



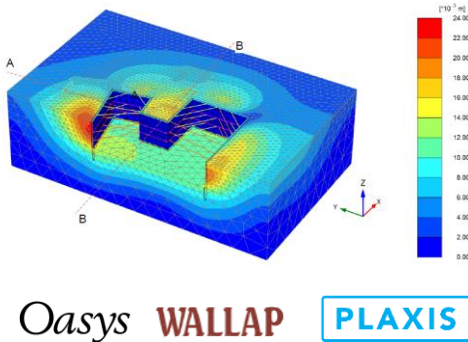
*Report for*  
Gilbert Ash Limited

# 115-119 Premier Inn Camden High Street London

## Pile Foundation Design



v1.0



*Prepared by:*  
Anca Munteanu

*Approved by:*  
Sebastian Draghici

*Location:*  
London



*Ref:*  
41713A3

*Date:*  
29<sup>th</sup> March 2021

Central Piling  
Rawden Enterprise Park  
Sixth Avenue  
Bluebridge Industrial Estate  
Halstead, Essex CO9 2FL

☎ 01787 474000  
✉ [info@centralpiling.com](mailto:info@centralpiling.com)  
🖱 [www.centrapiling.com](http://www.centrapiling.com)

Document Verification

Rev.	Date	Prepared	Approved	Comments
P01	29.03.2021	A. Munteanu, MSc Eng Design and Estimating Engineer 	S. Draghici, MSc Eng Technical Manager 	Preliminary issue. Design approval only

# Contents

1	Design Brief.....	1
2	Data Provided.....	1
3	Soil Assessment .....	1
3.1	Soil Properties.....	1
3.2	Ground Water Table.....	2
4	Bearing Pile Design .....	2
4.1	Software.....	2
4.2	Design Standard .....	3
4.3	Pile loads .....	3
4.4	Load tests .....	4
4.5	Pile dimensions .....	4
4.6	Materials .....	4
4.7	Concrete compressive strength.....	4
4.8	Reinforcement design .....	5
4.9	Pile Settlement Calculations.....	6
4.10	Comments.....	6
5	Design Risk Assessment.....	6
6	Piling mat design .....	7
7	Validation .....	7
8	Environmental considerations.....	7
9	Disclaimer .....	7
10	References .....	8

# Appendices

Appendix 1 – Design Line

Appendix 2 – Pile calculations. Oasys Output Report

Appendix 3 – Pile settlement calculations. Oasys Output Report

Appendix 4 – Pile calculations. Reinforcement design

Appendix 5 – Pile Schedule

Appendix 6 – Pile Load Summary

Appendix 7 – Design Risk Assessment

Appendix 8 – ACEC Concrete class

Appendix 9 – Piling mat design

# 1 Design Brief

Enclosed is the load bearing piles design for 115-119 Premier Inn Development, located in London, NW1 7JS.

The client for the present document and piling works is Gilbert Ash Limited.

The proposed method for the installation of the piles will be continuous flight auger (CFA) using a Soilmec SF50 rig.

The piles are designed to a diameter of 350mm. The pile lengths range from 17.9m to 24.5m, with the length indicative of the distance between the pile platform level and pile toes.

The design is conducted according to BS EN 1997 (Eurocode 7) and UK NA.

# 2 Data Provided

The following documents have been used as the basis for the design:

Table 1. Documents used for pile design

Document type	No.	Rev.	Date	Issued by	Comments
Drawing	CCL-28791-S-CAM-GA-B1-0097	C1	Dec. 2020	Clancy Consulting	Piling GA
Drawing	CCL-28791-S-CAM-GA-B1-0098	C1	Dec. 2020	Clancy Consulting	Foundation GA
Drawing	CCL-28791-S-CAM-GA-B1-0099	C1	Dec. 2020	Clancy Consulting	Basement GA
Ground Investigation Report	10/1345	00	May 2020	Clancy Consulting	Phase II

# 3 Soil Assessment

## 3.1 Soil Properties

Soil properties have been chosen based upon the data provided in the Clancy Consulting report and our experience of the local conditions. The design soil profile is indicated in Table 2, while the adopted values for the soil properties are summarized in Table 3.

Table 2.1 Design soil profile – High Level

Depth from ground level (m)	Levels (mAOD)	Soil Type
0...3.00		Made Ground (Soft dark sandy gravelly clay)/Ignored depth
Below 3.00		London Clay (Firm becoming stiff laminated Clay)

Table 3.2 Design soil profile – Low Level (basement)

Depth from ground level (m)	Levels (mAOD)	Soil Type
0...6.00		Ignored depth
Below 6.00		London Clay (Firm becoming stiff laminated Clay)

The ground investigations comprised two cable tool percussion boreholes drilled from ground level down to a maximum depth of 25m and three window samples down to a depth of 6.5m. Standard penetration tests (SPT) were carried out within the boreholes. Undrained triaxial tests were also performed, their results being considered for the design line.

The top of the piling mat is to be confirmed by the client.

Table 4. Soil properties

Soil type	Bulk density kN/m <sup>3</sup>	Adhesion factor $\alpha$	Cohesion <sup>a)</sup> kN/m <sup>2</sup>	Soil friction angle <sup>b)</sup> $\phi$
Made Ground	18	-	-	-
London Clay	19	0.5	*70+7.5z	-

<sup>a)</sup> After Stroud, 1975, *The standard penetration test in insensitive clays*

<sup>b)</sup> After Peck et al., 1974, *Foundation Engineering*, 2<sup>nd</sup> Edition

z indicates that the value is applied per metre depth (increasing linearly from the initial value).

\* from 3mbgl

The design allowed for a trimmed depth of up to 3m for the piles outside basement and 6m for the basement piles.

The results obtained from the SPT's were used to obtain most of the geotechnical parameters, based on well-known and generally accepted correlations indicated in the technical literature.

The standard penetration tests results were used to assess the cohesion in the London Clay layer, by considering the correlation  $c_u = 4.5 \cdot N_{SPT}$ . According to the site investigations, the undrained cohesion for the London Clay ranges between 70kPa at the top of the layer to 235kPa at 25m depth. The adopted Design Line for the undrained cohesion is presented in Appendix 1.

Given the findings of the Soil Report, the BRE Special Digest 1 - concrete in aggressive ground - recommends a design concrete class of DC-3. Additional details on the calculation of the concrete class can be found in Appendix 8.

### 3.2 Ground Water Table

The calculations allowed for a groundwater level at 9.5m depth, as per the findings of the ground investigations.

## 4 Bearing Pile Design

### 4.1 Software

The software used for the bearing pile design is Oasys version 19.6, developed by Arup and in-house EXCEL applications.

The Oasys Pile, used in its version 19.6, calculates the vertical load bearing capacities and vertical

settlements of a range of individual piles in a layered soil deposit. The theory is based on both conventional and new methods for drained (frictional) and undrained (cohesive) soils.

## 4.2 Design Standard

The bearing piles are designed in accordance with BS EN 1997-1:1994, BS EN 1992-1-1:2004 and the relevant UK National Annexes.

The partial resistance factors used to assess the piles bearing capacity are as per the NA to BS 1997-1:2004, table A.NA.8, based on Design Approach 1, Combination 2.

Table 5. Partial resistance factors for pile design

Resistance	Symbol	Partial factor
Model factor	$\gamma_{rd}$	1.4
Base	$\gamma_b$	2.0
Shaft resistance for compression load	$\gamma_s$	1.6
Shaft resistance for tension load	$\gamma_{s,t}$	2.0

The bearing capacity of the piles is assessed using the following formulas, as per BS EN 1997-1:2004:

$$R_{c,d} = \frac{R_{b,k}}{\gamma_b \cdot \gamma_{rd}} + \frac{R_{s,k}}{\gamma_s \cdot \gamma_{rd}}$$

$$R_{b,k} = A_b \cdot N_c \cdot c_u$$

$$R_{s,k} = A_s \cdot \alpha \cdot c_u$$

Where:

$R_{c,d}$  - the pile bearing capacity for compression load

$R_{b,k}$  - the pile base resistance

$R_{s,k}$  - the pile shaft capacity

$N_c$  - bearing coefficient

$c_u$  - undrained cohesion

$\alpha$  - adhesion factor

## 4.3 Pile loads

The structural engineer provided a full list of characteristic loads (compression and horizontal) for each bearing pile, included on the piling schedule drawings.

The loads have been factored using the appropriate partial factors on loads as per DA1 in accordance to BS EN 1997-1:2004.

Table 6. ULS partial factors on loads

Load component	Design Approach 1	
	Combination 2 Geotechnical design	Combination 1 Structural design
Permanent (dead) load	1.00	1.35
Variable (live) load	1.30	1.50

Table 7. Loads factored as per DA1, C2 – Geotechnical design

Pile diameter (mm)	Factored compression load (kN)
350	450 to 800

Table 8. Loads factored as per DA1, C1 – Structural design

Pile diameter (mm)	Factored horizontal load (kN)
350	30

#### 4.4 Load tests

The partial resistance factors allowed for in the pile design, being the highest ones recommended by EC7, negate the need for load testing, as per BS EN 1997-1:2004 and UK NA.

#### 4.5 Pile dimensions

Total number of bearing piles for the project is 99 with a diameter of 350mm.

#### 4.6 Materials

The materials used in the design are as follows:

- Concrete: C28/35 strength class and DC-3 ACEC class according to the recommendations of the BRE Special Digest 1, concrete in aggressive ground and has been chosen in accordance with the site investigation report conclusions.
- Steel: yield resistance of 500N/mm<sup>2</sup> (H ribbed bars).

#### 4.7 Concrete compressive strength

By applying the partial safety factors (A1) as per DA1, Combination 1, the design load for checking the maximum compression stress in the piles is calculated as follows:

$$N_d = A1 \cdot DL + A1 \cdot (LL + \psi_{0,1} \cdot WL + \psi_{0,2} \cdot F)$$

Thus the maximum design vertical load is as follows:

$$N_d = A1 \cdot DL + A1 \cdot (LL + \psi_0 \cdot WL) = 1.35 \cdot 605 + 1.5 \cdot (120 + 0.5 \cdot 0) = 997kN$$

The maximum compressive stress within the piles is calculated as follows:

$$\sigma_{c,350} = \frac{N}{A_c} = \frac{997 \cdot 10^3 N}{96 \cdot 10^3 mm^2} = 10.4 MPa$$

The compressive resistance of the concrete is calculated using the relation indicated in BS EN 1992-1:2004 (3.1.6):

$$f_{cd} = \alpha_{cc} \cdot f_{ck} / \gamma_c \cdot k_f = 0.85 \cdot 28 MPa / 1.50 \cdot 1.1 = 14.4 MPa$$

$$f_{cd} = 14.4 MPa > \sigma_{c,350} = 10.4 MPa$$

Where:

$f_{cd}$  design compressive strength of the concrete

$\alpha_{cc}$  coefficient taking account of long term effects on the compressive strength with a value of 0.85

$\gamma_c$  partial factor for concrete compressive strength equal to 1.5

$k_f$  reduction factor for cast in place piles without permanent casing.

The results obtained indicate that the concrete strength for C28/35 is sufficient to withstand the maximum compression loads acting on piles.

The concrete cover is 75mm.

## 4.8 Reinforcement design

The structural reinforcement is designed for the horizontal and tension loads specified by the structural engineer. The pile head fixity has been assumed as unrestrained (i.e. unable to rotate in any direction).

The minimum anchorage length specified by the structural engineer is 40 bar diameters. When establishing the piling mat level, the main contractor and the structural engineer should consider that for CFA technique, the top of the cage is left at piling mat level and this might affect the requirement for minimum anchorage.

The reinforcement design considered also the tension induced by a potential heave of the clay, caused by desiccation or stress relief.

Design is for heave induced tension for piles only. A suitable void former should be adopted to ensure that no heave force is put onto ground beams and pile caps.

The tension force is calculated as per the following relation:

$$H_f = \alpha \cdot c_u \cdot B \cdot \pi \cdot D$$

Where

$\alpha$  – adhesion factor

$c_u$  – undrained cohesion

$B$  – diameter of pile

$D$  – depth of desiccation

Detailed calculations are presented in Appendix 4.

A lateral load of 20kN has been specified for the piles design. The design of the reinforcement is based on Brom's theory for unrestrained pile head, considering the mobilisation of the ultimate soil resistance. Detailed calculations, including the relations used, are presented in Appendix 4 (Structural Design).



## 4.9 Pile Settlement Calculations

The software used for the settlement calculations is Oasys version 19.6, developed by Arup.

The Oasys Pile, used in its version 19.6, calculates the vertical load bearing capacities and vertical settlements of a range of individual piles in a layered soil deposit. The theory is based on both conventional and new methods for drained (frictional) and undrained (cohesive) soils.

The Mindlin method was used to calculate the settlements. Mindlin method calculates relative displacements across a stratum directly from the applied loads.

The pile settlement has been calculated for the minimum and maximum compression load for a 350mm pile diameter.

Table 8. Load summary

Pile diameter (mm)	Compression load (kN)	Pile Depth (m)	Pile settlement (mm)
350	420	17.9	2.6
	725	24.5	4.4

The full calculations are present in *Appendix 3*.

## 4.10 Comments

The construction tolerances (agreed by the in force legislation – ICE Specification for piling) are 75mm for plan positioning and 1 in 75 verticality tolerance. This tolerance should be allowed in the structural design of the pile caps.

The reinforcement bars will be de-bonded in accordance with the provided cut-off levels for the piles, using de-bonding foam. A tolerance of 150mm is adopted for the lower level of the de-bonding foam, as per the attached figure.

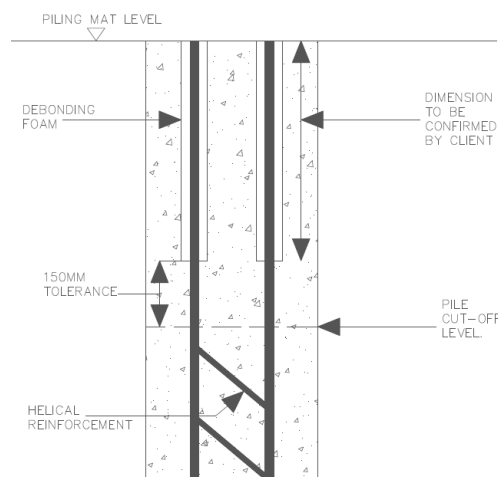


Figure 1 De-bonding detail

## 5 Design Risk Assessment

Appendix 7 contains the risk assessment for this project. Hazards associated with the design aspects of this project are described as follows:

- Hazard effect
- Severity

- Probability
- Initial risk (product of Severity and Probability)
- Control measures
- Residual risk (product of Severity and Probability after implementation of control measures).

## 6 Piling mat design

Appendix 9 includes the piling mat design for the rig to be used for the piling works. The design was conducted in accordance with BRE 470. Based on a granular subgrade, the piling mat should be 470mm thick with the use of geosynthetic reinforcement ( $T_{ult}=30\text{kN/m}$ ) or 560mm without geosynthetic reinforcement thick with aggregate size no greater than 75mm crushed concrete, installed in layers no thicker than 150mm.

Plate load testing on the piling mat will be required to verify the installation and quality of the piling mat. The specification for testing is indicated in the Working Platform Certificate.

## 7 Validation

Given the factor of safety and design parameters adopted, load testing is not required. Sonic echo testing has been allowed for all bearing piles. If required this can be arranged by contacting Central Piling's office with a notice period of a minimum of three working days. Please note that piles should not be trimmed until seven days have elapsed following installation.

In regard to the concrete cube testing BS8500 suggests that where a standard mix is supplied by a readymix company their compliance testing methods will be sufficient and no site testing will be necessary. The ICE SPERW requirement for testing is a set of 4 cubes per day with one cube being tested at 7 days, two at 28 days and a spare being kept in the event of the failure of the 28-day result to reach the design strength. We currently have an allowance for one set of cubes per day, as required by the ICE SPERW.

We would suggest that testing requirements are discussed and agreed with your checking engineer and approving authority prior to commencement.

## 8 Environmental considerations

The piles are installed using the continuous flight auger method, considered as the most appropriate in terms of minimising the environmental impact due to noise and vibration.

The concrete resulted from trimming before the piles are put into use or at the end of the building's life cycle, may be recycled, being a potential source of recycled aggregate for a range of applications. The reinforcing steel bars are also suitable for recycling.

Together with all the relevant information and records, the piles installed can be further used in case the current building is subject to structural modifications or they can be used to support new buildings.

## 9 Disclaimer

This is the property of Central Piling and had been issued for the named Client.

No part of this document may be copied, changed or multiplied without the written permission of Central Piling.

## 10 References

BRE Construction Division. (2005). *Concrete in Aggressive Ground* (3rd ed.). Garston: BRE.

