April 2015

Calibration Location : Setsco Services Pte Ltd; Mechanical Calibration Laboratory (2nd Level)
The instrument was calibrated under the conditions stated above.

Method of Calibration
The method of calibration is generally stated in SETSCO Procedure MTD/CAL-05:2012 and BS EN 837-1:1998 as a guide.
The true force method was used to effect the calibration.

Reference Instrument Traceability : NMC-Singapore
The following reference instruments are traceable to National Standard.

No.	Description	Serial No.	Calibration Certificate	Calibration Date	Due Date
1	HIGH PRESSURE GENERATOR	1041684	PL001043	20/02/2014	20/02/2015

As Found Results

Applied Pressure (MPa)	Indicated Pressure (MPa)			
	Increasing		Decreasing	
	Mean Reading	Error	Mean Reading	Error
0	0	0	0	0
60	61	1	62	2
120	121	1	122	2
180	181	1	182	2
240	241	1	242	2
300	298	-2	-	-

Accuracy of the instrument was found within ± 1.4 % of maximum scale value.

Expanded Uncertainty = 2 (MPa) ; Coverage : k - factor = 2.05

Remarks:
1. If the pressure instrument is dismantled, or subject to major repairs or adjustment, or if there is any reason to doubt the accuracy of its results, it shall be re-calibrated.
2. The user should determine the suitability of the pressure instrument for its intended use.
3. The expanded uncertainty of measurement is at confidence level of approximately 95%.
4. No adjustment was made on the instrument.

KARTHI
Calibration Officer

RAJ KUMAR
Assistant Engineer (Calibration & Measurement)
Mechanical Technology Division

ilac-MRA ACCREDITED LABORATORY SAC-SINGLAS
The results reported herein have been performed in accordance with the laboratory's terms of accreditation under the Singapore Accreditation Council - Singapore Laboratory Accreditation Scheme
LA-1994-0068-A, LA-1987-0001-B, LA-1993-0067-G, LA-1993-0051-C, LA-1998-0144-D, LA-2000-0181-F, LA 2012-0519-E, LA 1993-0051-C-1

Displacement transducer

SETSCO SERVICES PTE LTD
18 Teban Gardens Crescent
Singapore 608925
Tel : (65) 6566 7777
Fax: (65) 6566 7718
Website: www.setsco.com
Business Reg. No. 196900269D

Calibration Report No.: CM-41792/1

(This Report is issued subject to the terms & conditions set out below)

Your Ref: -

Our Ref: CM-41792/TCH/1

Date: 07/10/2014

CALIBRATION REPORT
ON
VIBRATING WIRE DISPLACEMENT TRANSDUCER c/w DISPLAY

Issued To : KFLT-CELL PTE LTD
19 Jalan Tukang
Singapore 619265
Attn : Kim Sang

Description : Vibrating Wire Displacement Transducer c/w Display
Manufacturer : GEOKON
Serial No. : 1232445
Display Serial No. : 123883

Range : 0 – 150 mm
Resolution : 0.1 mm
Date Calibrated : 03 October 2014

This instrument calibration was performed at SETSCO Services Pte Ltd, Calibration Laboratory (Dimension) under the ambient temperature of 20°C ± 1°C and relative humidity of 50% ± 5% r.h.

Calibration Method
The method of calibration is generally as stated in SETSCO procedure MTD/CAL-109 : 2012 , as a guide.

Reference Equipment Used

1. Gauge Block Set of Serial No. 040044, traceable to NPL via Northlab Certificate No. ML/2013/0990 dated on 15.11.2013 due on 15.11.2014.
2. Gauge Block Set of Serial No. 103247, traceable to NVLAP via Mahr Federal Certificate No. 127354000 dated on 24.02.2014 due on 24.02.2015.

Results: As Found

Linearity Readings

Nominal Value (mm)	Mean Measured Value (mm)
0	0.0
30	30.5
60	60.5
90	90.4
120	120.3
150	150.2

Note : Linear Gage Factor (G) = 0.03077 (mm/digit)

The expanded uncertainty of measurement to be associated with the mean value of accuracy measurement is 0.2 mm at a confidence level of approximately 95% with coverage factor k = 3.31.

The user should determine the suitability of this instrument for its intended use.

TEU CIHUA
Calibration Officer

ANTONY ALWIN
Assistant Engineer (Calibration & Measurement)
Mechanical Technology Division

CM-41792/TCH/1(CM Word)Tch

Displacement transducer

SETSCO SERVICES PTE LTD
18 Teban Gardens Crescent
Singapore 608925
Tel : (65) 6566 7777
Fax: (65) 6566 7718
Website: www.setsco.com
Business Reg. No. 196900269D

Calibration Report No.: CM-41792/2

(This Report is issued subject to the terms & conditions set out below)

Your Ref: -

Our Ref: CM-41792/TCH/2

Date: 07/10/2014

CALIBRATION REPORT
ON
VIBRATING WIRE DISPLACEMENT TRANSDUCER c/w DISPLAY

Issued To : KFLT-CELL PTE LTD
19 Jalan Tukang
Singapore 619265
Attn : Kim Sang

Description : Vibrating Wire Displacement Transducer c/w Display
Manufacturer : GEOKON
Serial No. : 1232446
Display Serial No. : 123883

Range : 0 – 150 mm
Resolution : 0.1 mm
Date Calibrated : 03 October 2014

This instrument calibration was performed at SETSCO Services Pte Ltd, Calibration Laboratory (Dimension) under the ambient temperature of 20°C ± 1°C and relative humidity of 50% ± 5% r.h.

Calibration Method
The method of calibration is generally as stated in SETSCO procedure MTD/CAL-109 : 2012 , as a guide.

Reference Equipment Used

1. Gauge Block Set of Serial No. 040044, traceable to NPL via Northlab Certificate No. ML/2013/0990 dated on 15.11.2013 due on 15.11.2014.
2. Gauge Block Set of Serial No. 103247, traceable to NVLAP via Mahr Federal Certificate No. 127354000 dated on 24.02.2014 due on 24.02.2015.

Results: As Found

Linearity Readings

Nominal Value (mm)	Mean Measured Value (mm)
0	0.0
30	30.5
60	60.7
90	90.7
120	120.5
150	150.2

Note : Linear Gage Factor (G) = 0.03081 (mm/digit)

The expanded uncertainty of measurement to be associated with the mean value of accuracy measurement is 0.2 mm at a confidence level of approximately 95% with coverage factor k = 2.87.

The user should determine the suitability of this instrument for its intended use.

TEU CIHUA
Calibration Officer

ANTONY ALWIN
Assistant Engineer (Calibration & Measurement)
Mechanical Technology Division

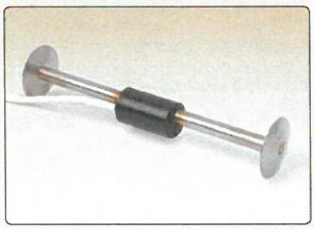
CM-41792/TCH/2(CM Word)Tch

Concrete Embedment Strain Gages

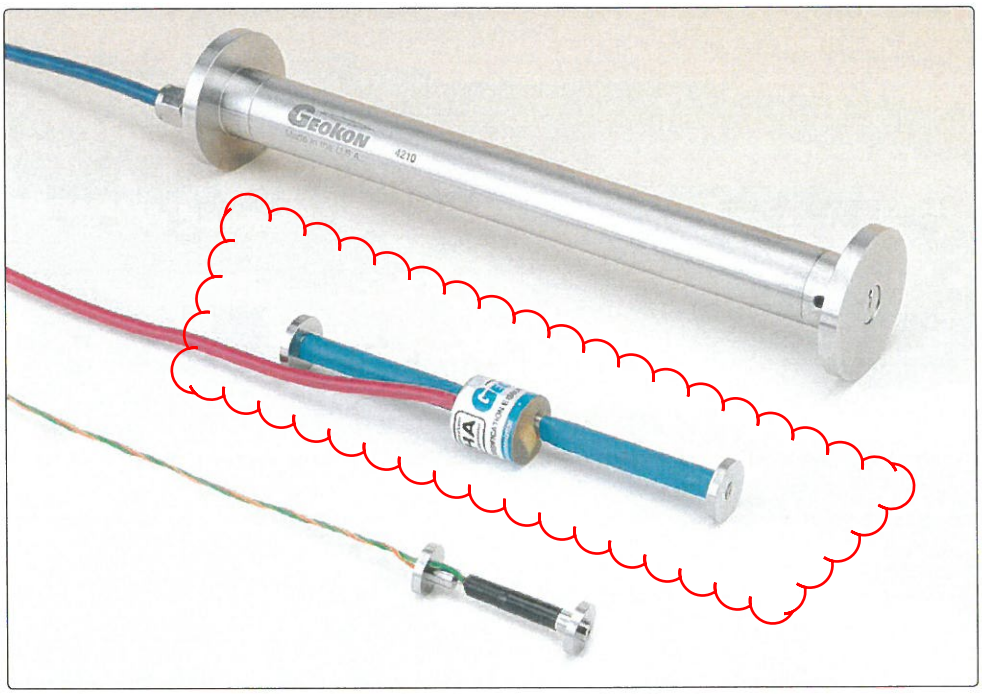
Applications

The Model 4200, 4202 and 4210 are designed to measure strains in or on...

- **Foundations**
- **Piles**
- **Bridges**
- **Dams**
- **Containment vessels**
- **Tunnel liners**
- **Mass concrete with coarse aggregates**
- **Laboratories and/or where space limitations exist (Model 4202)**



Geokon Model 4200HT-T High Temperature Strain Gage.



Model 4202 (front), Model 4200 (center) and Model 4210 (rear) Concrete Embedment Strain Gages.