British Standards Institution. (2015). *Code of Practice for Foundations (BS 8004)*. BSI.

European Committee for Standardization. (2004). *Eurocode 2: Design of Concrete Structures - Part 1-1: General Rules and Rules for Buildings*. British Standards Institution.

European Committee for Standardization. (2004). *Eurocode 7: Geotechnical Design - Part 1: General Rules*. British Standards Institution.

Gaba, A. R., Hardy, S., Powrie, W., Doughty, L and Selemetas, D. (2017). *CIRIA 760: Guidance on embedded retaining wall design*. Construction Industry Research and Information Association. London: CIRIA.

Institution of Civil Engineers. (2017). *ICE Specification for Piling and Embedded Retaining Walls* (3rd ed.). London, United Kingdom: Thomas Telford Publishing.

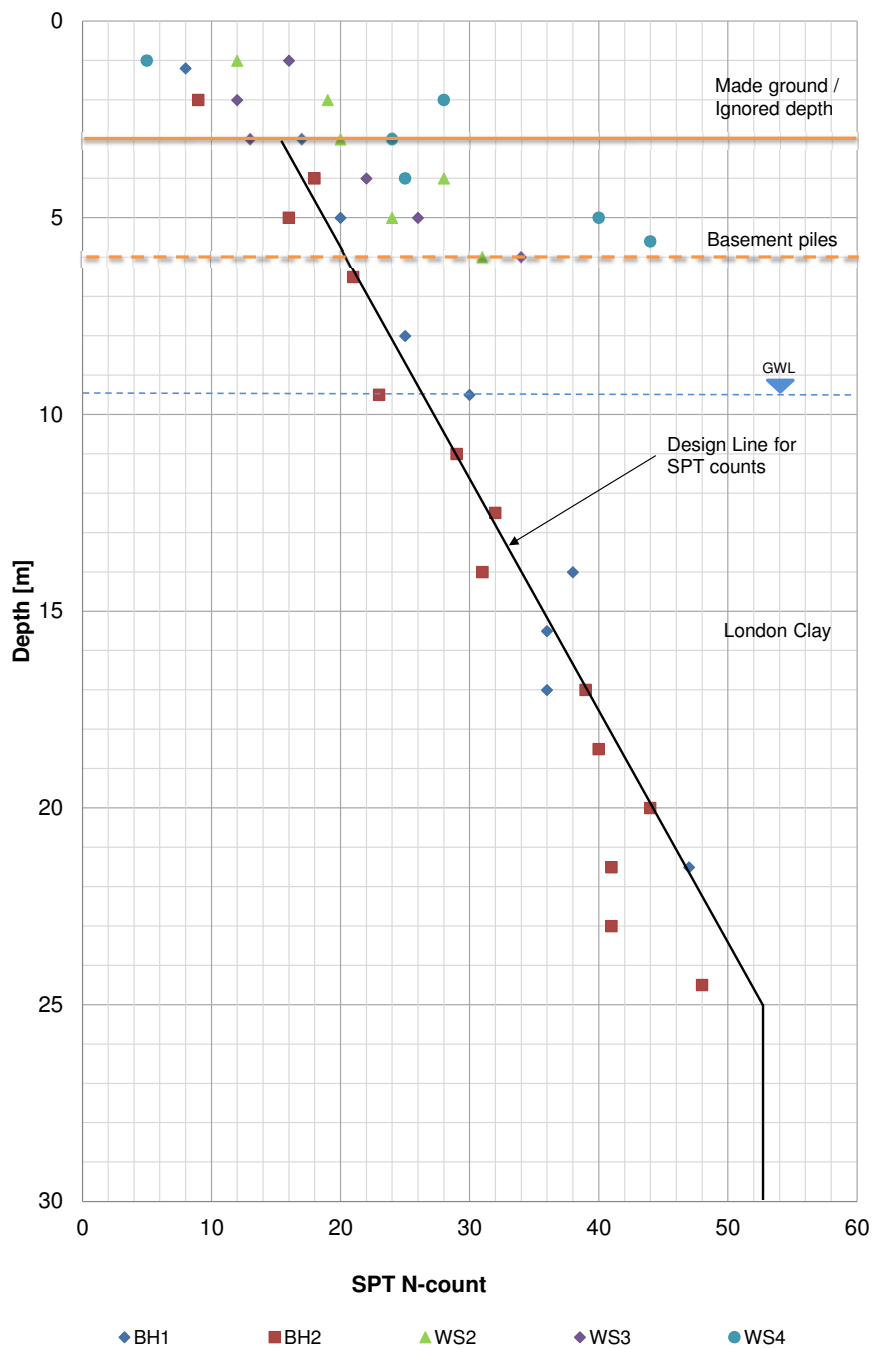
Peck, R. B. (1974). *Foundation Engineering* (2nd ed.). Canada: John Wiley & Sons.

Tomlinson, M., & Woodward, J. (2008). *Pile Design and Construction Practice* (5th ed.). Abington, Oxon, United Kingdom: Taylor & Francis.

---

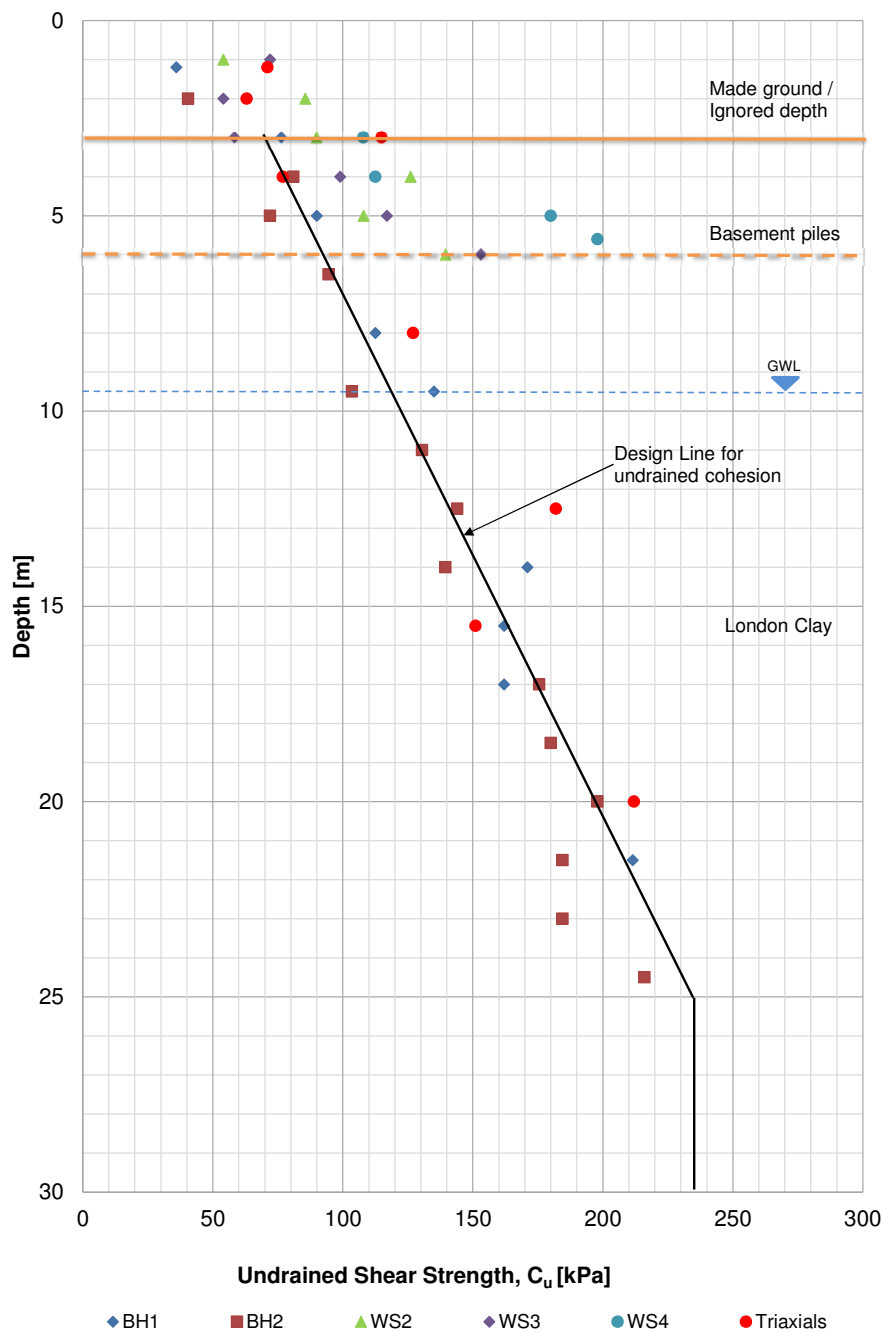
## **Appendix 1**

### *Design Line*



**Notes:**

Design properties have been derived in accordance with the Clancy Consulting site investigation reports.



#### Notes:

Design properties have been derived in accordance with the Clancy Consulting site investigation report.

Equivalent undrained shear strength derived from SPT N values converted by a multiple of 4.5.

## **Appendix 2**

---

### *Pile Calculations*

Job No.	Sheet No.	Rev.
<b>40631A3</b>		
<b>Drg. Ref.</b>		
<b>Made by</b> <b>AM</b>	<b>Date</b>	<b>Checked</b>

## Analysis Options

Design approach:	DA1 (C1 + C2)
File type:	CFA
Model factor:	1.40
Partial factor on negative skin friction - Set A1:	1.00
Partial factor on negative skin friction - Set A2:	1.00
Serviceability verified by load tests (preliminary/working) carried out on more than 1% of constructed piles to loads not less than 1.5 times the representative load for which they are designed?	No
Resistance verified by a maintained load test taken to the calculated, unfactored, ultimate resistance?	No
Datum type	Depth based
Effective stress profile	Calculated

## Pile Properties

Pile type	Solid
Pile cross-section	Circular
Under-ream	No
Calculation profile	Range
Minimum pile length	8.0000 m
Maximum pile length	25.000 m
Increment size	0.10000

Cross-section	Number of cross sections	Top Diameter [m]	Second Diameter location [m]	Second Diameter [m]	Third Diameter location [m]	Third Diameter [m]
Cross-section 1	1	0.35000				

## Undrained Materials - General Data

No.	Material description	Bulk unit weight [kN/m <sup>3</sup> ]	Cu material factor	Top Cu [kPa]	Base Cu [kPa]
1	London Clay 1	20.000	NA	70.000	235.00
2	London Clay 2	20.000	NA	90.000	235.00
3	London Clay Base	20.000	NA	235.00	235.00

## Undrained Materials - Skin Friction Data

No.	Material description	Skin friction computation	Alpha	q <sub>s</sub> Top [kPa]	q <sub>s</sub> Base [kPa]	Spec. Value [kPa]	q <sub>s,lim</sub> Value [kPa]
1	London Clay 1	Alpha specified	0.50000	NA	NA	Yes	140.00
2	London Clay 2	Alpha specified	0.50000	NA	NA	Yes	140.00
3	London Clay Base	Alpha specified	0.50000	NA	NA	Yes	140.00

## Undrained Materials - End Bearing Data

No.	Material description	End bearing computation	Nc	q <sub>b</sub> Top [kPa]	q <sub>b</sub> Base [kPa]	Spec. Value [kPa]	q <sub>b,lim</sub> Value [kPa]
1	London Clay 1	Nc specified	9.0000	NA	NA	Yes	2500.0
2	London Clay 2	Nc specified	9.0000	NA	NA	Yes	2500.0
3	London Clay Base	Nc specified	9.0000	NA	NA	Yes	2500.0



Job No.	Sheet No.	Rev.
40631A3		
Drg. Ref.		
Made by AM	Date	Checked

No.	Material description	End bearing computation	Nc	Qb	Qb, lim
			Top [kPa]	Base Spec. [kPa]	Value [kPa]

### Undrained Materials - Material Factors (Code Based)

No.	Material description	Qs factors		Nc factors		Qb factors	
		M1	M2	M1	M2	M1	M2
1	London Clay 1	N.A.	N.A.	1.0000	1.0000	N.A.	N.A.
2	London Clay 2	N.A.	N.A.	1.0000	1.0000	N.A.	N.A.
3	London Clay Base	N.A.	N.A.	1.0000	1.0000	N.A.	N.A.

### Drained Materials - General Data

No.	Material description	Bulk unit weight [kN/m³]	Tan (δ) material factor
1	Made Ground	18.000	NA

### Drained Materials - Friction Data

No.	Material description	Skin friction computation	Beta	Delta (δ) [deg]	Coefficient of earth pressure K	qs [kPa]	qs, lim [kPa]
1	Made Ground	qs specified	NA	NA	NA	0.0	0.0 No

### Drained Materials - End Bearing Data

No.	Material description	End bearing computation	Nq	Phi' [deg]	PhiD [deg]	Phicv' [deg]	Ir	Qb [kPa]	Qb, lim [kPa]	Nq-Phi curves
1	Made Ground	qb specified	NA	NA	NA	NA	NA	0.0	0.0 No	NA NA

### Drained Materials - Material Factors (Code Based)

No.	Material description	Qs factors		Nq factors		Qb factors	
		M1	M2	M1	M2	M1	M2
1	Made Ground	1.0000	1.0000	N.A.	N.A.	1.0000	1.0000

### Nq-Phi curve data

Curve 1 : Nq-Phi Curve 1

Nq Phi'  
[deg]

## STAGE SPECIFIC DATA

### Stage 0 : Initial Stage

#### Groundwater

No.	Level [m]	Pressure [kPa]	Unit weight of water [kN/m³]
1	9.5000	0.0	10.000

#### Soil Profiles

##### Soil Profile 1: Soil Profile 1 - High Level

No.	Depth	Material description	Contributes to negative skin
-----	-------	----------------------	------------------------------

Job No.	Sheet No.	Rev.
<b>40631A3</b>		
<b>Drg. Ref.</b>		
<b>Made by</b> <b>AM</b>	<b>Date</b>	<b>Checked</b>

			friction
	[m]		
1	0.0	Made Ground	No
2	3.0000	London Clay 1	No
3	25.000	London Clay Base	No

#### Soil Profile 2: Soil Profile 2 - Low Level

No.	Depth	Material description	Contributes to negative skin friction
	[m]		
1	0.0	Made Ground	No
2	6.0000	London Clay 2	No
3	25.000	London Clay Base	No

#### Soil Profile - Groundwater Map

No.	Soil Profile	Groundwater
1	Soil Profile 1 - High Level	Groundwater Profile 1
2	Soil Profile 2 - Low Level	Groundwater Profile 1

#### Stage specific warnings

- 1 - Stage 0 - The bottom most layer in Soil Profile 1 - High Level is assigned "Total stress" material. For this layer the cohesion is assumed to be constant at "Cu-Top", i.e cohesion specified at the top of this layer. The user specified value of cohesion at the bottom of this layer, "Cu-Bottom" is ignored. (Material Properties)
- 2 - Stage 0 - The bottom most layer in Soil Profile 2 - Low Level is assigned "Total stress" material. For this layer the cohesion is assumed to be constant at "Cu-Top", i.e cohesion specified at the top of this layer. The user specified value of cohesion at the bottom of this layer, "Cu-Bottom" is ignored. (Material Properties)

## CAPACITY RESULTS

#### Partial Resistance Factors Used:

##### DA1 C1

Shaft resistance factor for set R1 (Compression):	1.00
Base resistance factor for set R1:	1.00
Shaft resistance factor for set R1 (Tension):	1.00

##### DA1 C2

Shaft resistance factor for set R4 (Compression):	1.60
Base resistance factor for set R4:	2.00
Shaft resistance factor for set R4 (Tension):	2.00

Model factor:	1.40
---------------	------

#### Stress Profiles

##### Soil Profile 1: Soil Profile 1 - High Level

Depth	Density	Undrained Cohesion	Nq	Total vertical stress	Porewater pressure	Effective vertical stress	Effective horizontal stress*	Cumulative skin friction per unit perimeter
[m]	[kN/m³]	[kPa]		[kPa]	[kPa]	[kPa]	[kPa]	[kN/m]
0.0	18.000	0.0	N.A.	0.0	0.0	0.0	NA	0.0
3.0000	18.000	0.0	N.A.	54.000	0.0	54.000	NA	0.0
3.0000	20.000	70.000	N.A.	54.000	0.0	54.000	NA	0.0

Job No.	Sheet No.	Rev.
<b>40631A3</b>		
<b>Drg. Ref.</b>		
<b>Made by</b> <b>AM</b>	<b>Date</b>	<b>Checked</b>