Operating Principle

The Model 4200(HT/HT-T), 4202 and 4210 Vibrating Wire Embedment Strain Gages are designed for direct embedment in concrete. The Model 4200 (standard model) has a 153 mm gage length and is commonly used for strain measurements in foundations, piles, bridges, dams, containment vessels, tunnel liners, etc. The Model 4210 has a 250 mm gage length and is designed for use in mass concrete with coarse aggregates. It is extra rugged to resist bending, and has large flanges to provide greater engagement area. The 4202, with a 51 mm gage length, is designed for laboratory use and/or where there are space limitations.

Strains are measured using the vibrating wire principle: a length of steel wire is tensioned between two end blocks that are embedded directly in concrete. Deformations (i.e. strain changes) of the concrete mass, will cause the two end blocks to move relative to one another, thus altering the tension in the steel wire. The tension is measured by plucking the wire and measuring its resonant frequency of vibration using an electromagnetic coil.

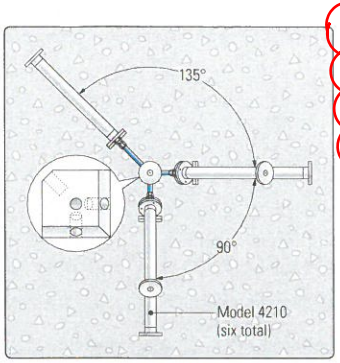
Advantages and Limitations

The Model 4200 Series Strain Gages enjoy all the advantages of vibrating wire sensors, which includes excellent long term stability, maximum resistance to the effects of water, and a frequency output suitable for transmission over very long cables.

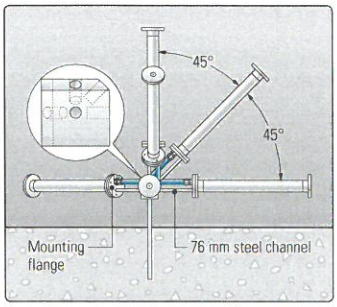
All components are made from stainless steel for corrosion protection and the gages are fully waterproof. The Model 4210 is very rugged and designed to withstand the rigors of concrete placement.

Each gage incorporates a thermistor so that the temperature can be read and displayed by the readout box.

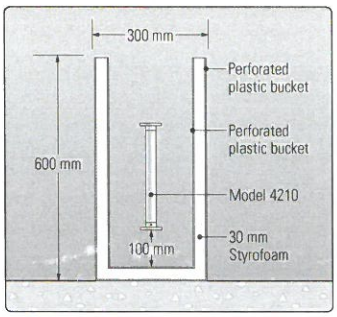
High temperature versions are also available: The Model 4200HT is designed for short-term use at temperatures up to 200°C and the Model 4200HT-T is designed for long-term use at temperatures up to 220°C, making it particularly suitable for installation in steam-cured concrete piles.



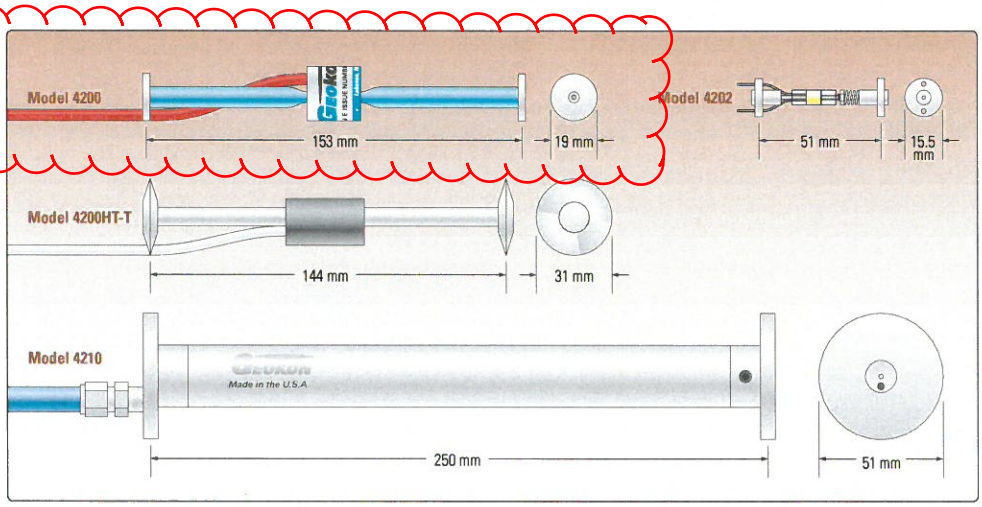
• *Top view of a Model 4210 strain gage rosette configuration. Inset shows rosette fixture (enlarged for detail).*



• *Front view of a Model 4210 strain gage rosette configuration. Inset shows rosette fixture (enlarged for detail).*



• *"No stress-strain" enclosure using the Model 4210.*



• *Dimensions of the 4200 Series Strain Gages.*

System Components

The strain gages are shipped ready for installation with the correct amount of cable attached. Installation is accomplished by attaching the strain gage to any steel reinforcement bar, or, in mass concrete, to special rosette fixtures designed to hold multiple strain gages in different orientations to allow the measurement of strain in three dimensions.

Also available are no stress-strain enclosures for use in concrete dams. These enclosures are double-wall, sheet-steel containers, lined with Styrofoam, designed to isolate one or more strain gages from the stress field in the concrete, and to allow an estimate of, and correction for the effects of moisture, temperature, autogenous growth, etc.

All models are equipped with integral thermistors for the simultaneous measurement of temperature.

Readout is accomplished using the Model GK-401, GK-403, GK-404 or GK-405 Readout Boxes, which can, when used with the Model 4200, display the strain directly in microstrain.

Technical Specifications

	4200	4200HT	4200HT-T	4202	4210
Standard Range	3000 με	3000 με	3000 με	3000 με	3000 με
Resolution	1.0 με	1.0 με	1.0 με	0.4 με	0.4 με
Accuracy[1]	±0.5% F.S.	±0.5% F.S.	±0.5% F.S.	±0.5% F.S.	±0.5% F.S.
Nonlinearity	< 0.5% F.S.	< 0.5% F.S.	< 0.5% F.S.	< 0.5% F.S.	< 0.5% F.S.
Temperature Range	–20°C to +80°C	–20°C to +200°C	–20°C to +220°C	–20°C to +80°C	–20°C to +80°C
Active Gage Length	153 mm	144 mm	144 mm	51 mm	250 mm[2]
Thermal Coefficient of Expansion	12.0 ppm/°C	12.0 ppm/°C	12.0 ppm/°C	12.0 ppm/°C	12.0 ppm/°C
Coil Resistance	180 Ω	120 Ω	120 Ω	50 Ω	180 Ω
Cable Type	4-conductor, 2 twisted pairs, 22 AWG *(for all models)*				
Cable Jacket	Red PVC, 4.75 mm Ø	White Teflon® 5.20 mm Ø	White Teflon® 5.20 mm Ø	Red PVC, 4.75 mm Ø	Blue PVC 6.35 mm Ø
Frequency Datum[3]	800 Hz	800 Hz	800 Hz	2600 Hz	2600 Hz

[1] *±0.5% F.S. with standard batch calibration. ±0.1% F.S. with individual calibration. Accuracy established under laboratory conditions.*
[2] *Other lengths available on request.*
[3] *Typical.*

GEOKON
The World Leader in Vibrating Wire Technology™

Geokon, Incorporated
48 Spencer Street
Lebanon, NH 03766
USA

1 • 603 • 448 • 1562
1 • 603 • 448 • 3216
geokon@geokon.com
www.geokon.com

STRAIN GAUGE

GEOKON

The World Leader in Vibrating Wire Technology™

Certificate of Quality & Conformity

WE HEREBY CERTIFY that the manufactured materials listed below (Schedule A)
Furnished to:
KFLT-CELL PTE LTD

Reference Geokon Job No.: 20041085

In the amount specified in Schedule A, identified by our label "Geokon Inc."
Complies/Conforms to, or exceeds the requirements and specifications of your purchase order no.: , contract no.: N/A in all aspects
Country(s) of Origin: United States of America

WE FURTHER CERTIFY that the product supplied has been inspected, tested and calibrated as applicable, in conformance to the relevant specifications and drawings of the Geokon, Inc. registered ISO 9001:2008 Quality Program. Calibration and testing standards are maintained per ANSI Z540-1 and are traceable to N.I.S.T.

SCHEDULE A

Model No.	Quantity	Type of Instrument	Serial Nos.
4450-3-150MM	10	VW Displacement Transducer, 150mm (6") range, Loadtest Style	1417830~1417839
02-250V6-M	10m	Blue PVC Cable, 0.250", 2 twisted pairs	N/A
4150-6	152	VW Strain Gage with plucking coil (NO coverplate) cable sold a seprate item. No HRD-A1007 Shim	N/A
02-187V3-M	152m	Red PVC Cable, 0.187", 2 twisted pairs	N/A

Signed by: M. J. Gibson Date: August 28, 2014

Martin Gibson

Quality Assurance Manager

STRAIN GAUGE

GEOKON 48 Spencer St. Lebanon, NH 03766 USA

Vibrating Wire Strain Gage Batch Calibrations

Revision Date: July 15, 2013

Strain Gage Type	Nominal Batch Factor (B)
Model 4000	0.96
Model 4100 / 4150 / 4151 / 4202	0.92
Model 4200	0.97

Please Note: To calculate changes of strain use the formula $\Delta\mu = (R1-R0)G \times B$ where G is the gage factor for that particular model of strain gage.

This applies only to dataloggers

Where the strains are read using GK403 or GK404 readout boxes on the appropriate channels C, D or E, the displayed readings already include the gage factor ,G, so that with portable readout boxes the change of strain is simply (R1-R0) x B microstrain

Gage Model	G
4000	4.062
4100/4150/4202	0.391
4200	3.304

Model:	4200	4202	4204	4210	4212	4214
Gage Factor:	3.304	0.391	1.422	0.3568	0.3624	0.3665
Start Frequency (P28):	4 (450 Hz)	14 (1400 Hz)	8 (800 Hz)	14 (1400 Hz)	14 (1400 Hz)	14 (1400 Hz)
End Frequency (P28):	12 (1200 Hz)	35 (3500 Hz)	16 (1600 Hz)	35 (3500 Hz)	35 (3500 Hz)	35 (3500 Hz)

The above factor is derived by averaging the gage factors of controlled samples of all gages produced. The data from calibration of the above instrument samples was collected using standards traceable to the NIST and in compliance with NCSL/ANSI Z540-1.

Appendix G

Test Loading Procedure

Loading Cycle of Prelininary Load Test(PTP©-01)

Date	:		01-Jun-16
Test location	:		PTP©-01
Borehole reference	:		PTP01
Loading procedure type:	:		3 Cycle
Bored Pile	:		Φ1500mm
Cell serial number(s)	:		-
Cell Jack number(s) and size	:	2 nos.	425 mm
Cell gross capacity	:		16 MN
Cell effective area	:		683.1 cm^2/no.
Working load	:		14.8 MN
Test load (2.5X WL)	:		37.0 MN
Pile length above Cell	:		58.5 m
Pile weight above Cell(BW)	:		1368 kN

Increment No.	Cell Pressure		Cell Load		Gross Load (=Net Load + BW)			Net Load	Percent of Working Load (%)	Holding Time
	(Bar)	(Mpa)	(tonf)	(KN)	(tonf)	(KN)	(MN)	(MN)		Min (min)
1L-0	0	0.0	0	0	0	0	0.0	0.0	0.0	-
1L-1	185	18.5	258	2534	517	5068	5.1	3.7	25.0	60
1L-2	321	32.1	447	4384	894	8768	8.8	7.4	50.0	60
1L-3	456	45.6	635	6234	1271	12468	12.5	11.1	75.0	60
1L-4	**592**	**59.2**	**824**	**8084**	**1648**	**16168**	**16.2**	**14.8**	**100.0**	**6 hours**
1U-1	456	45.6	635	6234	1271	12468	12.5	11.1	75.0	10
1U-2	321	32.1	447	4384	894	8768	8.8	7.4	50.0	10
1U-3	185	18.5	258	2534	517	5068	5.1	3.7	25.0	10
1U-4	0	0.0	0	0	0	0	0.0	0.0	0.0	60
2L-1	185	18.5	258	2534	517	5068	5.1	3.7	25.0	10
2L-2	321	32.1	447	4384	894	8768	8.8	7.4	50.0	10
2L-3	456	45.6	635	6234	1271	12468	12.5	11.1	75.0	10
2L-4	592	59.2	824	8084	1648	16168	16.2	14.8	100.0	**6 hours**
2L-5	727	72.7	1013	9934	2025	19868	19.9	18.5	125.0	60
2L-6	**862**	**86.2**	**1201**	**11784**	**2402**	**23568**	**23.6**	**22.2**	**150.0**	**6 hours**
2U-1	727	72.7	1013	9934	2025	19868	19.9	18.5	125.0	10
2U-2	592	59.2	824	8084	1648	16168	16.2	14.8	100.0	10
2U-3	456	45.6	635	6234	1271	12468	12.5	11.1	75.0	10
2U-4	321	32.1	447	4384	894	8768	8.8	7.4	50.0	10
2U-5	185	18.5	258	2534	517	5068	5.1	3.7	25.0	10
2U-6	50	5.0	70	684	139	1368	0.0	0.0	0.0	60
3L-1	185	18.5	258	2534	517	5068	5.1	3.7	25.0	10
3L-2	321	32.1	447	4384	894	8768	8.8	7.4	50.0	10
3L-3	456	45.6	635	6234	1271	12468	12.5	11.1	75.0	10
3L-4	592	59.2	824	8084	1648	16168	16.2	14.8	100.0	10
3L-5	727	72.7	1013	9934	2025	19868	19.9	18.5	125.0	10
3L-6	862	86.2	1201	11784	2402	23568	23.6	22.2	150.0	60
3L-7	998	99.8	1390	13634	2780	27268	27.3	25.9	175.0	60
3L-8	1133	113.3	1578	15484	3157	30968	31.0	29.6	200.0	60
3L-9	1268	126.8	1767	17334	3534	34668	34.7	33.3	225.0	60
3L-10	**1404**	**140.4**	**1956**	**19184**	**3911**	**38368**	**38.4**	**37.0**	**250.0**	**24hours**
3U-1	1133	113.3	1578	15484	3157	30968	31.0	29.6	200.0	10
3U-2	862	86.2	1201	11784	2402	23568	23.6	22.2	150.0	10
3U-3	592	59.2	824	8084	1648	16168	16.2	14.8	100.0	10
3U-4	321	32.1	447	4384	894	8768	8.8	7.4	50.0	10
3U-5	0	0.0	0	0	0	0	0.0	0.0	0.0	30

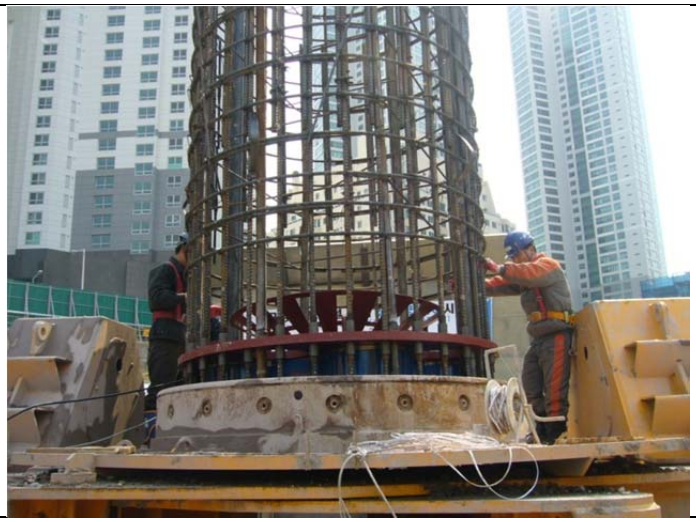
Appendix H

Illustration Photo of K-Cell Installation

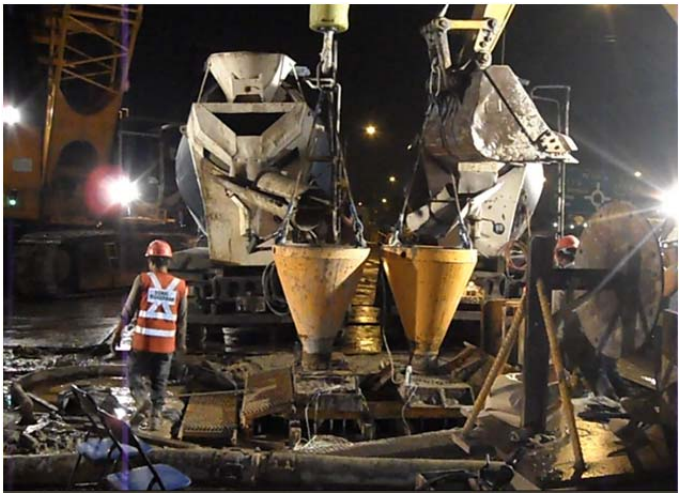
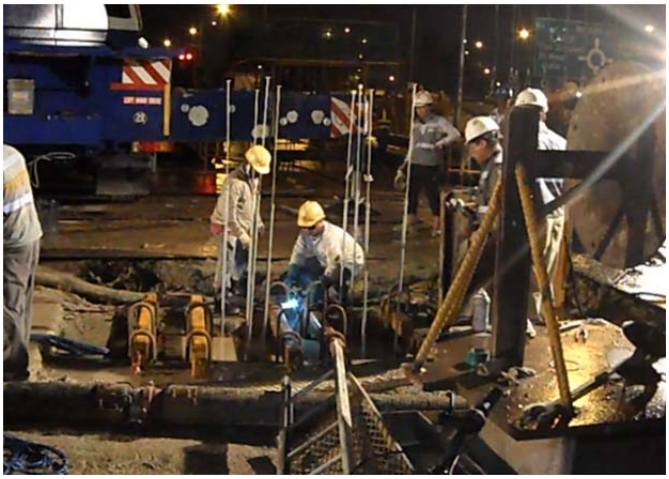
ASSEMBLY AND INSTALLATION 1

Loading equipment delivers to site after fabrication in the factory		To carry the fabricated K-Cell with upper & lower Steel plate in site. The assembled K-Cell consists of funnel for tremie pipe installation location, steel plates, and K-cells. The size of steel plate decides as the dimension of the test pile, the quantity of K-cell has to get a capacity more than the maximum test load safely.
Attachment of the K-Cell to the reinforcing cage		Method of welding: When it isn't proper coupler with main rebar, it should properly weld the steel plates to main rebar of the cage.
		Method of coupler joint: When the suitable couplers to main rebar are provided from factory production, it must use a coupler to fabricate K-cell and the cage.

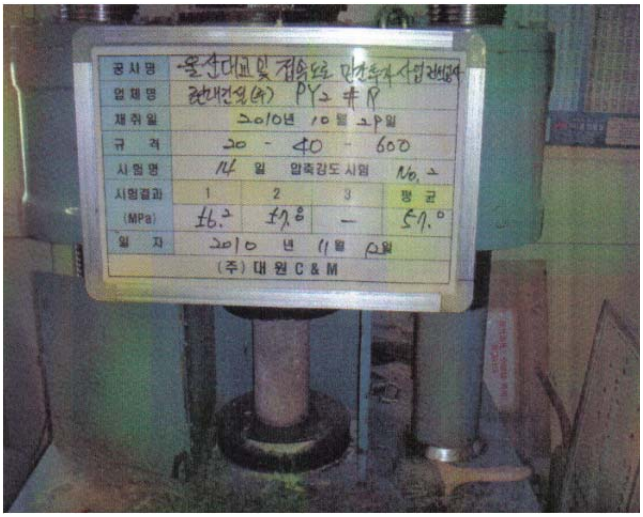
ASSEMBLY AND INSTALLATION 2

Lifting of cage to position		The lifting of each cage to vertical should be carried out using a lifting beam or several pick points to ensure the cage remains reasonably straight during lifting.
Slowly lowering the cage into the excavation		The temporary stiffening bars between the bearing plates (for handling purposes) will be cut just above the bottom plate. Top of the bottom bearing plate will be greased to aid development of the fracture plane at this level.
Connection of additional cages and instrumentation		Where cage splices are required, all of the cables from the instruments of the lower cage need to be pulled up to the top of the additional cage and secured in place. Telltale casings and vents need to be connected and secured.