Depth	Density	Undrained Cohesion	Nq	Total vertical stress	Porewater pressure	Effective vertical stress	Effective horizontal stress*	Cumulative skin friction per unit
8.0000	20.000	107.50	N.A.	154.00	0.0	154.00	NA	221.88
8.1000	20.000	108.25	N.A.	156.00	0.0	156.00	NA	227.27
8.2000	20.000	109.00	N.A.	158.00	0.0	158.00	NA	232.70
8.3000	20.000	109.75	N.A.	160.00	0.0	160.00	NA	238.17
8.4000	20.000	110.50	N.A.	162.00	0.0	162.00	NA	243.67
8.5000	20.000	111.25	N.A.	164.00	0.0	164.00	NA	249.22
8.6000	20.000	112.00	N.A.	166.00	0.0	166.00	NA	254.80
8.7000	20.000	112.75	N.A.	168.00	0.0	168.00	NA	260.42
8.8000	20.000	113.50	N.A.	170.00	0.0	170.00	NA	266.08
8.9000	20.000	114.25	N.A.	172.00	0.0	172.00	NA	271.77
9.0000	20.000	115.00	N.A.	174.00	0.0	174.00	NA	277.50
9.1000	20.000	115.75	N.A.	176.00	0.0	176.00	NA	283.27
9.2000	20.000	116.50	N.A.	178.00	0.0	178.00	NA	289.08
9.3000	20.000	117.25	N.A.	180.00	0.0	180.00	NA	294.92
9.4000	20.000	118.00	N.A.	182.00	0.0	182.00	NA	300.80
9.5000	20.000	118.75	N.A.	184.00	0.0	184.00	NA	306.72
9.6000	20.000	119.50	N.A.	186.00	1.0000	185.00	NA	312.68
9.7000	20.000	120.25	N.A.	188.00	2.0000	186.00	NA	318.67
9.8000	20.000	121.00	N.A.	190.00	3.0000	187.00	NA	324.70
9.9000	20.000	121.75	N.A.	192.00	4.0000	188.00	NA	330.77
10.000	20.000	122.50	N.A.	194.00	5.0000	189.00	NA	336.88
10.100	20.000	123.25	N.A.	196.00	6.0000	190.00	NA	343.02
10.200	20.000	124.00	N.A.	198.00	7.0000	191.00	NA	349.20
10.300	20.000	124.75	N.A.	200.00	8.0000	192.00	NA	355.42
10.400	20.000	125.50	N.A.	202.00	9.0000	193.00	NA	361.68
10.500	20.000	126.25	N.A.	204.00	10.000	194.00	NA	367.97
10.600	20.000	127.00	N.A.	206.00	11.000	195.00	NA	374.30
10.700	20.000	127.75	N.A.	208.00	12.000	196.00	NA	380.67
10.800	20.000	128.50	N.A.	210.00	13.000	197.00	NA	387.08
10.900	20.000	129.25	N.A.	212.00	14.000	198.00	NA	393.52
11.000	20.000	130.00	N.A.	214.00	15.000	199.00	NA	400.00
11.100	20.000	130.75	N.A.	216.00	16.000	200.00	NA	406.52
11.200	20.000	131.50	N.A.	218.00	17.000	201.00	NA	413.08
11.300	20.000	132.25	N.A.	220.00	18.000	202.00	NA	419.67
11.400	20.000	133.00	N.A.	222.00	19.000	203.00	NA	426.30
11.500	20.000	133.75	N.A.	224.00	20.000	204.00	NA	432.97
11.600	20.000	134.50	N.A.	226.00	21.000	205.00	NA	439.68
11.700	20.000	135.25	N.A.	228.00	22.000	206.00	NA	446.42
11.800	20.000	136.00	N.A.	230.00	23.000	207.00	NA	453.20
11.900	20.000	136.75	N.A.	232.00	24.000	208.00	NA	460.02
12.000	20.000	137.50	N.A.	234.00	25.000	209.00	NA	466.88
12.100	20.000	138.25	N.A.	236.00	26.000	210.00	NA	473.77
12.200	20.000	139.00	N.A.	238.00	27.000	211.00	NA	480.70
12.300	20.000	139.75	N.A.	240.00	28.000	212.00	NA	487.67
12.400	20.000	140.50	N.A.	242.00	29.000	213.00	NA	494.68
12.500	20.000	141.25	N.A.	244.00	30.000	214.00	NA	501.72
12.600	20.000	142.00	N.A.	246.00	31.000	215.00	NA	508.80
12.700	20.000	142.75	N.A.	248.00	32.000	216.00	NA	515.92
12.800	20.000	143.50	N.A.	250.00	33.000	217.00	NA	523.08
12.900	20.000	144.25	N.A.	252.00	34.000	218.00	NA	530.27
13.000	20.000	145.00	N.A.	254.00	35.000	219.00	NA	537.50
13.100	20.000	145.75	N.A.	256.00	36.000	220.00	NA	544.77
13.200	20.000	146.50	N.A.	258.00	37.000	221.00	NA	552.08
13.300	20.000	147.25	N.A.	260.00	38.000	222.00	NA	559.42
13.400	20.000	148.00	N.A.	262.00	39.000	223.00	NA	566.80
13.500	20.000	148.75	N.A.	264.00	40.000	224.00	NA	574.22
13.600	20.000	149.50	N.A.	266.00	41.000	225.00	NA	581.68
13.700	20.000	150.25	N.A.	268.00	42.000	226.00	NA	589.17
13.800	20.000	151.00	N.A.	270.00	43.000	227.00	NA	596.70
13.900	20.000	151.75	N.A.	272.00	44.000	228.00	NA	604.27
14.000	20.000	152.50	N.A.	274.00	45.000	229.00	NA	611.87
14.100	20.000	153.25	N.A.	276.00	46.000	230.00	NA	619.52
14.200	20.000	154.00	N.A.	278.00	47.000	231.00	NA	627.20
14.300	20.000	154.75	N.A.	280.00	48.000	232.00	NA	634.92
14.400	20.000	155.50	N.A.	282.00	49.000	233.00	NA	642.67
14.500	20.000	156.25	N.A.	284.00	50.000	234.00	NA	650.47
14.600	20.000	157.00	N.A.	286.00	51.000	235.00	NA	658.30
14.700	20.000	157.75	N.A.	288.00	52.000	236.00	NA	666.17
14.800	20.000	158.50	N.A.	290.00	53.000	237.00	NA	674.07
14.900	20.000	159.25	N.A.	292.00	54.000	238.00	NA	682.02
15.000	20.000	160.00	N.A.	294.00	55.000	239.00	NA	690.00
15.100	20.000	160.75	N.A.	296.00	56.000	240.00	NA	698.02
15.200	20.000	161.50	N.A.	298.00	57.000	241.00	NA	706.07
15.300	20.000	162.25	N.A.	300.00	58.000	242.00	NA	714.17
15.400	20.000	163.00	N.A.	302.00	59.000	243.00	NA	722.30
15.500	20.000	163.75	N.A.	304.00	60.000	244.00	NA	730.47
15.600	20.000	164.50	N.A.	306.00	61.000	245.00	NA	738.67

Job No.	Sheet No.	Rev.
<b>40631A3</b>		
<b>Drg. Ref.</b>		
<b>Made by</b> <b>AM</b>	<b>Date</b>	<b>Checked</b>

Depth	Density	Undrained Cohesion	Nq	Total vertical stress	Porewater pressure	Effective vertical stress	Effective horizontal stress*	Cumulative skin friction per unit
15.700	20.000	165.25	N.A.	308.00	62.000	246.00	NA	746.92
15.800	20.000	166.00	N.A.	310.00	63.000	247.00	NA	755.20
15.900	20.000	166.75	N.A.	312.00	64.000	248.00	NA	763.52
16.000	20.000	167.50	N.A.	314.00	65.000	249.00	NA	771.87
16.100	20.000	168.25	N.A.	316.00	66.000	250.00	NA	780.27
16.200	20.000	169.00	N.A.	318.00	67.000	251.00	NA	788.70
16.300	20.000	169.75	N.A.	320.00	68.000	252.00	NA	797.17
16.400	20.000	170.50	N.A.	322.00	69.000	253.00	NA	805.67
16.500	20.000	171.25	N.A.	324.00	70.000	254.00	NA	814.22
16.600	20.000	172.00	N.A.	326.00	71.000	255.00	NA	822.80
16.700	20.000	172.75	N.A.	328.00	72.000	256.00	NA	831.42
16.800	20.000	173.50	N.A.	330.00	73.000	257.00	NA	840.07
16.900	20.000	174.25	N.A.	332.00	74.000	258.00	NA	848.77
17.000	20.000	175.00	N.A.	334.00	75.000	259.00	NA	857.50
17.100	20.000	175.75	N.A.	336.00	76.000	260.00	NA	866.27
17.200	20.000	176.50	N.A.	338.00	77.000	261.00	NA	875.07
17.300	20.000	177.25	N.A.	340.00	78.000	262.00	NA	883.92
17.400	20.000	178.00	N.A.	342.00	79.000	263.00	NA	892.80
17.500	20.000	178.75	N.A.	344.00	80.000	264.00	NA	901.72
17.600	20.000	179.50	N.A.	346.00	81.000	265.00	NA	910.67
17.700	20.000	180.25	N.A.	348.00	82.000	266.00	NA	919.67
17.800	20.000	181.00	N.A.	350.00	83.000	267.00	NA	928.70
17.900	20.000	181.75	N.A.	352.00	84.000	268.00	NA	937.77
18.000	20.000	182.50	N.A.	354.00	85.000	269.00	NA	946.87
18.100	20.000	183.25	N.A.	356.00	86.000	270.00	NA	956.02
18.200	20.000	184.00	N.A.	358.00	87.000	271.00	NA	965.20
18.300	20.000	184.75	N.A.	360.00	88.000	272.00	NA	974.42
18.400	20.000	185.50	N.A.	362.00	89.000	273.00	NA	983.67
18.500	20.000	186.25	N.A.	364.00	90.000	274.00	NA	992.97
18.600	20.000	187.00	N.A.	366.00	91.000	275.00	NA	1002.3
18.700	20.000	187.75	N.A.	368.00	92.000	276.00	NA	1011.7
18.800	20.000	188.50	N.A.	370.00	93.000	277.00	NA	1021.1
18.900	20.000	189.25	N.A.	372.00	94.000	278.00	NA	1030.5
19.000	20.000	190.00	N.A.	374.00	95.000	279.00	NA	1040.0
19.100	20.000	190.75	N.A.	376.00	96.000	280.00	NA	1049.5
19.200	20.000	191.50	N.A.	378.00	97.000	281.00	NA	1059.1
19.300	20.000	192.25	N.A.	380.00	98.000	282.00	NA	1068.7
19.400	20.000	193.00	N.A.	382.00	99.000	283.00	NA	1078.3
19.500	20.000	193.75	N.A.	384.00	100.00	284.00	NA	1088.0
19.600	20.000	194.50	N.A.	386.00	101.00	285.00	NA	1097.7
19.700	20.000	195.25	N.A.	388.00	102.00	286.00	NA	1107.4
19.800	20.000	196.00	N.A.	390.00	103.00	287.00	NA	1117.2
19.900	20.000	196.75	N.A.	392.00	104.00	288.00	NA	1127.0
20.000	20.000	197.50	N.A.	394.00	105.00	289.00	NA	1136.9
20.100	20.000	198.25	N.A.	396.00	106.00	290.00	NA	1146.8
20.200	20.000	199.00	N.A.	398.00	107.00	291.00	NA	1156.7
20.300	20.000	199.75	N.A.	400.00	108.00	292.00	NA	1166.7
20.400	20.000	200.50	N.A.	402.00	109.00	293.00	NA	1176.7
20.500	20.000	201.25	N.A.	404.00	110.00	294.00	NA	1186.7
20.600	20.000	202.00	N.A.	406.00	111.00	295.00	NA	1196.8
20.700	20.000	202.75	N.A.	408.00	112.00	296.00	NA	1206.9
20.800	20.000	203.50	N.A.	410.00	113.00	297.00	NA	1217.1
20.900	20.000	204.25	N.A.	412.00	114.00	298.00	NA	1227.3
21.000	20.000	205.00	N.A.	414.00	115.00	299.00	NA	1237.5
21.100	20.000	205.75	N.A.	416.00	116.00	300.00	NA	1247.8
21.200	20.000	206.50	N.A.	418.00	117.00	301.00	NA	1258.1
21.300	20.000	207.25	N.A.	420.00	118.00	302.00	NA	1268.4
21.400	20.000	208.00	N.A.	422.00	119.00	303.00	NA	1278.8
21.500	20.000	208.75	N.A.	424.00	120.00	304.00	NA	1289.2
21.600	20.000	209.50	N.A.	426.00	121.00	305.00	NA	1299.7
21.700	20.000	210.25	N.A.	428.00	122.00	306.00	NA	1310.2
21.800	20.000	211.00	N.A.	430.00	123.00	307.00	NA	1320.7
21.900	20.000	211.75	N.A.	432.00	124.00	308.00	NA	1331.3
22.000	20.000	212.50	N.A.	434.00	125.00	309.00	NA	1341.9
22.100	20.000	213.25	N.A.	436.00	126.00	310.00	NA	1352.5
22.200	20.000	214.00	N.A.	438.00	127.00	311.00	NA	1363.2
22.300	20.000	214.75	N.A.	440.00	128.00	312.00	NA	1373.9
22.400	20.000	215.50	N.A.	442.00	129.00	313.00	NA	1384.7
22.500	20.000	216.25	N.A.	444.00	130.00	314.00	NA	1395.5
22.600	20.000	217.00	N.A.	446.00	131.00	315.00	NA	1406.3
22.700	20.000	217.75	N.A.	448.00	132.00	316.00	NA	1417.2
22.800	20.000	218.50	N.A.	450.00	133.00	317.00	NA	1428.1
22.900	20.000	219.25	N.A.	452.00	134.00	318.00	NA	1439.0
23.000	20.000	220.00	N.A.	454.00	135.00	319.00	NA	1450.0
23.100	20.000	220.75	N.A.	456.00	136.00	320.00	NA	1461.0
23.200	20.000	221.50	N.A.	458.00	137.00	321.00	NA	1472.1
23.300	20.000	222.25	N.A.	460.00	138.00	322.00	NA	1483.2

Job No.	Sheet No.	Rev.
<b>40631A3</b>		
<b>Drg. Ref.</b>		
<b>Made by</b> <b>AM</b>	<b>Date</b>	<b>Checked</b>

Depth	Density	Undrained Cohesion	Nq	Total vertical stress	Porewater pressure	Effective vertical stress	Effective horizontal stress*	Cumulative skin friction per unit
23.400	20.000	223.00	N.A.	462.00	139.00	323.00	NA	1494.3
23.500	20.000	223.75	N.A.	464.00	140.00	324.00	NA	1505.5
23.600	20.000	224.50	N.A.	466.00	141.00	325.00	NA	1516.7
23.700	20.000	225.25	N.A.	468.00	142.00	326.00	NA	1527.9
23.800	20.000	226.00	N.A.	470.00	143.00	327.00	NA	1539.2
23.900	20.000	226.75	N.A.	472.00	144.00	328.00	NA	1550.5
24.000	20.000	227.50	N.A.	474.00	145.00	329.00	NA	1561.9
24.100	20.000	228.25	N.A.	476.00	146.00	330.00	NA	1573.3
24.200	20.000	229.00	N.A.	478.00	147.00	331.00	NA	1584.7
24.300	20.000	229.75	N.A.	480.00	148.00	332.00	NA	1596.2
24.400	20.000	230.50	N.A.	482.00	149.00	333.00	NA	1607.7
24.500	20.000	231.25	N.A.	484.00	150.00	334.00	NA	1619.2
24.600	20.000	232.00	N.A.	486.00	151.00	335.00	NA	1630.8
24.700	20.000	232.75	N.A.	488.00	152.00	336.00	NA	1642.4
24.800	20.000	233.50	N.A.	490.00	153.00	337.00	NA	1654.1
24.900	20.000	234.25	N.A.	492.00	154.00	338.00	NA	1665.8
25.000	20.000	235.00	N.A.	494.00	155.00	339.00	NA	1677.5