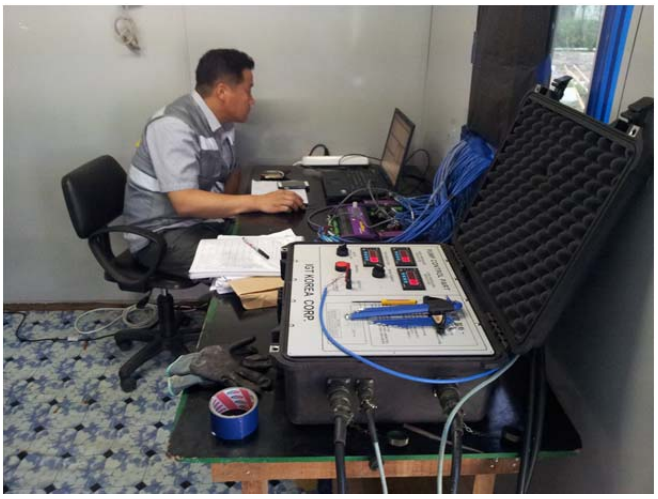
ASSEMBLY AND INSTALLATION 3

Concrete cut-off level		The top of concrete need not be brought up to ground level. It can be left at cut-off level or just sufficient for the level at which the test is required. The empty bore is sometimes backfilled with granular material or just made safe.
Concrete placement		The approved concrete mix should contain sufficient retarding agent to maintain workability. Concrete placement will commence utilizing a slick line tremie pipe (with no joints below K-CELL cell level) of sufficient length so as to extend beyond the K-CELL cell assembly to the toe of the pipe.
Concrete placement **(post pour)**		The reinforcing cage or a support assembly will be extended beyond the concrete cut-off level to above ground level, where appropriate, to support telltales, instrumentation wiring, and hydraulic supply lines above the concrete level.

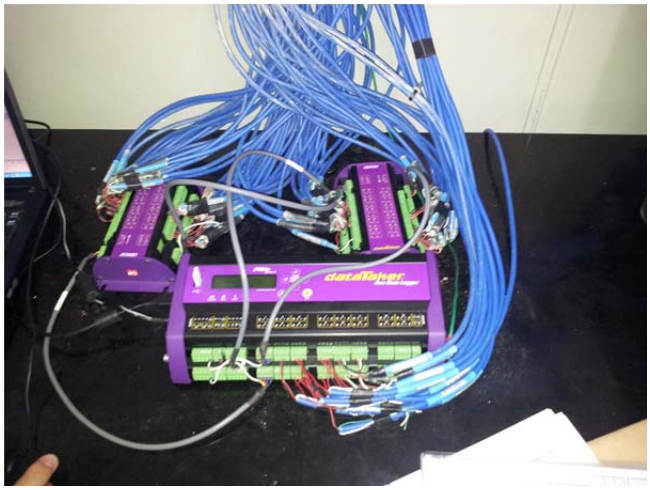
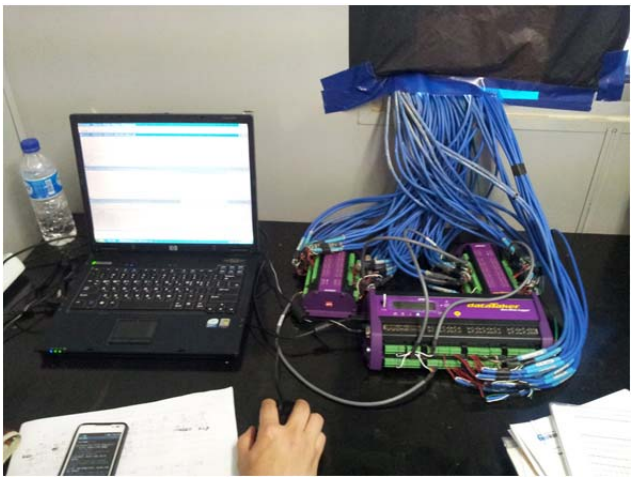
TESTING 1

Setup for testing		After the concrete reaches the required strength, the test may be started. An conditioned environment (cooled or heated) is required as the working area.
Telltale instrumentation and assembly		If not previously installed, the telltale rods need to be coupled together and inserted so that movement of the top of the upper bearing plate can be monitored.
Measurement of pile head movement from a reference beam		When on land, a simple reference beam can be set up using a rigid steel I-beam resting on supports at least 3 pile diameters away from the test pile. LVDTs or LVWDTs mounted on the reference beam can measure the top of pile movement.

TESTING 2

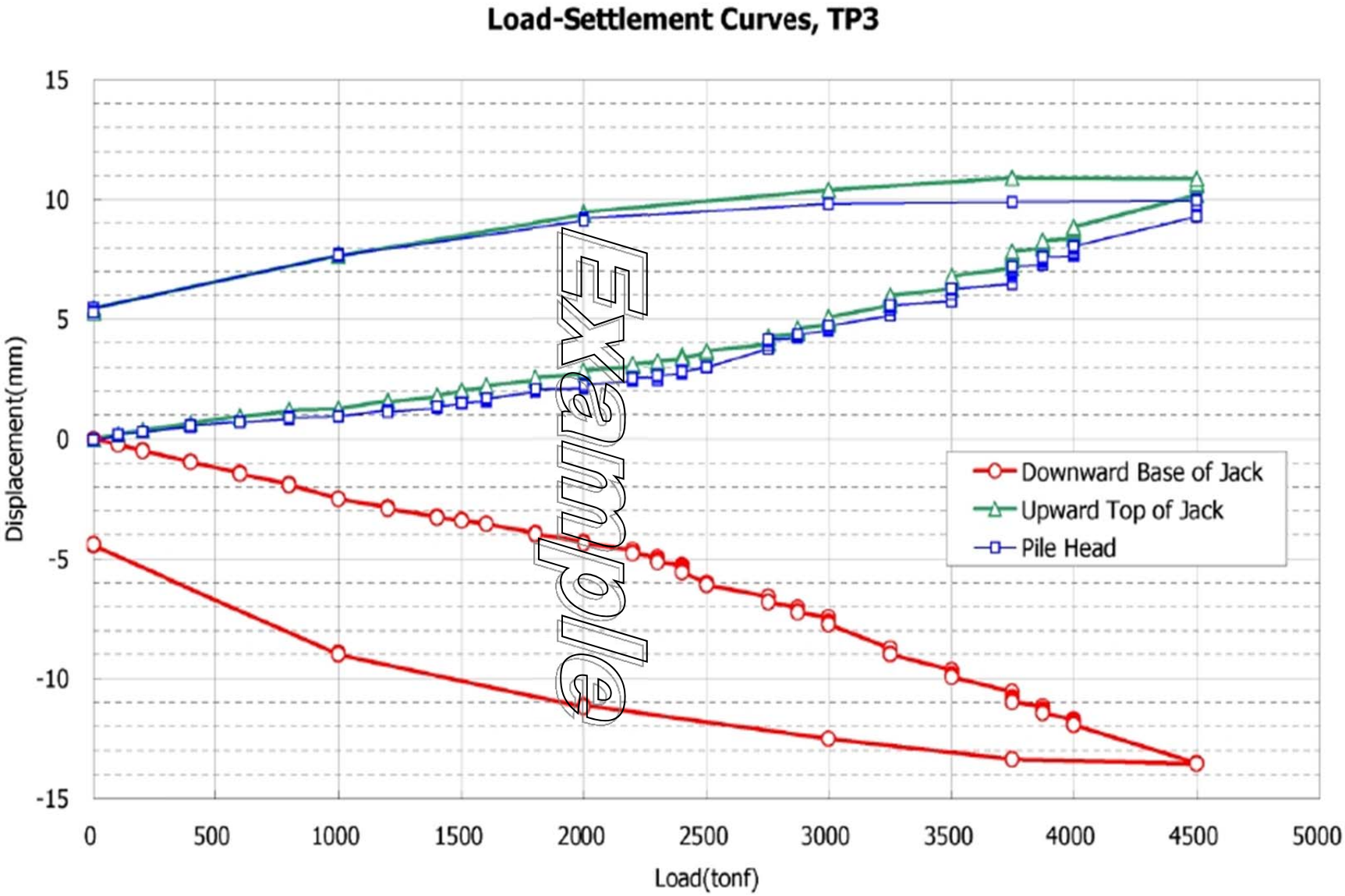
Typical K-CELL Instrumentation at ground level		Once the instrumentation is set up and before zero readings are taken, the area should be cordoned off and any adjacent site operations which might disturb the test must be stopped.
Instrument readings performed automatically using data acquisition system		Testing is carried out from inside a cabin. K-CELL cell will be pressurized high pressure hydraulic pumps.
Hydraulic pump and control system		A calibrated, high-pressure bourdon gauge will be used to read the pressure on the pump line and calibrated pressure transducer will read the pressure on the return line. Applied load is determined by relating the hydraulic pressure to the K-CELL cell load calibration curves.