**Soil Profile 2: Soil Profile 2 - Low Level**

Depth	Density	Undrained Cohesion	Nq	Total vertical stress	Porewater pressure	Effective vertical stress	Effective horizontal stress*	Cumulative skin friction per unit perimeter
[m]	[kN/m³]	[kPa]		[kPa]	[kPa]	[kPa]	[kPa]	[kN/m]
0.0	18.000	0.0	N.A.	0.0	0.0	0.0	NA	0.0
6.0000	18.000	0.0	N.A.	108.00	0.0	108.00	NA	0.0
6.0000	20.000	90.000	N.A.	108.00	0.0	108.00	NA	0.0
8.0000	20.000	105.26	N.A.	148.00	0.0	148.00	NA	97.632
8.1000	20.000	106.03	N.A.	150.00	0.0	150.00	NA	102.91
8.2000	20.000	106.79	N.A.	152.00	0.0	152.00	NA	108.23
8.3000	20.000	107.55	N.A.	154.00	0.0	154.00	NA	113.59
8.4000	20.000	108.32	N.A.	156.00	0.0	156.00	NA	118.99
8.5000	20.000	109.08	N.A.	158.00	0.0	158.00	NA	124.42
8.6000	20.000	109.84	N.A.	160.00	0.0	160.00	NA	129.90
8.7000	20.000	110.61	N.A.	162.00	0.0	162.00	NA	135.41
8.8000	20.000	111.37	N.A.	164.00	0.0	164.00	NA	140.96
8.9000	20.000	112.13	N.A.	166.00	0.0	166.00	NA	146.55
9.0000	20.000	112.89	N.A.	168.00	0.0	168.00	NA	152.17
9.1000	20.000	113.66	N.A.	170.00	0.0	170.00	NA	157.83
9.2000	20.000	114.42	N.A.	172.00	0.0	172.00	NA	163.54
9.3000	20.000	115.18	N.A.	174.00	0.0	174.00	NA	169.28
9.4000	20.000	115.95	N.A.	176.00	0.0	176.00	NA	175.06
9.5000	20.000	116.71	N.A.	178.00	0.0	178.00	NA	180.87
9.6000	20.000	117.47	N.A.	180.00	1.0000	179.00	NA	186.73
9.7000	20.000	118.24	N.A.	182.00	2.0000	180.00	NA	192.62
9.8000	20.000	119.00	N.A.	184.00	3.0000	181.00	NA	198.55
9.9000	20.000	119.76	N.A.	186.00	4.0000	182.00	NA	204.52
10.000	20.000	120.53	N.A.	188.00	5.0000	183.00	NA	210.53
10.100	20.000	121.29	N.A.	190.00	6.0000	184.00	NA	216.57
10.200	20.000	122.05	N.A.	192.00	7.0000	185.00	NA	222.66
10.300	20.000	122.82	N.A.	194.00	8.0000	186.00	NA	228.78
10.400	20.000	123.58	N.A.	196.00	9.0000	187.00	NA	234.94
10.500	20.000	124.34	N.A.	198.00	10.0000	188.00	NA	241.13
10.600	20.000	125.11	N.A.	200.00	11.0000	189.00	NA	247.37
10.700	20.000	125.87	N.A.	202.00	12.0000	190.00	NA	253.65
10.800	20.000	126.63	N.A.	204.00	13.0000	191.00	NA	259.96
10.900	20.000	127.39	N.A.	206.00	14.0000	192.00	NA	266.31
11.000	20.000	128.16	N.A.	208.00	15.0000	193.00	NA	272.70
11.100	20.000	128.92	N.A.	210.00	16.0000	194.00	NA	279.12
11.200	20.000	129.68	N.A.	212.00	17.0000	195.00	NA	285.59
11.300	20.000	130.45	N.A.	214.00	18.0000	196.00	NA	292.09
11.400	20.000	131.21	N.A.	216.00	19.0000	197.00	NA	298.63
11.500	20.000	131.97	N.A.	218.00	20.0000	198.00	NA	305.21
11.600	20.000	132.74	N.A.	220.00	21.0000	199.00	NA	311.83
11.700	20.000	133.50	N.A.	222.00	22.0000	200.00	NA	318.49
11.800	20.000	134.26	N.A.	224.00	23.0000	201.00	NA	325.18
11.900	20.000	135.03	N.A.	226.00	24.0000	202.00	NA	331.91
12.000	20.000	135.79	N.A.	228.00	25.0000	203.00	NA	338.68
12.100	20.000	136.55	N.A.	230.00	26.0000	204.00	NA	345.49
12.200	20.000	137.32	N.A.	232.00	27.0000	205.00	NA	352.34
12.300	20.000	138.08	N.A.	234.00	28.0000	206.00	NA	359.22
12.400	20.000	138.84	N.A.	236.00	29.0000	207.00	NA	366.15
12.500	20.000	139.61	N.A.	238.00	30.0000	208.00	NA	373.11
12.600	20.000	140.37	N.A.	240.00	31.0000	209.00	NA	380.11

Job No.	Sheet No.	Rev.
<b>40631A3</b>		
<b>Drg. Ref.</b>		
<b>Made by</b> <b>AM</b>	<b>Date</b>	<b>Checked</b>

Depth	Density	Undrained Cohesion	Nq	Total vertical stress	Porewater pressure	Effective vertical stress	Effective horizontal stress*	Cumulative skin friction per unit
12.700	20.000	141.13	N.A.	242.00	32.000	210.00	NA	387.15
12.800	20.000	141.89	N.A.	244.00	33.000	211.00	NA	394.22
12.900	20.000	142.66	N.A.	246.00	34.000	212.00	NA	401.33
13.000	20.000	143.42	N.A.	248.00	35.000	213.00	NA	408.49
13.100	20.000	144.18	N.A.	250.00	36.000	214.00	NA	415.68
13.200	20.000	144.95	N.A.	252.00	37.000	215.00	NA	422.91
13.300	20.000	145.71	N.A.	254.00	38.000	216.00	NA	430.17
13.400	20.000	146.47	N.A.	256.00	39.000	217.00	NA	437.48
13.500	20.000	147.24	N.A.	258.00	40.000	218.00	NA	444.82
13.600	20.000	148.00	N.A.	260.00	41.000	219.00	NA	452.20
13.700	20.000	148.76	N.A.	262.00	42.000	220.00	NA	459.62
13.800	20.000	149.53	N.A.	264.00	43.000	221.00	NA	467.08
13.900	20.000	150.29	N.A.	266.00	44.000	222.00	NA	474.57
14.000	20.000	151.05	N.A.	268.00	45.000	223.00	NA	482.11
14.100	20.000	151.82	N.A.	270.00	46.000	224.00	NA	489.68
14.200	20.000	152.58	N.A.	272.00	47.000	225.00	NA	497.29
14.300	20.000	153.34	N.A.	274.00	48.000	226.00	NA	504.93
14.400	20.000	154.11	N.A.	276.00	49.000	227.00	NA	512.62
14.500	20.000	154.87	N.A.	278.00	50.000	228.00	NA	520.35
14.600	20.000	155.63	N.A.	280.00	51.000	229.00	NA	528.11
14.700	20.000	156.39	N.A.	282.00	52.000	230.00	NA	535.91
14.800	20.000	157.16	N.A.	284.00	53.000	231.00	NA	543.75
14.900	20.000	157.92	N.A.	286.00	54.000	232.00	NA	551.62
15.000	20.000	158.68	N.A.	288.00	55.000	233.00	NA	559.54
15.100	20.000	159.45	N.A.	290.00	56.000	234.00	NA	567.49
15.200	20.000	160.21	N.A.	292.00	57.000	235.00	NA	575.48
15.300	20.000	160.97	N.A.	294.00	58.000	236.00	NA	583.51
15.400	20.000	161.74	N.A.	296.00	59.000	237.00	NA	591.58
15.500	20.000	162.50	N.A.	298.00	60.000	238.00	NA	599.69
15.600	20.000	163.26	N.A.	300.00	61.000	239.00	NA	607.83
15.700	20.000	164.03	N.A.	302.00	62.000	240.00	NA	616.01
15.800	20.000	164.79	N.A.	304.00	63.000	241.00	NA	624.23
15.900	20.000	165.55	N.A.	306.00	64.000	242.00	NA	632.49
16.000	20.000	166.32	N.A.	308.00	65.000	243.00	NA	640.79
16.100	20.000	167.08	N.A.	310.00	66.000	244.00	NA	649.12
16.200	20.000	167.84	N.A.	312.00	67.000	245.00	NA	657.50
16.300	20.000	168.61	N.A.	314.00	68.000	246.00	NA	665.91
16.400	20.000	169.37	N.A.	316.00	69.000	247.00	NA	674.36
16.500	20.000	170.13	N.A.	318.00	70.000	248.00	NA	682.85
16.600	20.000	170.89	N.A.	320.00	71.000	249.00	NA	691.37
16.700	20.000	171.66	N.A.	322.00	72.000	250.00	NA	699.93
16.800	20.000	172.42	N.A.	324.00	73.000	251.00	NA	708.54
16.900	20.000	173.18	N.A.	326.00	74.000	252.00	NA	717.18
17.000	20.000	173.95	N.A.	328.00	75.000	253.00	NA	725.86
17.100	20.000	174.71	N.A.	330.00	76.000	254.00	NA	734.57
17.200	20.000	175.47	N.A.	332.00	77.000	255.00	NA	743.33
17.300	20.000	176.24	N.A.	334.00	78.000	256.00	NA	752.12
17.400	20.000	177.00	N.A.	336.00	79.000	257.00	NA	760.95
17.500	20.000	177.76	N.A.	338.00	80.000	258.00	NA	769.82
17.600	20.000	178.53	N.A.	340.00	81.000	259.00	NA	778.73
17.700	20.000	179.29	N.A.	342.00	82.000	260.00	NA	787.67
17.800	20.000	180.05	N.A.	344.00	83.000	261.00	NA	796.66
17.900	20.000	180.82	N.A.	346.00	84.000	262.00	NA	805.68
18.000	20.000	181.58	N.A.	348.00	85.000	263.00	NA	814.74
18.100	20.000	182.34	N.A.	350.00	86.000	264.00	NA	823.83
18.200	20.000	183.11	N.A.	352.00	87.000	265.00	NA	832.97
18.300	20.000	183.87	N.A.	354.00	88.000	266.00	NA	842.15
18.400	20.000	184.63	N.A.	356.00	89.000	267.00	NA	851.36
18.500	20.000	185.39	N.A.	358.00	90.000	268.00	NA	860.61
18.600	20.000	186.16	N.A.	360.00	91.000	269.00	NA	869.90
18.700	20.000	186.92	N.A.	362.00	92.000	270.00	NA	879.22
18.800	20.000	187.68	N.A.	364.00	93.000	271.00	NA	888.59
18.900	20.000	188.45	N.A.	366.00	94.000	272.00	NA	897.99
19.000	20.000	189.21	N.A.	368.00	95.000	273.00	NA	907.43
19.100	20.000	189.97	N.A.	370.00	96.000	274.00	NA	916.91
19.200	20.000	190.74	N.A.	372.00	97.000	275.00	NA	926.43
19.300	20.000	191.50	N.A.	374.00	98.000	276.00	NA	935.99
19.400	20.000	192.26	N.A.	376.00	99.000	277.00	NA	945.58
19.500	20.000	193.03	N.A.	378.00	100.00	278.00	NA	955.21
19.600	20.000	193.79	N.A.	380.00	101.00	279.00	NA	964.88
19.700	20.000	194.55	N.A.	382.00	102.00	280.00	NA	974.59
19.800	20.000	195.32	N.A.	384.00	103.00	281.00	NA	984.34
19.900	20.000	196.08	N.A.	386.00	104.00	282.00	NA	994.12
20.000	20.000	196.84	N.A.	388.00	105.00	283.00	NA	1003.9
20.100	20.000	197.61	N.A.	390.00	106.00	284.00	NA	1013.8
20.200	20.000	198.37	N.A.	392.00	107.00	285.00	NA	1023.7
20.300	20.000	199.13	N.A.	394.00	108.00	286.00	NA	1033.6

Job No.	Sheet No.	Rev.
<b>40631A3</b>		
<b>Drg. Ref.</b>		
<b>Made by</b> <b>AM</b>	<b>Date</b>	<b>Checked</b>

Depth	Density	Undrained Cohesion	Nq	Total vertical stress	Porewater pressure	Effective vertical stress	Effective horizontal stress*	Cumulative skin friction per unit
20.400	20.000	199.89	N.A.	396.00	109.00	287.00	NA	1043.6
20.500	20.000	200.66	N.A.	398.00	110.00	288.00	NA	1053.6
20.600	20.000	201.42	N.A.	400.00	111.00	289.00	NA	1063.7
20.700	20.000	202.18	N.A.	402.00	112.00	290.00	NA	1073.8
20.800	20.000	202.95	N.A.	404.00	113.00	291.00	NA	1083.9
20.900	20.000	203.71	N.A.	406.00	114.00	292.00	NA	1094.1
21.000	20.000	204.47	N.A.	408.00	115.00	293.00	NA	1104.3
21.100	20.000	205.24	N.A.	410.00	116.00	294.00	NA	1114.5
21.200	20.000	206.00	N.A.	412.00	117.00	295.00	NA	1124.8
21.300	20.000	206.76	N.A.	414.00	118.00	296.00	NA	1135.1
21.400	20.000	207.53	N.A.	416.00	119.00	297.00	NA	1145.5
21.500	20.000	208.29	N.A.	418.00	120.00	298.00	NA	1155.9
21.600	20.000	209.05	N.A.	420.00	121.00	299.00	NA	1166.3
21.700	20.000	209.82	N.A.	422.00	122.00	300.00	NA	1176.8
21.800	20.000	210.58	N.A.	424.00	123.00	301.00	NA	1187.3
21.900	20.000	211.34	N.A.	426.00	124.00	302.00	NA	1197.8
22.000	20.000	212.11	N.A.	428.00	125.00	303.00	NA	1208.4
22.100	20.000	212.87	N.A.	430.00	126.00	304.00	NA	1219.0
22.200	20.000	213.63	N.A.	432.00	127.00	305.00	NA	1229.7
22.300	20.000	214.39	N.A.	434.00	128.00	306.00	NA	1240.4
22.400	20.000	215.16	N.A.	436.00	129.00	307.00	NA	1251.1
22.500	20.000	215.92	N.A.	438.00	130.00	308.00	NA	1261.9
22.600	20.000	216.68	N.A.	440.00	131.00	309.00	NA	1272.7
22.700	20.000	217.45	N.A.	442.00	132.00	310.00	NA	1283.6
22.800	20.000	218.21	N.A.	444.00	133.00	311.00	NA	1294.5
22.900	20.000	218.97	N.A.	446.00	134.00	312.00	NA	1305.4
23.000	20.000	219.74	N.A.	448.00	135.00	313.00	NA	1316.4
23.100	20.000	220.50	N.A.	450.00	136.00	314.00	NA	1327.4
23.200	20.000	221.26	N.A.	452.00	137.00	315.00	NA	1338.4
23.300	20.000	222.03	N.A.	454.00	138.00	316.00	NA	1349.5
23.400	20.000	222.79	N.A.	456.00	139.00	317.00	NA	1360.6
23.500	20.000	223.55	N.A.	458.00	140.00	318.00	NA	1371.8
23.600	20.000	224.32	N.A.	460.00	141.00	319.00	NA	1383.0
23.700	20.000	225.08	N.A.	462.00	142.00	320.00	NA	1394.2
23.800	20.000	225.84	N.A.	464.00	143.00	321.00	NA	1405.5
23.900	20.000	226.61	N.A.	466.00	144.00	322.00	NA	1416.8
24.000	20.000	227.37	N.A.	468.00	145.00	323.00	NA	1428.2
24.100	20.000	228.13	N.A.	470.00	146.00	324.00	NA	1439.5
24.200	20.000	228.89	N.A.	472.00	147.00	325.00	NA	1451.0
24.300	20.000	229.66	N.A.	474.00	148.00	326.00	NA	1462.4
24.400	20.000	230.42	N.A.	476.00	149.00	327.00	NA	1473.9
24.500	20.000	231.18	N.A.	478.00	150.00	328.00	NA	1485.5
24.600	20.000	231.95	N.A.	480.00	151.00	329.00	NA	1497.1
24.700	20.000	232.71	N.A.	482.00	152.00	330.00	NA	1508.7
24.800	20.000	233.47	N.A.	484.00	153.00	331.00	NA	1520.3
24.900	20.000	234.24	N.A.	486.00	154.00	332.00	NA	1532.0
25.000	20.000	235.00	N.A.	488.00	155.00	333.00	NA	1543.7

\* Effective horizontal stress not calculated for "Total Stress" materials and for Beta Method.