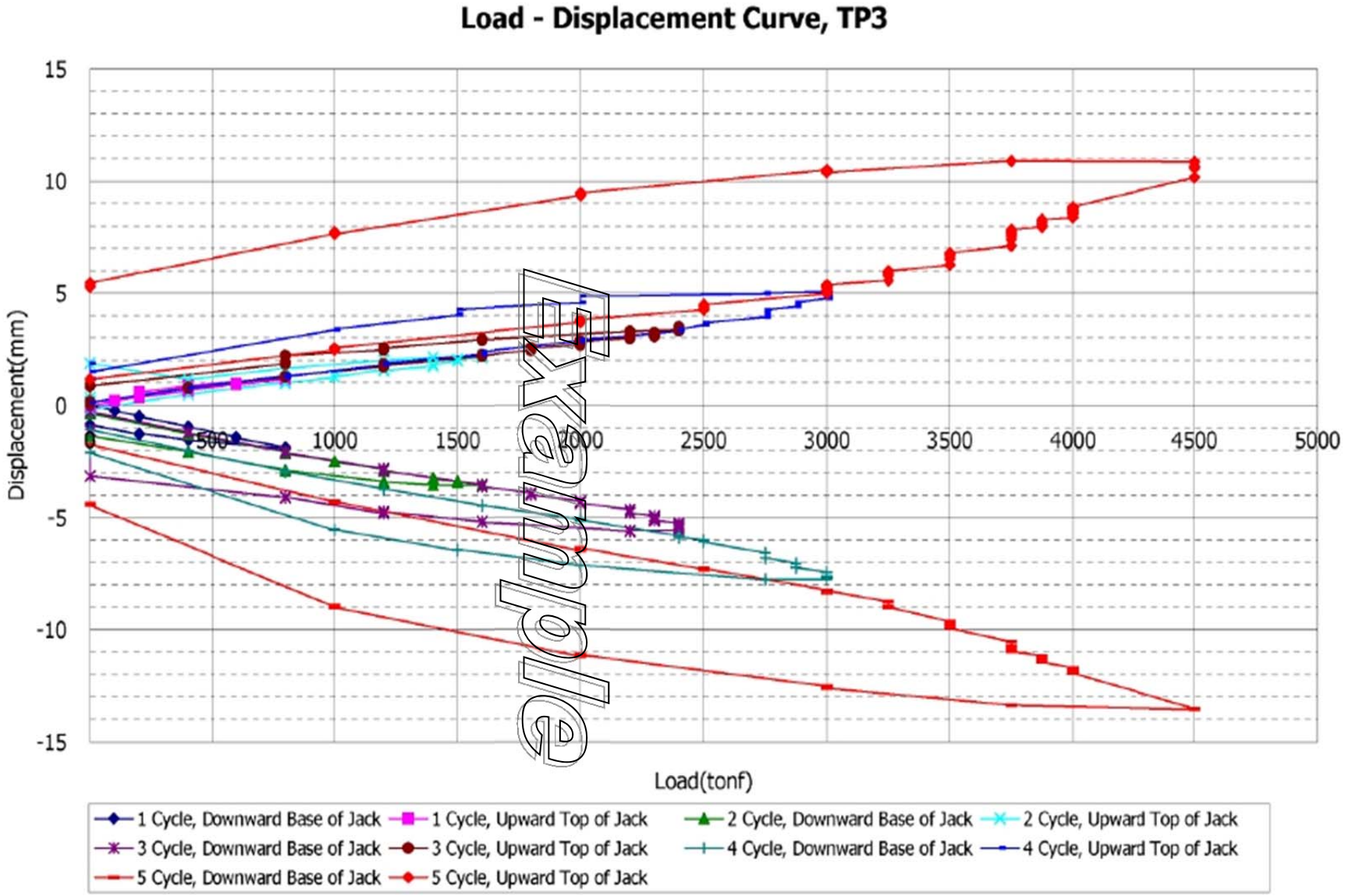
TESTING 3

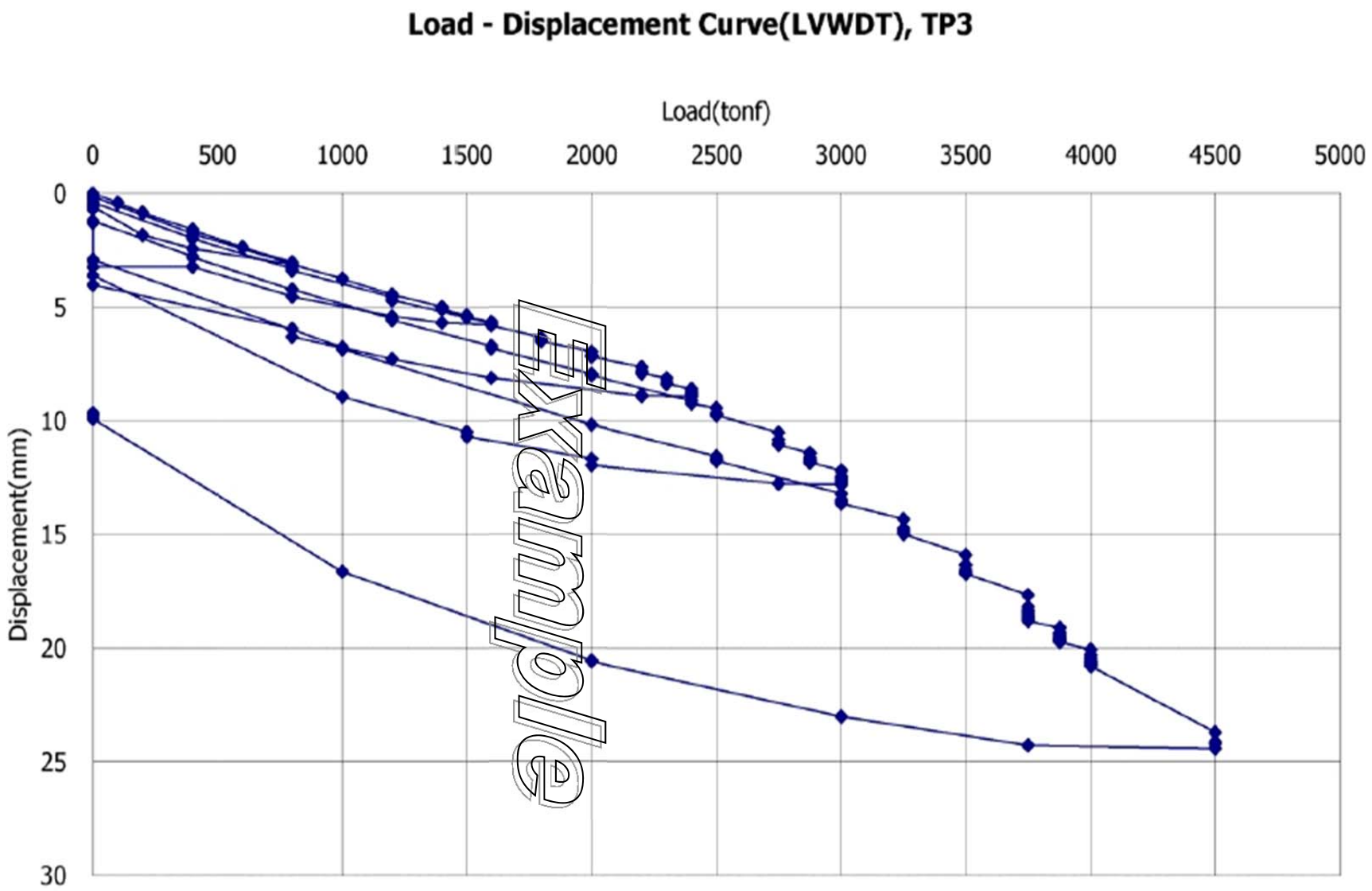
Data acquisition system		A datalogger will be used to measure and record directly data from all of the sensors from within the pile and on the pile head at intervals of 30 or 60 seconds. Data is stored in the datalogger memory and transmitted directly to the filed computer for live monitoring.
Real time display		The filed computer displays in real time the results from all of the sensors. The computer can also control the pumps directly and allow supervision of the loading schedule according to the agreed test specification.

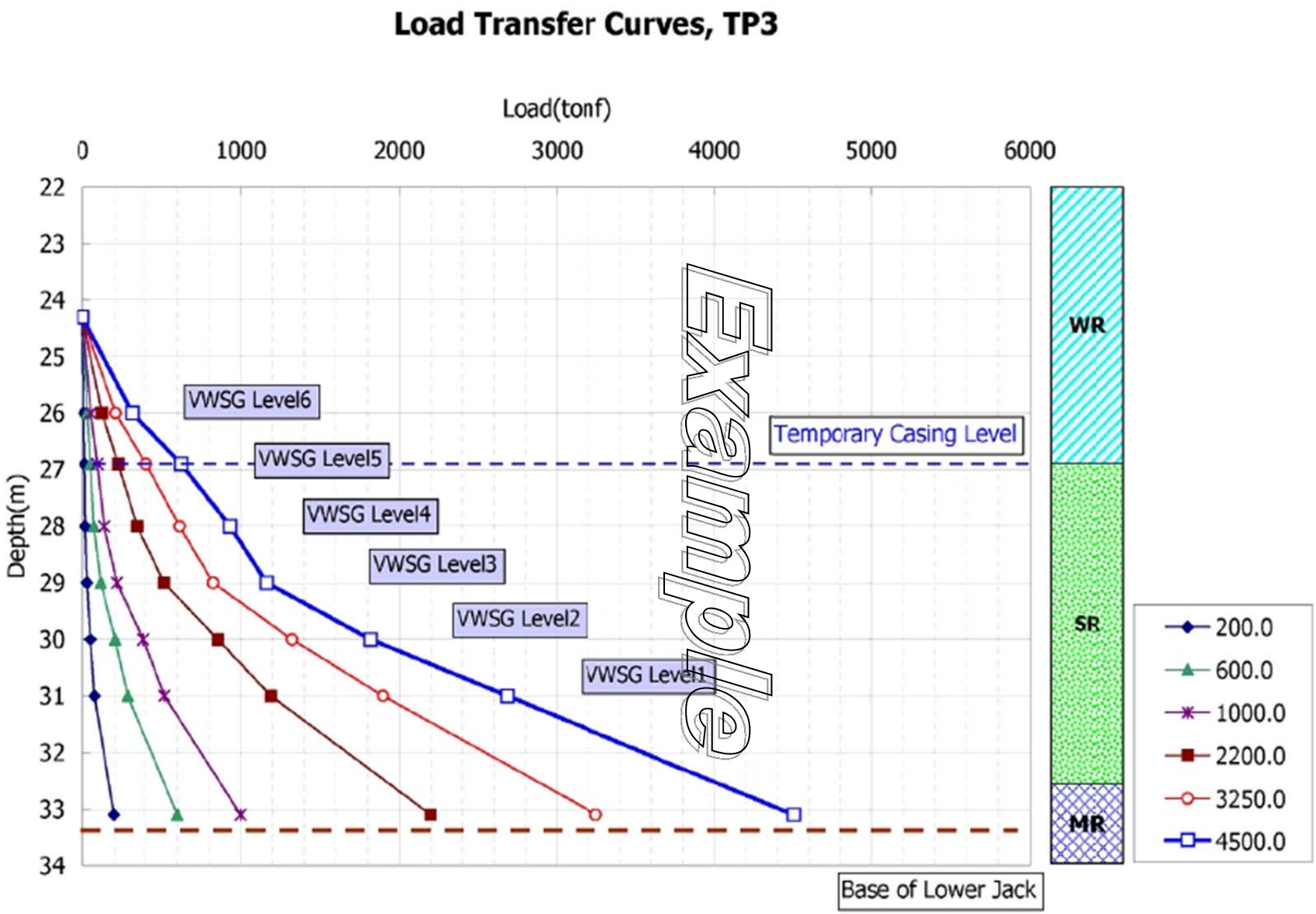
Appendix I

Sample Typical Figures and Tables Used for Reporting

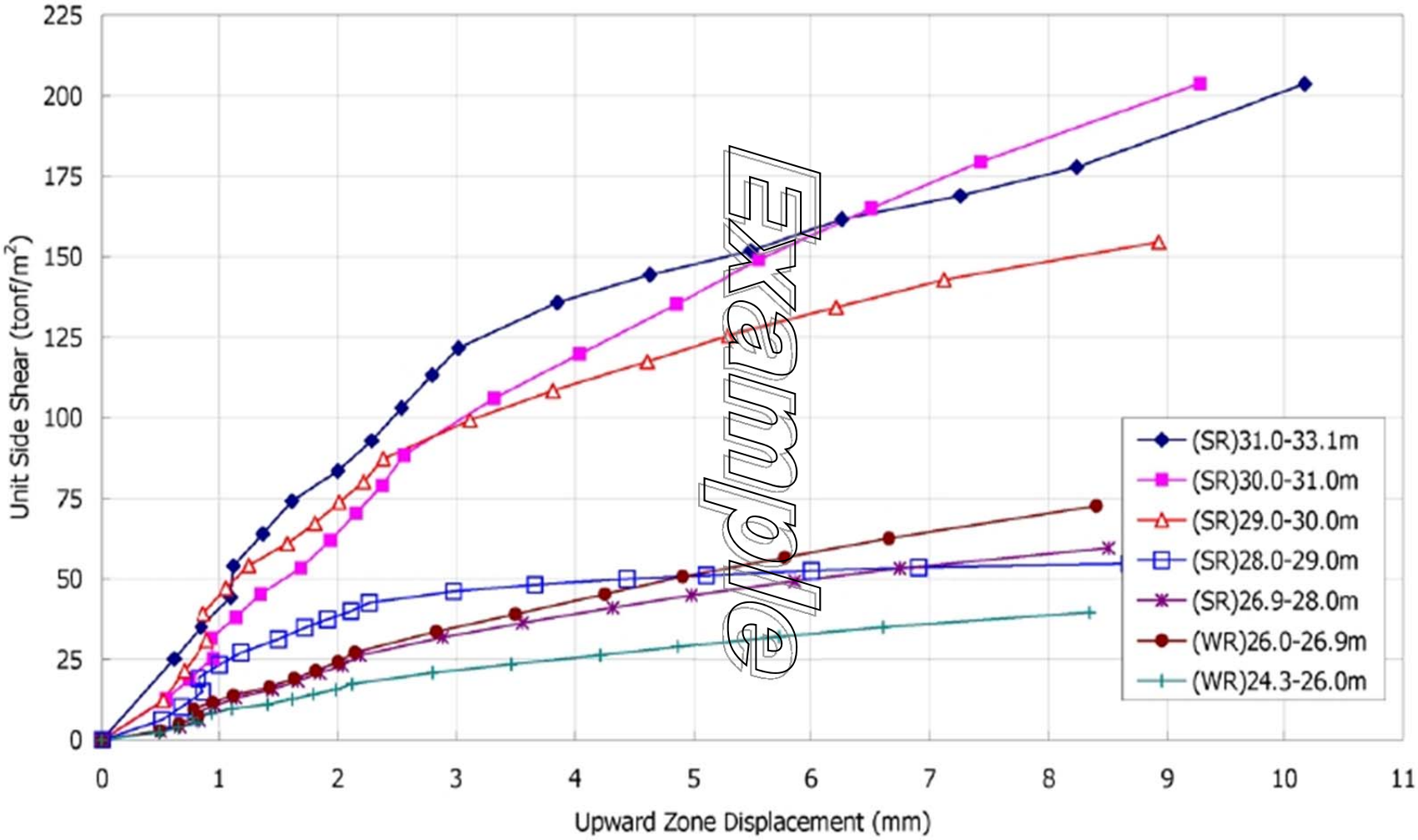

Load-Settlement Curves, TP3
Displacement(mm)
15
10
5
0
-5
-10
-15
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
Load(tonf)
Downward Base of Jack
Upward Top of Jack
Pile Head
Example

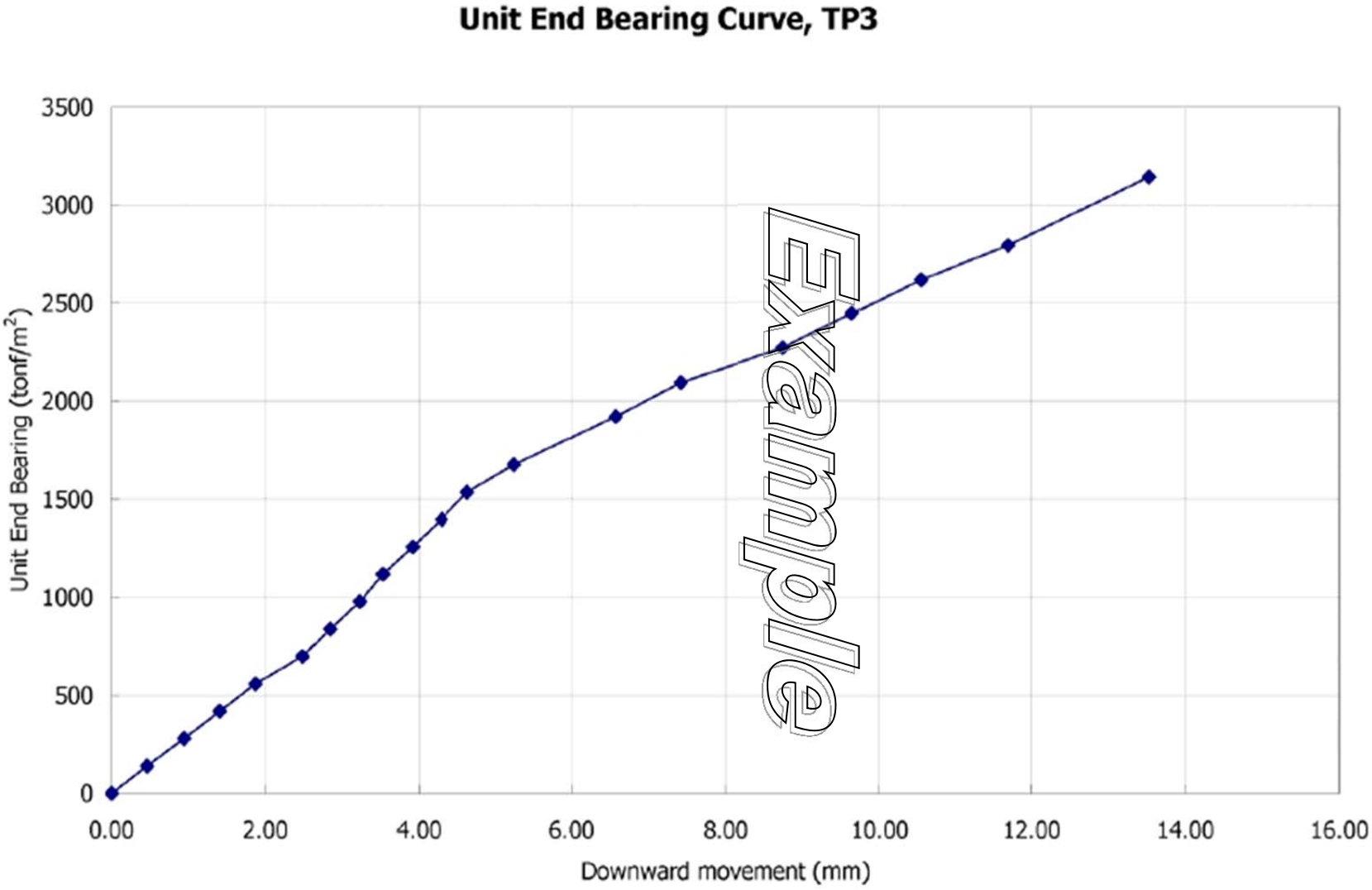

Load - Displacement Curve, TP3
15
10
5
0
-5
-10
-15
Displacement(mm)
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
Load(tonf)
1 Cycle, Downward Base of Jack
1 Cycle, Upward Top of Jack
2 Cycle, Downward Base of Jack
2 Cycle, Upward Top of Jack
3 Cycle, Downward Base of Jack
3 Cycle, Upward Top of Jack
4 Cycle, Downward Base of Jack
4 Cycle, Upward Top of Jack
5 Cycle, Downward Base of Jack
5 Cycle, Upward Top of Jack