## Cross-section 1 results:

Uniform pile with top shaft diameter = 0.35 m

## Results - Compression

### Soil Profile 1: Soil Profile 1 - High Level

Depth	File length	Ultimate base capacity	Cumulative external Friction	Negative skin friction	Net ultimate resistance	Design resistance	Combination with least resistance	Factored load*
		(Q <sub>b</sub> )	(Q <sub>s</sub> )	(Q <sub>nsf</sub> )		DA1-C1	DA1-C2	
[m]	[m]	[kN]	[kN]	[kN]	[kN]	[kN]	[kN]	[kN]
8.0000	8.0000	93.084	243.96	0.0	337.05	240.75	142.16	2 0.0 (C) 0.0 (C)
8.1000	8.1000	93.734	249.90	0.0	343.63	245.45	145.04	2 0.0 (C) 0.0 (C)
8.2000	8.2000	94.383	255.87	0.0	350.25	250.18	147.93	2 0.0 (C) 0.0 (C)
8.3000	8.3000	95.033	261.88	0.0	356.91	254.94	150.85	2 0.0 (C) 0.0 (C)
8.4000	8.4000	95.682	267.93	0.0	363.62	259.73	153.79	2 0.0 (C) 0.0 (C)
8.5000	8.5000	96.332	274.03	0.0	370.36	264.54	156.74	2 0.0 (C) 0.0 (C)
8.6000	8.6000	96.981	280.17	0.0	377.15	269.39	159.71	2 0.0 (C) 0.0 (C)
8.7000	8.7000	97.630	286.35	0.0	383.98	274.27	162.70	2 0.0 (C) 0.0 (C)
8.8000	8.8000	98.280	292.56	0.0	390.84	279.17	165.71	2 0.0 (C) 0.0 (C)
8.9000	8.9000	98.929	298.83	0.0	397.75	284.11	168.74	2 0.0 (C) 0.0 (C)



Job No.	Sheet No.	Rev.
40631A3		
Drg. Ref.		
Made by AM	Date	Checked

Depth	Pile length	Ultimate base capacity	Cumulative external Friction	Negative skin friction	Net ultimate resistance	Design resistance	Combination with least resistance	Factored load*
							#	
9.0000	9.0000	99.579	305.13	0.0	404.71	289.08	171.78	2 0.0 (C) 0.0 (C)
9.1000	9.1000	100.23	311.47	0.0	411.70	294.07	174.84	2 0.0 (C) 0.0 (C)
9.2000	9.2000	100.88	317.85	0.0	418.73	299.09	177.93	2 0.0 (C) 0.0 (C)
9.3000	9.3000	101.53	324.28	0.0	425.81	304.15	181.03	2 0.0 (C) 0.0 (C)
9.4000	9.4000	102.18	330.75	0.0	432.92	309.23	184.15	2 0.0 (C) 0.0 (C)
9.5000	9.5000	102.83	337.25	0.0	440.08	314.34	187.28	2 0.0 (C) 0.0 (C)
9.6000	9.6000	103.48	343.80	0.0	447.28	319.49	190.44	2 0.0 (C) 0.0 (C)
9.7000	9.7000	104.12	350.39	0.0	454.52	324.66	193.61	2 0.0 (C) 0.0 (C)
9.8000	9.8000	104.77	357.03	0.0	461.80	329.86	196.81	2 0.0 (C) 0.0 (C)
9.9000	9.9000	105.42	363.70	0.0	469.12	335.09	200.02	2 0.0 (C) 0.0 (C)
10.0000	10.0000	106.07	370.41	0.0	476.49	340.35	203.25	2 0.0 (C) 0.0 (C)
10.1000	10.1000	106.72	377.17	0.0	483.89	345.64	206.49	2 0.0 (C) 0.0 (C)
10.2000	10.2000	107.37	383.97	0.0	491.34	350.96	209.76	2 0.0 (C) 0.0 (C)
10.3000	10.3000	108.02	390.80	0.0	498.82	356.30	213.04	2 0.0 (C) 0.0 (C)
10.4000	10.4000	108.67	397.68	0.0	506.35	361.68	216.35	2 0.0 (C) 0.0 (C)
10.5000	10.5000	109.32	404.60	0.0	513.92	367.09	219.67	2 0.0 (C) 0.0 (C)
10.6000	10.6000	109.97	411.56	0.0	521.53	372.52	223.01	2 0.0 (C) 0.0 (C)
10.7000	10.7000	110.62	418.57	0.0	529.19	377.99	226.37	2 0.0 (C) 0.0 (C)
10.8000	10.8000	111.27	425.61	0.0	536.88	383.49	229.74	2 0.0 (C) 0.0 (C)
10.9000	10.9000	111.92	432.70	0.0	544.61	389.01	233.14	2 0.0 (C) 0.0 (C)
11.0000	11.0000	112.57	439.82	0.0	552.39	394.56	236.55	2 0.0 (C) 0.0 (C)
11.1000	11.1000	113.22	446.99	0.0	560.21	400.15	239.98	2 0.0 (C) 0.0 (C)
11.2000	11.2000	113.87	454.20	0.0	568.07	405.76	243.43	2 0.0 (C) 0.0 (C)
11.3000	11.3000	114.52	461.45	0.0	575.97	411.40	246.90	2 0.0 (C) 0.0 (C)
11.4000	11.4000	115.16	468.74	0.0	583.91	417.08	250.39	2 0.0 (C) 0.0 (C)
11.5000	11.5000	115.81	476.07	0.0	591.89	422.78	253.90	2 0.0 (C) 0.0 (C)
11.6000	11.6000	116.46	483.45	0.0	599.91	428.51	257.42	2 0.0 (C) 0.0 (C)
11.7000	11.7000	117.11	490.86	0.0	607.98	434.27	260.96	2 0.0 (C) 0.0 (C)
11.8000	11.8000	117.76	498.32	0.0	616.08	440.06	264.52	2 0.0 (C) 0.0 (C)
11.9000	11.9000	118.41	505.82	0.0	624.23	445.88	268.10	2 0.0 (C) 0.0 (C)
12.0000	12.0000	119.06	513.36	0.0	632.42	451.73	271.70	2 0.0 (C) 0.0 (C)
12.1000	12.1000	119.71	520.94	0.0	640.65	457.60	275.31	2 0.0 (C) 0.0 (C)
12.2000	12.2000	120.36	528.56	0.0	648.92	463.51	278.95	2 0.0 (C) 0.0 (C)
12.3000	12.3000	121.01	536.22	0.0	657.23	469.45	282.60	2 0.0 (C) 0.0 (C)
12.4000	12.4000	121.66	543.92	0.0	665.58	475.42	286.27	2 0.0 (C) 0.0 (C)
12.5000	12.5000	122.31	551.67	0.0	673.98	481.41	289.96	2 0.0 (C) 0.0 (C)
12.6000	12.6000	122.96	559.45	0.0	682.41	487.44	293.67	2 0.0 (C) 0.0 (C)
12.7000	12.7000	123.61	567.28	0.0	690.89	493.49	297.40	2 0.0 (C) 0.0 (C)
12.8000	12.8000	124.26	575.15	0.0	699.41	499.58	301.14	2 0.0 (C) 0.0 (C)
12.9000	12.9000	124.91	583.06	0.0	707.97	505.69	304.90	2 0.0 (C) 0.0 (C)
13.0000	13.0000	125.56	591.01	0.0	716.57	511.83	308.69	2 0.0 (C) 0.0 (C)
13.1000	13.1000	126.21	599.00	0.0	725.21	518.01	312.49	2 0.0 (C) 0.0 (C)
13.2000	13.2000	126.85	607.04	0.0	733.89	524.21	316.30	2 0.0 (C) 0.0 (C)
13.3000	13.3000	127.50	615.11	0.0	742.62	530.44	320.14	2 0.0 (C) 0.0 (C)
13.4000	13.4000	128.15	623.23	0.0	751.38	536.70	324.00	2 0.0 (C) 0.0 (C)
13.5000	13.5000	128.80	631.39	0.0	760.19	542.99	327.87	2 0.0 (C) 0.0 (C)
13.6000	13.6000	129.45	639.59	0.0	769.04	549.31	331.76	2 0.0 (C) 0.0 (C)
13.7000	13.7000	130.10	647.82	0.0	777.93	555.66	335.67	2 0.0 (C) 0.0 (C)
13.8000	13.8000	130.75	656.11	0.0	786.86	562.04	339.60	2 0.0 (C) 0.0 (C)
13.9000	13.9000	131.40	664.43	0.0	795.83	568.45	343.55	2 0.0 (C) 0.0 (C)
14.0000	14.0000	132.05	672.79	0.0	804.84	574.89	347.51	2 0.0 (C) 0.0 (C)
14.1000	14.1000	132.70	681.20	0.0	813.90	581.35	351.50	2 0.0 (C) 0.0 (C)
14.2000	14.2000	133.35	689.64	0.0	822.99	587.85	355.50	2 0.0 (C) 0.0 (C)
14.3000	14.3000	134.00	698.13	0.0	832.13	594.38	359.52	2 0.0 (C) 0.0 (C)
14.4000	14.4000	134.65	706.66	0.0	841.31	600.93	363.56	2 0.0 (C) 0.0 (C)
14.5000	14.5000	135.30	715.23	0.0	850.52	607.52	367.62	2 0.0 (C) 0.0 (C)
14.6000	14.6000	135.95	723.84	0.0	859.79	614.13	371.69	2 0.0 (C) 0.0 (C)
14.7000	14.7000	136.60	732.49	0.0	869.09	620.78	375.79	2 0.0 (C) 0.0 (C)
14.8000	14.8000	137.25	741.18	0.0	878.43	627.45	379.90	2 0.0 (C) 0.0 (C)
14.9000	14.9000	137.89	749.92	0.0	887.81	634.15	384.03	2 0.0 (C) 0.0 (C)
15.0000	15.0000	138.54	758.69	0.0	897.24	640.88	388.18	2 0.0 (C) 0.0 (C)
15.1000	15.1000	139.19	767.51	0.0	906.71	647.65	392.35	2 0.0 (C) 0.0 (C)
15.2000	15.2000	139.84	776.37	0.0	916.21	654.44	396.54	2 0.0 (C) 0.0 (C)
15.3000	15.3000	140.49	785.27	0.0	925.76	661.26	400.74	2 0.0 (C) 0.0 (C)
15.4000	15.4000	141.14	794.21	0.0	935.35	668.11	404.97	2 0.0 (C) 0.0 (C)
15.5000	15.5000	141.79	803.19	0.0	944.98	674.99	409.21	2 0.0 (C) 0.0 (C)
15.6000	15.6000	142.44	812.22	0.0	954.66	681.90	413.47	2 0.0 (C) 0.0 (C)
15.7000	15.7000	143.09	821.28	0.0	964.37	688.84	417.75	2 0.0 (C) 0.0 (C)
15.8000	15.8000	143.74	830.39	0.0	974.13	695.80	422.04	2 0.0 (C) 0.0 (C)
15.9000	15.9000	144.39	839.53	0.0	983.92	702.80	426.36	2 0.0 (C) 0.0 (C)
16.0000	16.0000	145.04	848.72	0.0	993.76	709.83	430.69	2 0.0 (C) 0.0 (C)
16.1000	16.1000	145.69	857.95	0.0	1003.6	716.88	435.04	2 0.0 (C) 0.0 (C)
16.2000	16.2000	146.34	867.22	0.0	1013.6	723.97	439.42	2 0.0 (C) 0.0 (C)
16.3000	16.3000	146.99	876.53	0.0	1023.5	731.09	443.80	2 0.0 (C) 0.0 (C)
16.4000	16.4000	147.64	885.89	0.0	1033.5	738.23	448.21	2 0.0 (C) 0.0 (C)
16.5000	16.5000	148.29	895.28	0.0	1043.6	745.40	452.64	2 0.0 (C) 0.0 (C)
16.6000	16.6000	148.94	904.72	0.0	1053.7	752.61	457.08	2 0.0 (C) 0.0 (C)



Job No.	Sheet No.	Rev.
<b>40631A3</b>		
<b>Dr. Ref.</b>		
<b>Made by</b> <b>AM</b>	<b>Date</b>	<b>Checked</b>

Depth	Pile length	Ultimate base capacity	Cumulative external Friction	Negative skin friction	Net ultimate resistance	Design resistance	Combination with least resistance	Factored load*
							#	
16.700	16.700	149.58	914.19	0.0	1063.8	759.84	461.54	2 0.0 (C) 0.0 (C)
16.800	16.800	150.23	923.71	0.0	1073.9	767.10	466.03	2 0.0 (C) 0.0 (C)
16.900	16.900	150.88	933.27	0.0	1084.2	774.40	470.53	2 0.0 (C) 0.0 (C)
17.000	17.000	151.53	942.87	0.0	1094.4	781.72	475.04	2 0.0 (C) 0.0 (C)
17.100	17.100	152.18	952.51	0.0	1104.7	789.07	479.58	2 0.0 (C) 0.0 (C)
17.200	17.200	152.83	962.20	0.0	1115.0	796.45	484.13	2 0.0 (C) 0.0 (C)
17.300	17.300	153.48	971.92	0.0	1125.4	803.86	488.71	2 0.0 (C) 0.0 (C)
17.400	17.400	154.13	981.68	0.0	1135.8	811.30	493.30	2 0.0 (C) 0.0 (C)
17.500	17.500	154.78	991.49	0.0	1146.3	818.77	497.91	2 0.0 (C) 0.0 (C)
17.600	17.600	155.43	1001.3	0.0	1156.8	826.26	502.54	2 0.0 (C) 0.0 (C)
17.700	17.700	156.08	1011.2	0.0	1167.3	833.79	507.18	2 0.0 (C) 0.0 (C)
17.800	17.800	156.73	1021.2	0.0	1177.9	841.35	511.85	2 0.0 (C) 0.0 (C)
17.900	17.900	157.38	1031.1	0.0	1188.5	848.93	516.53	2 0.0 (C) 0.0 (C)
18.000	18.000	158.03	1041.1	0.0	1199.2	856.55	521.23	2 0.0 (C) 0.0 (C)
18.100	18.100	158.68	1051.2	0.0	1209.9	864.20	525.95	2 0.0 (C) 0.0 (C)
18.200	18.200	159.33	1061.3	0.0	1220.6	871.87	530.69	2 0.0 (C) 0.0 (C)
18.300	18.300	159.98	1071.4	0.0	1231.4	879.57	535.45	2 0.0 (C) 0.0 (C)
18.400	18.400	160.62	1081.6	0.0	1242.2	887.31	540.23	2 0.0 (C) 0.0 (C)
18.500	18.500	161.27	1091.8	0.0	1253.1	895.07	545.02	2 0.0 (C) 0.0 (C)
18.600	18.600	161.92	1102.1	0.0	1264.0	902.86	549.83	2 0.0 (C) 0.0 (C)
18.700	18.700	162.57	1112.4	0.0	1275.0	910.69	554.66	2 0.0 (C) 0.0 (C)
18.800	18.800	163.22	1122.7	0.0	1286.0	918.54	559.51	2 0.0 (C) 0.0 (C)
18.900	18.900	163.87	1133.1	0.0	1297.0	926.42	564.38	2 0.0 (C) 0.0 (C)
19.000	19.000	164.52	1143.5	0.0	1308.1	934.33	569.27	2 0.0 (C) 0.0 (C)
19.100	19.100	165.17	1154.0	0.0	1319.2	942.27	574.17	2 0.0 (C) 0.0 (C)
19.200	19.200	165.82	1164.5	0.0	1330.3	950.24	579.09	2 0.0 (C) 0.0 (C)
19.300	19.300	166.47	1175.1	0.0	1341.5	958.24	584.03	2 0.0 (C) 0.0 (C)
19.400	19.400	167.12	1185.7	0.0	1352.8	966.27	588.99	2 0.0 (C) 0.0 (C)
19.500	19.500	167.77	1196.3	0.0	1364.1	974.32	593.97	2 0.0 (C) 0.0 (C)
19.600	19.600	168.42	1207.0	0.0	1375.4	982.41	598.97	2 0.0 (C) 0.0 (C)
19.700	19.700	169.07	1217.7	0.0	1386.7	990.53	603.98	2 0.0 (C) 0.0 (C)
19.800	19.800	169.72	1228.4	0.0	1398.1	998.67	609.02	2 0.0 (C) 0.0 (C)
19.900	19.900	170.37	1239.2	0.0	1409.6	1006.8	614.07	2 0.0 (C) 0.0 (C)
20.000	20.000	171.02	1250.1	0.0	1421.1	1015.1	619.14	2 0.0 (C) 0.0 (C)
20.100	20.100	171.66	1260.9	0.0	1432.6	1023.3	624.23	2 0.0 (C) 0.0 (C)
20.200	20.200	172.31	1271.9	0.0	1444.2	1031.6	629.33	2 0.0 (C) 0.0 (C)
20.300	20.300	172.96	1282.8	0.0	1455.8	1039.8	634.46	2 0.0 (C) 0.0 (C)
20.400	20.400	173.61	1293.8	0.0	1467.4	1048.2	639.60	2 0.0 (C) 0.0 (C)
20.500	20.500	174.26	1304.9	0.0	1479.1	1056.5	644.77	2 0.0 (C) 0.0 (C)
20.600	20.600	174.91	1316.0	0.0	1490.9	1064.9	649.95	2 0.0 (C) 0.0 (C)
20.700	20.700	175.56	1327.1	0.0	1502.6	1073.3	655.15	2 0.0 (C) 0.0 (C)
20.800	20.800	176.21	1338.2	0.0	1514.5	1081.8	660.36	2 0.0 (C) 0.0 (C)
20.900	20.900	176.86	1349.5	0.0	1526.3	1090.2	665.60	2 0.0 (C) 0.0 (C)
21.000	21.000	177.51	1360.7	0.0	1538.2	1098.7	670.85	2 0.0 (C) 0.0 (C)
21.100	21.100	178.16	1372.0	0.0	1550.2	1107.3	676.13	2 0.0 (C) 0.0 (C)
21.200	21.200	178.81	1383.3	0.0	1562.1	1115.8	681.42	2 0.0 (C) 0.0 (C)
21.300	21.300	179.46	1394.7	0.0	1574.2	1124.4	686.73	2 0.0 (C) 0.0 (C)
21.400	21.400	180.11	1406.1	0.0	1586.2	1133.0	692.05	2 0.0 (C) 0.0 (C)
21.500	21.500	180.76	1417.6	0.0	1598.3	1141.7	697.40	2 0.0 (C) 0.0 (C)
21.600	21.600	181.41	1429.1	0.0	1610.5	1150.3	702.76	2 0.0 (C) 0.0 (C)
21.700	21.700	182.06	1440.6	0.0	1622.7	1159.0	708.15	2 0.0 (C) 0.0 (C)
21.800	21.800	182.71	1452.2	0.0	1634.9	1167.8	713.55	2 0.0 (C) 0.0 (C)
21.900	21.900	183.35	1463.8	0.0	1647.2	1176.5	718.97	2 0.0 (C) 0.0 (C)
22.000	22.000	184.00	1475.5	0.0	1659.5	1185.3	724.41	2 0.0 (C) 0.0 (C)
22.100	22.100	184.65	1487.2	0.0	1671.8	1194.2	729.86	2 0.0 (C) 0.0 (C)
22.200	22.200	185.30	1498.9	0.0	1684.2	1203.0	735.34	2 0.0 (C) 0.0 (C)
22.300	22.300	185.95	1510.7	0.0	1696.7	1211.9	740.83	2 0.0 (C) 0.0 (C)
22.400	22.400	186.60	1522.5	0.0	1709.1	1220.8	746.34	2 0.0 (C) 0.0 (C)
22.500	22.500	187.25	1534.4	0.0	1721.6	1229.7	751.87	2 0.0 (C) 0.0 (C)
22.600	22.600	187.90	1546.3	0.0	1734.2	1238.7	757.42	2 0.0 (C) 0.0 (C)
22.700	22.700	188.55	1558.3	0.0	1746.8	1247.7	762.99	2 0.0 (C) 0.0 (C)
22.800	22.800	189.20	1570.3	0.0	1759.4	1256.7	768.58	2 0.0 (C) 0.0 (C)
22.900	22.900	189.85	1582.3	0.0	1772.1	1265.8	774.18	2 0.0 (C) 0.0 (C)
23.000	23.000	190.50	1594.4	0.0	1784.9	1274.9	779.80	2 0.0 (C) 0.0 (C)
23.100	23.100	191.15	1606.5	0.0	1797.6	1284.0	785.44	2 0.0 (C) 0.0 (C)
23.200	23.200	191.80	1618.6	0.0	1810.4	1293.2	791.10	2 0.0 (C) 0.0 (C)
23.300	23.300	192.45	1630.8	0.0	1823.3	1302.3	796.78	2 0.0 (C) 0.0 (C)
23.400	23.400	193.10	1643.1	0.0	1836.2	1311.5	802.48	2 0.0 (C) 0.0 (C)
23.500	23.500	193.75	1655.3	0.0	1849.1	1320.8	808.19	2 0.0 (C) 0.0 (C)
23.600	23.600	194.39	1667.7	0.0	1862.1	1330.0	813.92	2 0.0 (C) 0.0 (C)
23.700	23.700	195.04	1680.0	0.0	1875.1	1339.3	819.67	2 0.0 (C) 0.0 (C)
23.800	23.800	195.69	1692.4	0.0	1888.1	1348.7	825.44	2 0.0 (C) 0.0 (C)
23.900	23.900	196.34	1704.9	0.0	1901.2	1358.0	831.23	2 0.0 (C) 0.0 (C)
24.000	24.000	196.99	1717.4	0.0	1914.4	1367.4	837.04	2 0.0 (C) 0.0 (C)
24.100	24.100	197.64	1729.9	0.0	1927.5	1376.8	842.86	2 0.0 (C) 0.0 (C)
24.200	24.200	198.29	1742.5	0.0	1940.8	1386.3	848.71	2 0.0 (C) 0.0 (C)
24.300	24.300	198.94	1755.1	0.0	1954.0	1395.7	854.57	2 0.0 (C) 0.0 (C)