Load - Displacement Curve(LVWDT), TP3
Load(tonf)
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
Displacement(mm)
0
5
10
15
20
25
30
Example


Load Transfer Curves, TP3
Load(tonf)
0
1000
2000
3000
4000
5000
6000
Depth(m)
22
23
24
25
26
27
28
29
30
31
32
33
34
VWSG Level6
VWSG Level5
VWSG Level4
VWSG Level3
VWSG Level2
VWSG Level1
Temporary Casing Level
Base of Lower Jack
Example
WR
SR
MR
200.0
600.0
1000.0
2200.0
3250.0
4500.0

Unit Side Shear Curves(t-z curves), TP3




Unit End Bearing Curve, TP3
Unit End Bearing (tonf/m²)
3500
3000
2500
2000
1500
1000
500
0
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
Downward movement (mm)
Example

Appendix J

Track Record

TEST RECORD(2013)

Report No.	PROJECT	Test Type	Test Pile Reference	Pile Size (mm)	Pile Length (m)	Design Load(WL) (KN)	Test Load (KN)	Date of Test Start	Strain Gauge	Remark 1	Remark 2
PL-2013001	Construction of Station EW30 and Viaducts for TUAS WEST Extension(C1688)	KENTLEDGE LOAD TEST (BORED PILE, WLT)	P092-1	ϕ 1,500	47.04	13,250	19,880	2013-08-27	x	WL x 1.5	SINGAPORE
PL-2013002	Construction of Station EW30 and Viaducts for TUAS WEST Extension(C1688)	LATERAL LOAD TEST (BORED PILE, WLT)	P129-5	ϕ 1,500		1,800	1,800	2013-09-20	x	WL x 1.0	SINGAPORE
PL-2013003	Construction of Station EW30 and Viaducts for TUAS WEST Extension(C1688)	LATERAL LOAD TEST (BORED PILE, WLT)	P090-2	ϕ 1,500		400	400	2013-09-27	x	WL x 1.0	SINGAPORE
PL-2013004	Construction of Station EW30 and Viaducts for TUAS WEST Extension(C1688)	LATERAL LOAD TEST (BORED PILE, WLT)	P089-2	ϕ 1,500		400	400	2013-09-30	x	WL x 1.0	SINGAPORE
PL-2013005	Construction of Station EW30 and Viaducts for TUAS WEST Extension(C1688)	KENTLEDGE LOAD TEST (BORED PILE, WLT)	C14A	ϕ 900	47.25	4,700	7,050	2013-10-10	x	WL x 1.5	SINGAPORE
PL-2013006	Construction of Station EW30 and Viaducts for TUAS WEST Extension(C1688)	KENTLEDGE LOAD TEST (BORED PILE, WLT)	C10	ϕ 800	49.65	3,700	5,550	2013-10-17	x	WL x 1.5	SINGAPORE
PL-2013007	Construction of Station EW30 and Viaducts for TUAS WEST Extension(C1688)	KENTLEDGE LOAD TEST (BORED PILE, WLT)	ENT-B05	ϕ 800	40.10	3,700	5,550	2013-12-04	x	WL x 1.5	SINGAPORE
PL-2013008	New Port North Hinterland - YoungWon Connections Roads Construction Works	K-CELL TEST (Cast-in-place PILE, WLT)	P2-10	ϕ 1,500	31.85	3,885	7,845	2013-11-25	x	WL x 2.0	KOREA
PL-2013009	Ulsan-Pohang Fifth Section Double Track Railway Roadbed Construction Works	K-CELL TEST (Cast-in-place PILE, WLT)	P40-2	ϕ 3,000	11.40	30,494	45,741	2013-12-18	O	WL x 1.5	KOREA
PL-2013010	Ulsan-Pohang Fifth Section Double Track Railway Roadbed Construction Works	K-CELL TEST (Cast-in-place PILE, WLT)	P8-2	ϕ 2,500	12.00	13,000	26,000	2014-01-09	O	WL x 2.0	KOREA

TEST RECORD(2014)

Report No.	PROJECT	Test Type	Test Pile Reference	Pile Size (mm)	Pile Length (m)	Design Load(WL) (KN)	Test Load (KN)	Date of Test Start	Strain Gauge	Remark 1	Remark 2
PL-2014001	Construction of Station EW30 and Viaducts for TUAS WEST Extension(C1688)	LATERAL LOAD TEST (BORED PILE, WLT)	C19-174	ϕ 1,500		550	550	2014-01-22	x	WL x 1.0	SINGAPORE
PL-2014002	Construction of Station EW30 and Viaducts for TUAS WEST Extension(C1688)	LATERAL LOAD TEST (BARRETTE PILE, WLT)	P096-B	1,500x2,800		452	452	2014-02-05	x	WL x 1.0	SINGAPORE
PL-2014003	Construction of Bridge Link Across Sungai Brunei	PDA TEST (STEEL PIPE PILE, WLT)	TB-4C	ϕ 508 t=12	19.70	980	2,650	2014-02-26	x	WL x 2.5	BRUNEI
PL-2014004	Construction of Station EW30 and Viaducts for TUAS WEST Extension(C1688)	LATERAL LOAD TEST (BARRETTE PILE, WLT)	P108-A	1,500x2,800		1,154	1,154	2014-03-26	x	WL x 1.0	SINGAPORE
PL-2014005	Construction of Bridge Link Across Sungai Brunei	K-CELL TEST (Cast-in-place PILE, WLT)	PYLON-A8	ϕ 1,500	75.50	15,000	60,000	2014-05-23	O	WL x 1.5	BRUNEI
PL-2014006	Construction of Bridge Link Across Sungai Brunei	K-CELL TEST (Cast-in-place PILE, WLT)	PYLON-D4	ϕ 1,500	64.60	14,900	22,350	2014-08-14	O	WL x 1.5	BRUNEI
PL-2014007	Construction of Maxwell Station For Thomson Line(Contract TSL223)	K-CELL TEST (BARRETTE PILE, PLT)	PTB-03	800x2,800	36.11	26,200	78,600	2014-09-30	O	WL x 3.0	SINGAPORE
PL-2014008	Construction of Maxwell Station For Thomson Line(Contract TSL223)	K-CELL TEST (BARRETTE PILE, PLT)	PTB-01	800x2,800	40.00	24,000	72,000	2014-11-04	O	WL x 3.0	SINGAPORE
CSL20140701	Construction of Bridge Link Across Sungai Brunei	CROSSHOLE SONIC LOGGING TEST	A-NO.3, 6, 7 B-NO-1	ϕ 1,500	75.50			2014-07-01			BRUNEI
CSL20140814	Construction of Bridge Link Across Sungai Brunei	CROSSHOLE SONIC LOGGING TEST	C-NO.1,2,3,4, 5,7,8 D-NO.3,7,9	ϕ 1,500	65.50			2014-08-14			BRUNEI

TEST RECORD(2015)

Report No.	PROJECT	Test Type	Test Pile Reference	Pile Size (mm)	Pile Length (m)	Design Load(WL) (KN)	Test Load (KN)	Date of Test Start	Strain Gauge	Remark 1	Remark 2
PL-2015001	Pusan New Port Roads Construction Works	K-CELL TEST (Cast-in-place PILE, WLT)	P6	ϕ 3,000	16.60	23,000	63,300	2015-01-08	x	WL x 2.75	KOREA
PL-2015002	Construction of marina Station For Thomson Line(Contract TSL226)	K-CELL TEST (BARRETTE PILE, PLT)	PTB-02	800x2,800	54.60	20,300	60,900	2015-05-16	O	WL x 3.0	SINGAPORE
PL-2015003	Construction of marina Station For Thomson Line(Contract TSL226)	K-CELL TEST (BARRETTE PILE, PLT)	PTB-01	800x2,800	54.60	21,200	63,600	2015-05-16	O	WL x 3.0	SINGAPORE
PL-2015004	DOWNTOWN 2 C915	K-CELL TEST (PRD PILE, UPLT)	UPLT-01B	ϕ 1200	17.00	8,420	21,050	2015-05-16	O	WL x 2.5	SINGAPORE
PL-2015005	Construction of Bridge Link Across Sungai Brunei	K-CELL TEST (Cast-in-place PILE, WLT)	PIER4-B3	ϕ 1,500	75.50	15,000	60,000	2015-06-19	O	WL x 1.5	BRUNEI
PL-2015006	Construction of Bridge Link Across Sungai Brunei	K-CELL TEST (Cast-in-place PILE, WLT)	PIER4-C2	ϕ 1,500	64.60	14,900	22,350	2015-06-19	O	WL x 1.5	BRUNEI
PL-2015007	DOWNTOWN 2 C915	K-CELL TEST (PRD PILE, WLT)	T-48	ϕ 1,200	17.92	5,890	8,840	2015-07-18		WL x 1.5	SINGAPORE
PL-2015008	DOWNTOWN 2 C915	K-CELL TEST (PRD PILE, WLT)	T-10	ϕ 1,200	16.73	8,480	12,720	2015-07-20		WL x 1.5	SINGAPORE
PL-2015009	Construction of Maxwell Station For Thomson Line(Contract TSL223)	K-CELL TEST (BARRETTE PILE, PLT)	PTB-02	800x2,800	38.30	24,000	72,000	2015-10-28	O	WL x 3.0	SINGAPORE

TEST RECORD(2015)