Job No.	Sheet No.	Rev.
<b>40631A3</b>		
<b>Drg. Ref.</b>		
<b>Made by</b> <b>AM</b>	<b>Date</b>	<b>Checked</b>

Depth	Pile length	Ultimate base capacity	Cumulative external Friction	Negative skin friction	Net ultimate resistance	Design resistance	Combination with least resistance	Factored load*
							#	
24.400	24.400	199.59	1767.7	0.0	1967.3	1405.2	860.45	2 0.0 (C) 0.0 (C)
24.500	24.500	200.24	1780.4	0.0	1980.7	1414.8	866.35	2 0.0 (C) 0.0 (C)
24.600	24.600	200.89	1793.2	0.0	1994.0	1424.3	872.26	2 0.0 (C) 0.0 (C)
24.700	24.700	201.54	1805.9	0.0	2007.5	1433.9	878.20	2 0.0 (C) 0.0 (C)
24.800	24.800	202.19	1818.8	0.0	2020.9	1443.5	884.15	2 0.0 (C) 0.0 (C)
24.900	24.900	202.84	1831.6	0.0	2034.4	1453.2	890.12	2 0.0 (C) 0.0 (C)
25.000	25.000	203.49	1844.5	0.0	2048.0	1462.9	896.11	2 0.0 (C) 0.0 (C)

# Limiting criteria :

1 : DA1 C1

2 : DA1 C2

\*(C)-> Compression load, (T)-> Tension load

Note: Design resistance does not include any consideration of negative skin friction.

**Soil Profile 2: Soil Profile 2 - Low Level**

Depth	Pile length	Ultimate base capacity	Cumulative external Friction	Negative skin friction	Net ultimate resistance	Design resistance	Combination with least resistance	Factored load*
							#	
		(Q <sub>b</sub> )	(Q <sub>s</sub> )	(Q <sub>nsf</sub> )		DA1-C1	DA1-C2	DA1-C1 DA1-C2
		[kN]	[kN]	[kN]	[kN]	[kN]	[kN]	[kN] [kN]
8.0000	8.0000	91.148	107.35	0.0	198.50	141.79	80.477	2 0.0 (C) 0.0 (C)
8.1000	8.1000	91.808	113.16	0.0	204.97	146.41	83.306	2 0.0 (C) 0.0 (C)
8.2000	8.2000	92.469	119.01	0.0	211.48	151.06	86.154	2 0.0 (C) 0.0 (C)
8.3000	8.3000	93.130	124.90	0.0	218.03	155.74	89.020	2 0.0 (C) 0.0 (C)
8.4000	8.4000	93.791	130.84	0.0	224.63	160.45	91.906	2 0.0 (C) 0.0 (C)
8.5000	8.5000	94.452	136.81	0.0	231.26	165.19	94.809	2 0.0 (C) 0.0 (C)
8.6000	8.6000	95.112	142.83	0.0	237.94	169.96	97.732	2 0.0 (C) 0.0 (C)
8.7000	8.7000	95.773	148.89	0.0	244.66	174.76	100.67	2 0.0 (C) 0.0 (C)
8.8000	8.8000	96.434	154.99	0.0	251.43	179.59	103.63	2 0.0 (C) 0.0 (C)
8.9000	8.9000	97.095	161.14	0.0	258.23	184.45	106.61	2 0.0 (C) 0.0 (C)
9.0000	9.0000	97.756	167.32	0.0	265.08	189.34	109.61	2 0.0 (C) 0.0 (C)
9.1000	9.1000	98.417	173.55	0.0	271.97	194.26	112.63	2 0.0 (C) 0.0 (C)
9.2000	9.2000	99.077	179.82	0.0	278.90	199.21	115.66	2 0.0 (C) 0.0 (C)
9.3000	9.3000	99.738	186.13	0.0	285.87	204.19	118.71	2 0.0 (C) 0.0 (C)
9.4000	9.4000	100.40	192.48	0.0	292.88	209.20	121.79	2 0.0 (C) 0.0 (C)
9.5000	9.5000	101.06	198.88	0.0	299.94	214.24	124.88	2 0.0 (C) 0.0 (C)
9.6000	9.6000	101.72	205.32	0.0	307.04	219.31	127.99	2 0.0 (C) 0.0 (C)
9.7000	9.7000	102.38	211.80	0.0	314.18	224.41	131.12	2 0.0 (C) 0.0 (C)
9.8000	9.8000	103.04	218.32	0.0	321.36	229.54	134.26	2 0.0 (C) 0.0 (C)
9.9000	9.9000	103.70	224.88	0.0	328.58	234.70	137.43	2 0.0 (C) 0.0 (C)
10.000	10.000	104.36	231.49	0.0	335.85	239.89	140.61	2 0.0 (C) 0.0 (C)
10.100	10.100	105.02	238.13	0.0	343.16	245.11	143.82	2 0.0 (C) 0.0 (C)
10.200	10.200	105.69	244.82	0.0	350.51	250.36	147.04	2 0.0 (C) 0.0 (C)
10.300	10.300	106.35	251.55	0.0	357.90	255.64	150.28	2 0.0 (C) 0.0 (C)
10.400	10.400	107.01	258.33	0.0	365.33	260.95	153.54	2 0.0 (C) 0.0 (C)
10.500	10.500	107.67	265.14	0.0	372.81	266.29	156.82	2 0.0 (C) 0.0 (C)
10.600	10.600	108.33	272.00	0.0	380.33	271.66	160.12	2 0.0 (C) 0.0 (C)
10.700	10.700	108.99	278.90	0.0	387.89	277.06	163.43	2 0.0 (C) 0.0 (C)
10.800	10.800	109.65	285.84	0.0	395.49	282.49	166.77	2 0.0 (C) 0.0 (C)
10.900	10.900	110.31	292.82	0.0	403.13	287.95	170.12	2 0.0 (C) 0.0 (C)
11.000	11.000	110.97	299.85	0.0	410.82	293.44	173.49	2 0.0 (C) 0.0 (C)
11.100	11.100	111.63	306.91	0.0	418.55	298.96	176.88	2 0.0 (C) 0.0 (C)
11.200	11.200	112.29	314.02	0.0	426.32	304.51	180.29	2 0.0 (C) 0.0 (C)
11.300	11.300	112.95	321.17	0.0	434.13	310.09	183.72	2 0.0 (C) 0.0 (C)
11.400	11.400	113.62	328.37	0.0	441.98	315.70	187.17	2 0.0 (C) 0.0 (C)
11.500	11.500	114.28	335.60	0.0	449.88	321.34	190.63	2 0.0 (C) 0.0 (C)
11.600	11.600	114.94	342.88	0.0	457.81	327.01	194.12	2 0.0 (C) 0.0 (C)
11.700	11.700	115.60	350.20	0.0	465.79	332.71	197.62	2 0.0 (C) 0.0 (C)
11.800	11.800	116.26	357.56	0.0	473.81	338.44	201.14	2 0.0 (C) 0.0 (C)
11.900	11.900	116.92	364.96	0.0	481.88	344.20	204.68	2 0.0 (C) 0.0 (C)
12.000	12.000	117.58	372.40	0.0	489.98	349.99	208.24	2 0.0 (C) 0.0 (C)
12.100	12.100	118.24	379.89	0.0	498.13	355.81	211.82	2 0.0 (C) 0.0 (C)
12.200	12.200	118.90	387.42	0.0	506.32	361.66	215.42	2 0.0 (C) 0.0 (C)
12.300	12.300	119.56	394.99	0.0	514.55	367.54	219.03	2 0.0 (C) 0.0 (C)
12.400	12.400	120.22	402.60	0.0	522.82	373.45	222.67	2 0.0 (C) 0.0 (C)
12.500	12.500	120.88	410.25	0.0	531.14	379.38	226.32	2 0.0 (C) 0.0 (C)
12.600	12.600	121.55	417.95	0.0	539.50	385.35	229.99	2 0.0 (C) 0.0 (C)
12.700	12.700	122.21	425.69	0.0	547.89	391.35	233.68	2 0.0 (C) 0.0 (C)
12.800	12.800	122.87	433.47	0.0	556.34	397.38	237.39	2 0.0 (C) 0.0 (C)
12.900	12.900	123.53	441.29	0.0	564.82	403.44	241.12	2 0.0 (C) 0.0 (C)
13.000	13.000	124.19	449.15	0.0	573.34	409.53	244.87	2 0.0 (C) 0.0 (C)
13.100	13.100	124.85	457.06	0.0	581.91	415.65	248.63	2 0.0 (C) 0.0 (C)
13.200	13.200	125.51	465.01	0.0	590.52	421.80	252.42	2 0.0 (C) 0.0 (C)
13.300	13.300	126.17	473.00	0.0	599.17	427.98	256.22	2 0.0 (C) 0.0 (C)
13.400	13.400	126.83	481.03	0.0	607.86	434.19	260.04	2 0.0 (C) 0.0 (C)
13.500	13.500	127.49	489.10	0.0	616.60	440.43	263.88	2 0.0 (C) 0.0 (C)

Job No.	Sheet No.	Rev.
<b>40631A3</b>		
<b>Dr. Ref.</b>		
<b>Made by</b> <b>AM</b>	<b>Date</b>	<b>Checked</b>

Depth	Pile length	Ultimate base capacity	Cumulative external Friction	Negative skin friction	Net ultimate resistance	Design resistance	Combination with least resistance	Factored load*
							#	
13.600	13.600	128.15	497.22	0.0	625.37	446.70	267.74	2 0.0 (C) 0.0 (C)
13.700	13.700	128.81	505.38	0.0	634.19	452.99	271.62	2 0.0 (C) 0.0 (C)
13.800	13.800	129.48	513.58	0.0	643.05	459.32	275.52	2 0.0 (C) 0.0 (C)
13.900	13.900	130.14	521.82	0.0	651.95	465.68	279.43	2 0.0 (C) 0.0 (C)
14.000	14.000	130.80	530.10	0.0	660.90	472.07	283.37	2 0.0 (C) 0.0 (C)
14.100	14.100	131.46	538.43	0.0	669.89	478.49	287.32	2 0.0 (C) 0.0 (C)
14.200	14.200	132.12	546.80	0.0	678.91	484.94	291.29	2 0.0 (C) 0.0 (C)
14.300	14.300	132.78	555.20	0.0	687.98	491.42	295.28	2 0.0 (C) 0.0 (C)
14.400	14.400	133.44	563.66	0.0	697.10	497.93	299.29	2 0.0 (C) 0.0 (C)
14.500	14.500	134.10	572.15	0.0	706.25	504.46	303.32	2 0.0 (C) 0.0 (C)
14.600	14.600	134.76	580.68	0.0	715.45	511.03	307.36	2 0.0 (C) 0.0 (C)
14.700	14.700	135.42	589.26	0.0	724.68	517.63	311.43	2 0.0 (C) 0.0 (C)
14.800	14.800	136.08	597.88	0.0	733.96	524.26	315.51	2 0.0 (C) 0.0 (C)
14.900	14.900	136.74	606.54	0.0	743.29	530.92	319.62	2 0.0 (C) 0.0 (C)
15.000	15.000	137.40	615.25	0.0	752.65	537.61	323.74	2 0.0 (C) 0.0 (C)
15.100	15.100	138.07	623.99	0.0	762.06	544.33	327.88	2 0.0 (C) 0.0 (C)
15.200	15.200	138.73	632.78	0.0	771.50	551.07	332.04	2 0.0 (C) 0.0 (C)
15.300	15.300	139.39	641.61	0.0	780.99	557.85	336.21	2 0.0 (C) 0.0 (C)
15.400	15.400	140.05	650.48	0.0	790.53	564.66	340.41	2 0.0 (C) 0.0 (C)
15.500	15.500	140.71	659.39	0.0	800.10	571.50	344.62	2 0.0 (C) 0.0 (C)
15.600	15.600	141.37	668.35	0.0	809.72	578.37	348.86	2 0.0 (C) 0.0 (C)
15.700	15.700	142.03	677.34	0.0	819.37	585.27	353.11	2 0.0 (C) 0.0 (C)
15.800	15.800	142.69	686.38	0.0	829.07	592.19	357.38	2 0.0 (C) 0.0 (C)
15.900	15.900	143.35	695.46	0.0	838.81	599.15	361.67	2 0.0 (C) 0.0 (C)
16.000	16.000	144.01	704.58	0.0	848.60	606.14	365.98	2 0.0 (C) 0.0 (C)
16.100	16.100	144.67	713.75	0.0	858.42	613.16	370.31	2 0.0 (C) 0.0 (C)
16.200	16.200	145.33	722.96	0.0	868.29	620.21	374.65	2 0.0 (C) 0.0 (C)
16.300	16.300	146.00	732.20	0.0	878.20	627.29	379.02	2 0.0 (C) 0.0 (C)
16.400	16.400	146.66	741.50	0.0	888.15	634.39	383.40	2 0.0 (C) 0.0 (C)
16.500	16.500	147.32	750.83	0.0	898.14	641.53	387.80	2 0.0 (C) 0.0 (C)
16.600	16.600	147.98	760.20	0.0	908.18	648.70	392.23	2 0.0 (C) 0.0 (C)
16.700	16.700	148.64	769.62	0.0	918.26	655.90	396.67	2 0.0 (C) 0.0 (C)
16.800	16.800	149.30	779.08	0.0	928.38	663.13	401.12	2 0.0 (C) 0.0 (C)
16.900	16.900	149.96	788.58	0.0	938.54	670.38	405.60	2 0.0 (C) 0.0 (C)
17.000	17.000	150.62	798.12	0.0	948.74	677.67	410.10	2 0.0 (C) 0.0 (C)
17.100	17.100	151.28	807.70	0.0	958.99	684.99	414.61	2 0.0 (C) 0.0 (C)
17.200	17.200	151.94	817.33	0.0	969.27	692.34	419.14	2 0.0 (C) 0.0 (C)
17.300	17.300	152.60	827.00	0.0	979.60	699.72	423.70	2 0.0 (C) 0.0 (C)
17.400	17.400	153.26	836.71	0.0	989.97	707.12	428.27	2 0.0 (C) 0.0 (C)
17.500	17.500	153.93	846.46	0.0	1000.4	714.56	432.86	2 0.0 (C) 0.0 (C)
17.600	17.600	154.59	856.25	0.0	1010.8	722.03	437.47	2 0.0 (C) 0.0 (C)
17.700	17.700	155.25	866.09	0.0	1021.3	729.53	442.09	2 0.0 (C) 0.0 (C)
17.800	17.800	155.91	875.97	0.0	1031.9	737.05	446.74	2 0.0 (C) 0.0 (C)
17.900	17.900	156.57	885.89	0.0	1042.5	744.61	451.40	2 0.0 (C) 0.0 (C)
18.000	18.000	157.23	895.85	0.0	1053.1	752.20	456.09	2 0.0 (C) 0.0 (C)
18.100	18.100	157.89	905.85	0.0	1063.7	759.82	460.79	2 0.0 (C) 0.0 (C)
18.200	18.200	158.55	915.90	0.0	1074.5	767.46	465.51	2 0.0 (C) 0.0 (C)
18.300	18.300	159.21	925.99	0.0	1085.2	775.14	470.25	2 0.0 (C) 0.0 (C)
18.400	18.400	159.87	936.12	0.0	1096.0	782.85	475.01	2 0.0 (C) 0.0 (C)
18.500	18.500	160.53	946.29	0.0	1106.8	790.59	479.78	2 0.0 (C) 0.0 (C)
18.600	18.600	161.19	956.50	0.0	1117.7	798.35	484.58	2 0.0 (C) 0.0 (C)
18.700	18.700	161.86	966.76	0.0	1128.6	806.15	489.39	2 0.0 (C) 0.0 (C)
18.800	18.800	162.52	977.05	0.0	1139.6	813.98	494.23	2 0.0 (C) 0.0 (C)
18.900	18.900	163.18	987.39	0.0	1150.6	821.84	499.08	2 0.0 (C) 0.0 (C)
19.000	19.000	163.84	997.78	0.0	1161.6	829.72	503.95	2 0.0 (C) 0.0 (C)
19.100	19.100	164.50	1008.2	0.0	1172.7	837.64	508.84	2 0.0 (C) 0.0 (C)
19.200	19.200	165.16	1018.7	0.0	1183.8	845.59	513.75	2 0.0 (C) 0.0 (C)
19.300	19.300	165.82	1029.2	0.0	1195.0	853.57	518.67	2 0.0 (C) 0.0 (C)
19.400	19.400	166.48	1039.7	0.0	1206.2	861.57	523.62	2 0.0 (C) 0.0 (C)
19.500	19.500	167.14	1050.3	0.0	1217.5	869.61	528.58	2 0.0 (C) 0.0 (C)
19.600	19.600	167.80	1060.9	0.0	1228.7	877.68	533.57	2 0.0 (C) 0.0 (C)
19.700	19.700	168.46	1071.6	0.0	1240.1	885.77	538.57	2 0.0 (C) 0.0 (C)
19.800	19.800	169.12	1082.3	0.0	1251.5	893.90	543.59	2 0.0 (C) 0.0 (C)
19.900	19.900	169.79	1093.1	0.0	1262.9	902.06	548.63	2 0.0 (C) 0.0 (C)
20.000	20.000	170.45	1103.9	0.0	1274.3	910.25	553.69	2 0.0 (C) 0.0 (C)
20.100	20.100	171.11	1114.7	0.0	1285.8	918.46	558.76	2 0.0 (C) 0.0 (C)
20.200	20.200	171.77	1125.6	0.0	1297.4	926.71	563.86	2 0.0 (C) 0.0 (C)
20.300	20.300	172.43	1136.6	0.0	1309.0	934.99	568.97	2 0.0 (C) 0.0 (C)
20.400	20.400	173.09	1147.5	0.0	1320.6	943.29	574.10	2 0.0 (C) 0.0 (C)
20.500	20.500	173.75	1158.5	0.0	1332.3	951.63	579.26	2 0.0 (C) 0.0 (C)
20.600	20.600	174.41	1169.6	0.0	1344.0	960.00	584.43	2 0.0 (C) 0.0 (C)
20.700	20.700	175.07	1180.7	0.0	1355.8	968.39	589.61	2 0.0 (C) 0.0 (C)
20.800	20.800	175.73	1191.8	0.0	1367.5	976.82	594.82	2 0.0 (C) 0.0 (C)
20.900	20.900	176.39	1203.0	0.0	1379.4	985.28	600.05	2 0.0 (C) 0.0 (C)
21.000	21.000	177.05	1214.2	0.0	1391.3	993.76	605.29	2 0.0 (C) 0.0 (C)
21.100	21.100	177.71	1225.5	0.0	1403.2	1002.3	610.56	2 0.0 (C) 0.0 (C)
21.200	21.200	178.38	1236.8	0.0	1415.2	1010.8	615.84	2 0.0 (C) 0.0 (C)

Job No.	Sheet No.	Rev.
<b>40631A3</b>		
<b>Dr. Ref.</b>		
<b>Made by</b> <b>AM</b>	<b>Date</b>	<b>Checked</b>

Depth	Pile length	Ultimate base capacity	Cumulative external Friction	Negative skin friction	Net ultimate resistance	Design resistance	Combination with least resistance	Factored load*
							#	
21.300	21.300	179.04	1248.1	0.0	1427.2	1019.4	621.14	2 0.0 (C) 0.0 (C)
21.400	21.400	179.70	1259.5	0.0	1439.2	1028.0	626.46	2 0.0 (C) 0.0 (C)
21.500	21.500	180.36	1270.9	0.0	1451.3	1036.6	631.80	2 0.0 (C) 0.0 (C)
21.600	21.600	181.02	1282.4	0.0	1463.4	1045.3	637.16	2 0.0 (C) 0.0 (C)
21.700	21.700	181.68	1293.9	0.0	1475.6	1054.0	642.53	2 0.0 (C) 0.0 (C)
21.800	21.800	182.34	1305.5	0.0	1487.8	1062.7	647.93	2 0.0 (C) 0.0 (C)
21.900	21.900	183.00	1317.1	0.0	1500.1	1071.5	653.34	2 0.0 (C) 0.0 (C)
22.000	22.000	183.66	1328.7	0.0	1512.4	1080.3	658.78	2 0.0 (C) 0.0 (C)
22.100	22.100	184.32	1340.4	0.0	1524.7	1089.1	664.23	2 0.0 (C) 0.0 (C)
22.200	22.200	184.98	1352.1	0.0	1537.1	1097.9	669.70	2 0.0 (C) 0.0 (C)
22.300	22.300	185.64	1363.9	0.0	1549.5	1106.8	675.19	2 0.0 (C) 0.0 (C)
22.400	22.400	186.31	1375.7	0.0	1562.0	1115.7	680.69	2 0.0 (C) 0.0 (C)
22.500	22.500	186.97	1387.6	0.0	1574.5	1124.7	686.22	2 0.0 (C) 0.0 (C)
22.600	22.600	187.63	1399.4	0.0	1587.1	1133.6	691.76	2 0.0 (C) 0.0 (C)
22.700	22.700	188.29	1411.4	0.0	1599.7	1142.6	697.33	2 0.0 (C) 0.0 (C)
22.800	22.800	188.95	1423.4	0.0	1612.3	1151.6	702.91	2 0.0 (C) 0.0 (C)
22.900	22.900	189.61	1435.4	0.0	1625.0	1160.7	708.51	2 0.0 (C) 0.0 (C)
23.000	23.000	190.27	1447.4	0.0	1637.7	1169.8	714.13	2 0.0 (C) 0.0 (C)
23.100	23.100	190.93	1459.5	0.0	1650.5	1178.9	719.77	2 0.0 (C) 0.0 (C)
23.200	23.200	191.59	1471.7	0.0	1663.3	1188.1	725.43	2 0.0 (C) 0.0 (C)
23.300	23.300	192.25	1483.9	0.0	1676.1	1197.2	731.10	2 0.0 (C) 0.0 (C)
23.400	23.400	192.91	1496.1	0.0	1689.0	1206.4	736.80	2 0.0 (C) 0.0 (C)
23.500	23.500	193.57	1508.4	0.0	1701.9	1215.7	742.51	2 0.0 (C) 0.0 (C)
23.600	23.600	194.24	1520.7	0.0	1714.9	1224.9	748.24	2 0.0 (C) 0.0 (C)
23.700	23.700	194.90	1533.0	0.0	1727.9	1234.2	753.99	2 0.0 (C) 0.0 (C)
23.800	23.800	195.56	1545.4	0.0	1741.0	1243.6	759.76	2 0.0 (C) 0.0 (C)
23.900	23.900	196.22	1557.9	0.0	1754.1	1252.9	765.55	2 0.0 (C) 0.0 (C)
24.000	24.000	196.88	1570.3	0.0	1767.2	1262.3	771.36	2 0.0 (C) 0.0 (C)
24.100	24.100	197.54	1582.9	0.0	1780.4	1271.7	777.19	2 0.0 (C) 0.0 (C)
24.200	24.200	198.20	1595.4	0.0	1793.6	1281.2	783.03	2 0.0 (C) 0.0 (C)
24.300	24.300	198.86	1608.0	0.0	1806.9	1290.6	788.89	2 0.0 (C) 0.0 (C)
24.400	24.400	199.52	1620.7	0.0	1820.2	1300.1	794.77	2 0.0 (C) 0.0 (C)
24.500	24.500	200.18	1633.4	0.0	1833.5	1309.7	800.68	2 0.0 (C) 0.0 (C)
24.600	24.600	200.84	1646.1	0.0	1846.9	1319.2	806.60	2 0.0 (C) 0.0 (C)
24.700	24.700	201.50	1658.9	0.0	1860.4	1328.8	812.53	2 0.0 (C) 0.0 (C)
24.800	24.800	202.17	1671.7	0.0	1873.9	1338.5	818.49	2 0.0 (C) 0.0 (C)
24.900	24.900	202.83	1684.5	0.0	1887.4	1348.1	824.47	2 0.0 (C) 0.0 (C)
25.000	25.000	203.49	1697.4	0.0	1900.9	1357.8	830.46	2 0.0 (C) 0.0 (C)

# Limiting criteria :

1 : DA1 C1

2 : DA1 C2

\*(C)-> Compression load, (T)-> Tension load

Note: Design resistance does not include any consideration of negative skin friction.

## Nq Calculation Details

### Soil Profile 1: Soil Profile 1 - High Level - Material Factor Set - 1

There are no pile toe levels in any drained material(with Berezzantzev/Bolton option) in the given soil profile.

### Soil Profile 1: Soil Profile 1 - High Level - Material Factor Set - 2

There are no pile toe levels in any drained material(with Berezzantzev/Bolton option) in the given soil profile.

### Soil Profile 2: Soil Profile 2 - Low Level - Material Factor Set - 1

There are no pile toe levels in any drained material(with Berezzantzev/Bolton option) in the given soil profile.

### Soil Profile 2: Soil Profile 2 - Low Level - Material Factor Set - 2

There are no pile toe levels in any drained material(with Berezzantzev/Bolton option) in the given soil profile.

## Results - Tension

### Soil Profile 1: Soil Profile 1 - High Level

Depth	Pile length	Cumulative external Friction	Net ultimate resistance	Design resistance	Combination with least resistance	Factored load*
		(Q <sub>s</sub> )	DA1-C1	DA1-C2	#	DA1-C1 DA1-C2
[m]	[m]	[kN]	[kN]	[kN]	[kN]	[kN]

Job No.	Sheet No.	Rev.
<b>40631A3</b>		
<b>Dr. Ref.</b>		
<b>Made by</b> <b>AM</b>	<b>Date</b>	<b>Checked</b>