Report No.	PROJECT	Test Type	Test Pile Reference	Pile Size (mm)	Pile Length (m)	Design Load(WL) (KN)	Test Load (KN)	Date of Test Start	Strain Gauge	Remark 1	Remark 2
LTR-2015001	EPCC OF RGT - 2 TERMINAL AT PENGERANG, JOHOR	LATERAL TEST	T2001-PLTP01	ϕ 1,200	25.00	625	1,313	2015-03-19		WL x 2.1	MALAYSIA
LTR-2015002	EPCC OF RGT - 2 TERMINAL AT PENGERANG, JOHOR	LATERAL TEST	T2002-PLTP02	ϕ 1,200	20.90	625	1,313	2015-04-06		WL x 2.1	MALAYSIA
LTR-2015003	EPCC OF RGT - 2 TERMINAL AT PENGERANG, JOHOR	LATERAL TEST	T2001-T14	ϕ 1,200	18.63	625	938	2015-06-08		WL x 1.5	MALAYSIA
LTR-2015004	EPCC OF RGT - 2 TERMINAL AT PENGERANG, JOHOR	LATERAL TEST	T2001-T4	ϕ 1,200	26.30	625	938	2015-06-11		WL x 1.5	MALAYSIA
LTR-2015005	EPCC OF RGT - 2 TERMINAL AT PENGERANG, JOHOR	LATERAL TEST	T2001-T66	ϕ 1,200	26.20	625	938	2015-06-13		WL x 1.5	MALAYSIA
LTR-2015006	EPCC OF RGT - 2 TERMINAL AT PENGERANG, JOHOR	LATERAL TEST	T2001-T89	ϕ 1,200	19.30	625	938	2015-07-05		WL x 1.5	MALAYSIA
LTR-2015007	EPCC OF RGT - 2 TERMINAL AT PENGERANG, JOHOR	LATERAL TEST	T2002-T21	ϕ 1,200	21.05	625	938	2015-08-14		WL x 1.5	MALAYSIA
LTR-2015008	EPCC OF RGT - 2 TERMINAL AT PENGERANG, JOHOR	LATERAL TEST	T2002-T11	ϕ 1,200	20.35	625	938	2015-08-17		WL x 1.5	MALAYSIA
LTR-2015009	EPCC OF RGT - 2 TERMINAL AT PENGERANG, JOHOR	LATERAL TEST	T2002-T39	ϕ 1,200	25.15	625	938	2015-08-23		WL x 1.5	MALAYSIA
LTR-2015010	EPCC OF RGT - 2 TERMINAL AT PENGERANG, JOHOR	LATERAL TEST	T2002-T70	ϕ 1,200	19.05	625	938	2015-08-25		WL x 1.5	MALAYSIA

TEST RECORD(2015)

Report No.	PROJECT	Test Type	Test Pile Reference	Pile Size (mm)	Pile Length (m)	Design Load(WL) (KN)	Test Load (KN)	Date of Test Start	Strain Gauge	Remark 1	Remark 2
CSL20150101	Construction of Bridge Link Across Sungai Brunei	CROSSHOLE SONIC LOGGING TEST	P6-NO.2, 3	ϕ 1,300	25.37			2015-01-14			BRUNEI
CSL20150102	MOFAT CARPARK C.B.P(Φ800mm) Additional Work	CROSSHOLE SONIC LOGGING TEST	A1-NO.7,9 A3-NO.19,23 A4-NO.1,3 A7-NO.9,19	ϕ 800	11.00-19.10			2015-01-14			BRUNEI
CSL20150103	MOFAT Carpark C.B.P Additional Work East Ramp-C Bottom(Φ900mm) & Approach Road 2(Φ900mm)	CROSSHOLE SONIC LOGGING TEST	NO.80,82,83,84,85,86,87,89,90,91,93,95,97,99,101,103,105	ϕ 900	3.80-11.80			2015-03-10			BRUNEI
CSL20150104	CONSTRUCTION OF MAXWELL STATION FOR THOMSON-EAST COAST LINE(CONTRACT T223)	CROSSHOLE SONIC LOGGING TEST	NO.21.155	1200*2800	33.35-43.74			2015-05-09			SINGAPORE
CSL20150105	Construction of Bridge Link Across Sungai Bruneifrom Kg. Sg. Kebun to Jalan Residency, Brunei-Muara District	CROSSHOLE SONIC LOGGING TEST	P4-A1,A2 B1,B2	ϕ 1,500	23.10			2015-06-18			BRUNEI
CSL20150106	CONSTRUCTION OF MAXWELL STATION FOR THOMSON-EAST COAST LINE(CONTRACT T223)	CROSSHOLE SONIC LOGGING TEST	P165B,BR13, BR03	1200*2800	38.70-52.70			2015-07-22			SINGAPORE
CSL20150107	Construction of Bridge Link Across Sungai Bruneifrom Kg. Sg. Kebun to Jalan Residency, Brunei-Muara District	CROSSHOLE SONIC LOGGING TEST	P3-A1,C1 LP-A1,B2 RP-A1,B1 P5-A2,3,4, B4,D3,4	ϕ 1,500	19.10-64.10			2015-07-23			BRUNEI
PDA-2015001	Construction of Bridge Link Across Sungai Bruneifrom Kg. Sg. Kebun to Jalan Residency, Brunei-Muara District	PDA TEST	A2-25	ϕ 600	13.50	1,690	5,400	2015-04-23			BRUNEI
PDA-2015002	Construction of Bridge Link Across Sungai Bruneifrom Kg. Sg. Kebun to Jalan Residency, Brunei-Muara District	PDA TEST	PENT PILE #122	300x300	13.00	500	1,300	2015-05-19			BRUNEI
PIT-20150101	MOFAT CARPARK C.B.P(Φ600mm) Additional Work	LOW STRAIN INTEGRITY TEST(PIT TEST)	A8-NO. 11, 12	ϕ 600	5.00			2015-01-14			BRUNEI

TEST RECORD(2016)

Report No.	PROJECT	Test Type	Test Pile Reference	Pile Size (mm)	Pile Length (m)	Design Load(WL) (KN)	Test Load (KN)	Date of Test Start	Strain Gauge	Remark 1	Remark 2
PL-2016001	TEMBURONG BRIDGE PROJECT "PACKAGE CC3 – NAVIGATION BRIDGES"	K-CELL TEST (Cast-in-place PILE, PLT)	PPT303A	ϕ 1,500	98.00	16,700	35,070	2016-02-10	O	WL x 2.1	BRUNEI
PL-2016002	Construction of Maxwell Station For Thomson Line(Contract TSL223)	K-CELL TEST (BORED PILE, PLT)	PTP-01	ϕ 1,800	44.80	18,000	59,400	2016-02-26	O	WL x 3.3	SINGAPORE
PL-2016003	TEMBURONG BRIDGE PROJECT "PACKAGE CC3 – NAVIGATION BRIDGES"	K-CELL TEST (Cast-in-place PILE, PLT)	PPT304	ϕ 1,500	20.00	10,716	22,504	2016-03-23	O	WL x 2.1	BRUNEI
PL-2016004	TEMBURONG BRIDGE PROJECT "PACKAGE CC3 – NAVIGATION BRIDGES"	K-CELL TEST (Cast-in-place PILE, PLT)	PPT302	ϕ 1,500	100.60	19,832	41,647	2016-04-03	O	WL x 2.1	BRUNEI

TEST RECORD(2016)

Report No.	PROJECT	Test Type	Test Pile Reference	Pile Size (mm)	Pile Length (m)	Design Load(WL) (KN)	Test Load (KN)	Date of Test Start	Strain Gauge	Remark 1	Remark 2
CSL2016001	TEMBURONG BRIDGE PROJECT "PACKAGE CC3 – NAVIGATION BRIDGES"	CROSSHOLE SONIC LOGGING TEST	PPT303A	ϕ 1,500	98.00			2016-02-09			BRUNEI
CSL2016002	Construction of Bridge Link Across Sungai Brunei	CROSSHOLE SONIC LOGGING TEST	A1NO4, P1NO10, P2NO15	ϕ 900	22.70			2016-02-15			BRUNEI
CSL2016003	CONTACT – T3008. ADVANCED WORK AT DEPOT	CROSSHOLE SONIC LOGGING TEST	AHE42	800x2,800	60.00			2016-04-11			SINGAPORE
CSL2016004	CONTACT – T3008. ADVANCED WORK AT DEPOT	CROSSHOLE SONIC LOGGING TEST	HA44	800x2,800	53.50			2016-04-11			SINGAPORE
CSL2016005	CONTACT – T3008. ADVANCED WORK AT DEPOT	CROSSHOLE SONIC LOGGING TEST	RD54	800x2,800	55.30			2016-04-11			SINGAPORE

Appendix K

Risk Assessment

RISK ASSESSMENT

K-CELL INSTALLATION

Operation Hazard or Potentially Hazardous	Hazard	Probability	People	Impact	Risk	Controls to Minimize Risk	Residual Risk
		1	2	3	4		
Attach instrumentation to cages	Injury to persons	**L**	**L**	**L**	**L**	Use trained personnel only. Work from outside the cage. Entry to cage should only be made in exceptional circumstances and only if egress is safe. Ensure "Permit to Work" is used where appropriate.	**L**
Attachment of K-cell assembly to cage	Injury to persons in the vicinity due to welding operations	**L**	**L**	**M**	**M**	Use established safe practices for welding and lifting. Use trained personnel only. Ensure "Permit to Work" is used where appropriate. Keep safe distance from welding operations. Ensure competent person oversees/directs operations.	**L**
Fixing cables upper cages as cages are spliced	Injury to persons	**L**	**L**	**M**	**M**	Do not climb cage unless absolutely necessary. Use safe access facilities. Use fall arrest devices.	**L**
FINAL ASSESSMENT						**OVERALL RISK**	**L**

1. Likelihood 2. Number of people affected 3. Impact 4. Risk Assessment

Appendix L

Organization Chart

Bi-Direction Test Team Organization Chart

Operation Manager

S. I. KIM

Load Test Team

C. S. LEE

Load Test Team

Soe Thi Ha Aung

Appendix M

Load Test Schedule

Load Test Schedule for T305 Preliminary Pile (K-CELL)

T305 PROJECT

Work Scope	Description	Duration	Day
Preliminary Load Test	K-CELL Mobilization	1 day	
	Rebar Cage Fabrication	2 days	
	Setting up of Test Instruments	5 days	
	Rebar Cage Installation & Con'c Casting	1 day	
	Concrete Curing	28 days	
	Testing	4 days	
	Report Preparation & Submission	7 days