Depth	Pile length	Cumulative external Friction	Net ultimate resistance	Design resistance	Combination resistance	Factored load* with least resistance	#
8.0000	8.0000	243.96	243.96	174.26	87.130	2 N.A. N.A.	
8.1000	8.1000	249.90	249.90	178.50	89.248	2 N.A. N.A.	
8.2000	8.2000	255.87	255.87	182.76	91.381	2 N.A. N.A.	
8.3000	8.3000	261.88	261.88	187.06	93.529	2 N.A. N.A.	
8.4000	8.4000	267.93	267.93	191.38	95.691	2 N.A. N.A.	
8.5000	8.5000	274.03	274.03	195.74	97.868	2 N.A. N.A.	
8.6000	8.6000	280.17	280.17	200.12	100.06	2 N.A. N.A.	
8.7000	8.7000	286.35	286.35	204.53	102.27	2 N.A. N.A.	
8.8000	8.8000	292.56	292.56	208.97	104.49	2 N.A. N.A.	
8.9000	8.9000	298.83	298.83	213.45	106.72	2 N.A. N.A.	
9.0000	9.0000	305.13	305.13	217.95	108.97	2 N.A. N.A.	
9.1000	9.1000	311.47	311.47	222.48	111.24	2 N.A. N.A.	
9.2000	9.2000	317.85	317.85	227.04	113.52	2 N.A. N.A.	
9.3000	9.3000	324.28	324.28	231.63	115.81	2 N.A. N.A.	
9.4000	9.4000	330.75	330.75	236.25	118.12	2 N.A. N.A.	
9.5000	9.5000	337.25	337.25	240.90	120.45	2 N.A. N.A.	
9.6000	9.6000	343.80	343.80	245.57	122.79	2 N.A. N.A.	
9.7000	9.7000	350.39	350.39	250.28	125.14	2 N.A. N.A.	
9.8000	9.8000	357.03	357.03	255.02	127.51	2 N.A. N.A.	
9.9000	9.9000	363.70	363.70	259.79	129.89	2 N.A. N.A.	
10.000	10.000	370.41	370.41	264.58	132.29	2 N.A. N.A.	
10.100	10.100	377.17	377.17	269.41	134.70	2 N.A. N.A.	
10.200	10.200	383.97	383.97	274.26	137.13	2 N.A. N.A.	
10.300	10.300	390.80	390.80	279.15	139.57	2 N.A. N.A.	
10.400	10.400	397.68	397.68	284.06	142.03	2 N.A. N.A.	
10.500	10.500	404.60	404.60	289.00	144.50	2 N.A. N.A.	
10.600	10.600	411.56	411.56	293.97	146.99	2 N.A. N.A.	
10.700	10.700	418.57	418.57	298.98	149.49	2 N.A. N.A.	
10.800	10.800	425.61	425.61	304.01	152.00	2 N.A. N.A.	
10.900	10.900	432.70	432.70	309.07	154.53	2 N.A. N.A.	
11.000	11.000	439.82	439.82	314.16	157.08	2 N.A. N.A.	
11.100	11.100	446.99	446.99	319.28	159.64	2 N.A. N.A.	
11.200	11.200	454.20	454.20	324.43	162.21	2 N.A. N.A.	
11.300	11.300	461.45	461.45	329.61	164.80	2 N.A. N.A.	
11.400	11.400	468.74	468.74	334.82	167.41	2 N.A. N.A.	
11.500	11.500	476.07	476.07	340.05	170.03	2 N.A. N.A.	
11.600	11.600	483.45	483.45	345.32	172.66	2 N.A. N.A.	
11.700	11.700	490.86	490.86	350.62	175.31	2 N.A. N.A.	
11.800	11.800	498.32	498.32	355.94	177.97	2 N.A. N.A.	
11.900	11.900	505.82	505.82	361.30	180.65	2 N.A. N.A.	
12.000	12.000	513.36	513.36	366.68	183.34	2 N.A. N.A.	
12.100	12.100	520.94	520.94	372.10	186.05	2 N.A. N.A.	
12.200	12.200	528.56	528.56	377.54	188.77	2 N.A. N.A.	
12.300	12.300	536.22	536.22	383.01	191.51	2 N.A. N.A.	
12.400	12.400	543.92	543.92	388.52	194.26	2 N.A. N.A.	
12.500	12.500	551.67	551.67	394.05	197.02	2 N.A. N.A.	
12.600	12.600	559.45	559.45	399.61	199.81	2 N.A. N.A.	
12.700	12.700	567.28	567.28	405.20	202.60	2 N.A. N.A.	
12.800	12.800	575.15	575.15	410.82	205.41	2 N.A. N.A.	
12.900	12.900	583.06	583.06	416.47	208.24	2 N.A. N.A.	
13.000	13.000	591.01	591.01	422.15	211.08	2 N.A. N.A.	
13.100	13.100	599.00	599.00	427.86	213.93	2 N.A. N.A.	
13.200	13.200	607.04	607.04	433.60	216.80	2 N.A. N.A.	
13.300	13.300	615.11	615.11	439.37	219.68	2 N.A. N.A.	
13.400	13.400	623.23	623.23	445.16	222.58	2 N.A. N.A.	
13.500	13.500	631.39	631.39	450.99	225.50	2 N.A. N.A.	
13.600	13.600	639.59	639.59	456.85	228.42	2 N.A. N.A.	
13.700	13.700	647.82	647.82	462.73	231.37	2 N.A. N.A.	
13.800	13.800	656.11	656.11	468.65	234.32	2 N.A. N.A.	
13.900	13.900	664.43	664.43	474.59	237.30	2 N.A. N.A.	
14.000	14.000	672.79	672.79	480.57	240.28	2 N.A. N.A.	
14.100	14.100	681.20	681.20	486.57	243.28	2 N.A. N.A.	
14.200	14.200	689.64	689.64	492.60	246.30	2 N.A. N.A.	
14.300	14.300	698.13	698.13	498.66	249.33	2 N.A. N.A.	
14.400	14.400	706.66	706.66	504.76	252.38	2 N.A. N.A.	
14.500	14.500	715.23	715.23	510.88	255.44	2 N.A. N.A.	
14.600	14.600	723.84	723.84	517.03	258.51	2 N.A. N.A.	
14.700	14.700	732.49	732.49	523.21	261.60	2 N.A. N.A.	
14.800	14.800	741.18	741.18	529.42	264.71	2 N.A. N.A.	
14.900	14.900	749.92	749.92	535.66	267.83	2 N.A. N.A.	
15.000	15.000	758.69	758.69	541.92	270.96	2 N.A. N.A.	
15.100	15.100	767.51	767.51	548.22	274.11	2 N.A. N.A.	
15.200	15.200	776.37	776.37	554.55	277.28	2 N.A. N.A.	
15.300	15.300	785.27	785.27	560.91	280.45	2 N.A. N.A.	
15.400	15.400	794.21	794.21	567.29	283.65	2 N.A. N.A.	
15.500	15.500	803.19	803.19	573.71	286.85	2 N.A. N.A.	
15.600	15.600	812.22	812.22	580.15	290.08	2 N.A. N.A.	

Job No.	Sheet No.	Rev.
<b>40631A3</b>		
<b>Dr. Ref.</b>		
<b>Made by</b> <b>AM</b>	<b>Date</b>	<b>Checked</b>

Depth	Pile length	Cumulative external Friction	Net ultimate resistance	Design resistance	Combination resistance	Factored load* with least resistance	#		
15.700	15.700	821.28	821.28	586.63	293.31	2	N.A.	N.A.	
15.800	15.800	830.39	830.39	593.13	296.57	2	N.A.	N.A.	
15.900	15.900	839.53	839.53	599.67	299.83	2	N.A.	N.A.	
16.000	16.000	848.72	848.72	606.23	303.11	2	N.A.	N.A.	
16.100	16.100	857.95	857.95	612.82	306.41	2	N.A.	N.A.	
16.200	16.200	867.22	867.22	619.44	309.72	2	N.A.	N.A.	
16.300	16.300	876.53	876.53	626.09	313.05	2	N.A.	N.A.	
16.400	16.400	885.89	885.89	632.78	316.39	2	N.A.	N.A.	
16.500	16.500	895.28	895.28	639.49	319.74	2	N.A.	N.A.	
16.600	16.600	904.72	904.72	646.23	323.11	2	N.A.	N.A.	
16.700	16.700	914.19	914.19	652.99	326.50	2	N.A.	N.A.	
16.800	16.800	923.71	923.71	659.79	329.90	2	N.A.	N.A.	
16.900	16.900	933.27	933.27	666.62	333.31	2	N.A.	N.A.	
17.000	17.000	942.87	942.87	673.48	336.74	2	N.A.	N.A.	
17.100	17.100	952.51	952.51	680.37	340.18	2	N.A.	N.A.	
17.200	17.200	962.20	962.20	687.28	343.64	2	N.A.	N.A.	
17.300	17.300	971.92	971.92	694.23	347.11	2	N.A.	N.A.	
17.400	17.400	981.68	981.68	701.20	350.60	2	N.A.	N.A.	
17.500	17.500	991.49	991.49	708.21	354.10	2	N.A.	N.A.	
17.600	17.600	1001.3	1001.3	715.24	357.62	2	N.A.	N.A.	
17.700	17.700	1011.2	1011.2	722.31	361.15	2	N.A.	N.A.	
17.800	17.800	1021.2	1021.2	729.40	364.70	2	N.A.	N.A.	
17.900	17.900	1031.1	1031.1	736.52	368.26	2	N.A.	N.A.	
18.000	18.000	1041.1	1041.1	743.67	371.84	2	N.A.	N.A.	
18.100	18.100	1051.2	1051.2	750.86	375.43	2	N.A.	N.A.	
18.200	18.200	1061.3	1061.3	758.07	379.03	2	N.A.	N.A.	
18.300	18.300	1071.4	1071.4	765.31	382.65	2	N.A.	N.A.	
18.400	18.400	1081.6	1081.6	772.58	386.29	2	N.A.	N.A.	
18.500	18.500	1091.8	1091.8	779.88	389.94	2	N.A.	N.A.	
18.600	18.600	1102.1	1102.1	787.20	393.60	2	N.A.	N.A.	
18.700	18.700	1112.4	1112.4	794.56	397.28	2	N.A.	N.A.	
18.800	18.800	1122.7	1122.7	801.95	400.98	2	N.A.	N.A.	
18.900	18.900	1133.1	1133.1	809.37	404.68	2	N.A.	N.A.	
19.000	19.000	1143.5	1143.5	816.81	408.41	2	N.A.	N.A.	
19.100	19.100	1154.0	1154.0	824.29	412.15	2	N.A.	N.A.	
19.200	19.200	1164.5	1164.5	831.80	415.90	2	N.A.	N.A.	
19.300	19.300	1175.1	1175.1	839.33	419.67	2	N.A.	N.A.	
19.400	19.400	1185.7	1185.7	846.89	423.45	2	N.A.	N.A.	
19.500	19.500	1196.3	1196.3	854.49	427.24	2	N.A.	N.A.	
19.600	19.600	1207.0	1207.0	862.11	431.06	2	N.A.	N.A.	
19.700	19.700	1217.7	1217.7	869.76	434.88	2	N.A.	N.A.	
19.800	19.800	1228.4	1228.4	877.45	438.72	2	N.A.	N.A.	
19.900	19.900	1239.2	1239.2	885.16	442.58	2	N.A.	N.A.	
20.000	20.000	1250.1	1250.1	892.90	446.45	2	N.A.	N.A.	
20.100	20.100	1260.9	1260.9	900.67	450.34	2	N.A.	N.A.	
20.200	20.200	1271.9	1271.9	908.47	454.24	2	N.A.	N.A.	
20.300	20.300	1282.8	1282.8	916.30	458.15	2	N.A.	N.A.	
20.400	20.400	1293.8	1293.8	924.16	462.08	2	N.A.	N.A.	
20.500	20.500	1304.9	1304.9	932.05	466.02	2	N.A.	N.A.	
20.600	20.600	1316.0	1316.0	939.96	469.98	2	N.A.	N.A.	
20.700	20.700	1327.1	1327.1	947.91	473.96	2	N.A.	N.A.	
20.800	20.800	1338.2	1338.2	955.89	477.94	2	N.A.	N.A.	
20.900	20.900	1349.5	1349.5	963.89	481.95	2	N.A.	N.A.	
21.000	21.000	1360.7	1360.7	971.93	485.97	2	N.A.	N.A.	
21.100	21.100	1372.0	1372.0	980.00	490.00	2	N.A.	N.A.	
21.200	21.200	1383.3	1383.3	988.09	494.04	2	N.A.	N.A.	
21.300	21.300	1394.7	1394.7	996.21	498.11	2	N.A.	N.A.	
21.400	21.400	1406.1	1406.1	1004.4	502.18	2	N.A.	N.A.	
21.500	21.500	1417.6	1417.6	1012.6	506.28	2	N.A.	N.A.	
21.600	21.600	1429.1	1429.1	1020.8	510.38	2	N.A.	N.A.	
21.700	21.700	1440.6	1440.6	1029.0	514.50	2	N.A.	N.A.	
21.800	21.800	1452.2	1452.2	1037.3	518.64	2	N.A.	N.A.	
21.900	21.900	1463.8	1463.8	1045.6	522.79	2	N.A.	N.A.	
22.000	22.000	1475.5	1475.5	1053.9	526.95	2	N.A.	N.A.	
22.100	22.100	1487.2	1487.2	1062.3	531.13	2	N.A.	N.A.	
22.200	22.200	1498.9	1498.9	1070.7	535.33	2	N.A.	N.A.	
22.300	22.300	1510.7	1510.7	1079.1	539.54	2	N.A.	N.A.	
22.400	22.400	1522.5	1522.5	1087.5	543.76	2	N.A.	N.A.	
22.500	22.500	1534.4	1534.4	1096.0	548.00	2	N.A.	N.A.	
22.600	22.600	1546.3	1546.3	1104.5	552.25	2	N.A.	N.A.	
22.700	22.700	1558.3	1558.3	1113.0	556.52	2	N.A.	N.A.	
22.800	22.800	1570.3	1570.3	1121.6	560.80	2	N.A.	N.A.	
22.900	22.900	1582.3	1582.3	1130.2	565.10	2	N.A.	N.A.	
23.000	23.000	1594.4	1594.4	1138.8	569.41	2	N.A.	N.A.	
23.100	23.100	1606.5	1606.5	1147.5	573.74	2	N.A.	N.A.	
23.200	23.200	1618.6	1618.6	1156.2	578.08	2	N.A.	N.A.	
23.300	23.300	1630.8	1630.8	1164.9	582.44	2	N.A.	N.A.	



Job No.	Sheet No.	Rev.
<b>40631A3</b>		
<b>Dr. Ref.</b>		
<b>Made by</b> <b>AM</b>	<b>Date</b>	<b>Checked</b>

Depth	Pile length	Cumulative external Friction	Net ultimate resistance	Design resistance	Combination resistance	Factored load* with least resistance	#
23.400	23.400	1643.1	1643.1	1173.6	586.81	2 N.A. N.A.	2
23.500	23.500	1655.3	1655.3	1182.4	591.20	2 N.A. N.A.	2
23.600	23.600	1667.7	1667.7	1191.2	595.60	2 N.A. N.A.	2
23.700	23.700	1680.0	1680.0	1200.0	600.01	2 N.A. N.A.	2
23.800	23.800	1692.4	1692.4	1208.9	604.44	2 N.A. N.A.	2
23.900	23.900	1704.9	1704.9	1217.8	608.89	2 N.A. N.A.	2
24.000	24.000	1717.4	1717.4	1226.7	613.35	2 N.A. N.A.	2
24.100	24.100	1729.9	1729.9	1235.6	617.82	2 N.A. N.A.	2
24.200	24.200	1742.5	1742.5	1244.6	622.31	2 N.A. N.A.	2
24.300	24.300	1755.1	1755.1	1253.6	626.81	2 N.A. N.A.	2
24.400	24.400	1767.7	1767.7	1262.7	631.33	2 N.A. N.A.	2
24.500	24.500	1780.4	1780.4	1271.7	635.87	2 N.A. N.A.	2
24.600	24.600	1793.2	1793.2	1280.8	640.41	2 N.A. N.A.	2
24.700	24.700	1805.9	1805.9	1290.0	644.98	2 N.A. N.A.	2
24.800	24.800	1818.8	1818.8	1299.1	649.55	2 N.A. N.A.	2
24.900	24.900	1831.6	1831.6	1308.3	654.15	2 N.A. N.A.	2
25.000	25.000	1844.5	1844.5	1317.5	658.75	2 N.A. N.A.	2

Note - The weight of the pile has not been included in the factored load.

# Limiting criteria :

1 : DA1 C1 [Shaft Tension]

2 : DA1 C2 [Shaft Tension]

\*(C)-> Compression load, (T)-> Tension load

Note: Design resistance does not include any consideration of negative skin friction.

**Soil Profile 2: Soil Profile 2 - Low Level**

Depth	Pile length	Cumulative external Friction	Net ultimate resistance	Design resistance	Combination resistance	Factored load* with least resistance	#
		(Q <sub>s</sub> )	DA1-C1	DA1-C2		DA1-C1	DA1-C2
[m]	[m]	[kN]	[kN]	[kN]		[kN]	[kN]
8.0000	8.0000	107.35	107.35	76.680	38.340	2 N.A. N.A.	2
8.1000	8.1000	113.16	113.16	80.828	40.414	2 N.A. N.A.	2
8.2000	8.2000	119.01	119.01	85.007	42.503	2 N.A. N.A.	2
8.3000	8.3000	124.90	124.90	89.216	44.608	2 N.A. N.A.	2
8.4000	8.4000	130.84	130.84	93.454	46.727	2 N.A. N.A.	2
8.5000	8.5000	136.81	136.81	97.723	48.861	2 N.A. N.A.	2
8.6000	8.6000	142.83	142.83	102.02	51.011	2 N.A. N.A.	2
8.7000	8.7000	148.89	148.89	106.35	53.175	2 N.A. N.A.	2
8.8000	8.8000	154.99	154.99	110.71	55.354	2 N.A. N.A.	2
8.9000	8.9000	161.14	161.14	115.10	57.548	2 N.A. N.A.	2
9.0000	9.0000	167.32	167.32	119.51	59.757	2 N.A. N.A.	2
9.1000	9.1000	173.55	173.55	123.96	61.982	2 N.A. N.A.	2
9.2000	9.2000	179.82	179.82	128.44	64.221	2 N.A. N.A.	2
9.3000	9.3000	186.13	186.13	132.95	66.475	2 N.A. N.A.	2
9.4000	9.4000	192.48	192.48	137.49	68.744	2 N.A. N.A.	2
9.5000	9.5000	198.88	198.88	142.06	71.028	2 N.A. N.A.	2
9.6000	9.6000	205.32	205.32	146.65	73.327	2 N.A. N.A.	2
9.7000	9.7000	211.80	211.80	151.28	75.641	2 N.A. N.A.	2
9.8000	9.8000	218.32	218.32	155.94	77.970	2 N.A. N.A.	2
9.9000	9.9000	224.88	224.88	160.63	80.314	2 N.A. N.A.	2
10.000	10.000	231.49	231.49	165.35	82.673	2 N.A. N.A.	2
10.100	10.100	238.13	238.13	170.10	85.048	2 N.A. N.A.	2
10.200	10.200	244.82	244.82	174.87	87.437	2 N.A. N.A.	2
10.300	10.300	251.55	251.55	179.68	89.841	2 N.A. N.A.	2
10.400	10.400	258.33	258.33	184.52	92.259	2 N.A. N.A.	2
10.500	10.500	265.14	265.14	189.39	94.693	2 N.A. N.A.	2
10.600	10.600	272.00	272.00	194.28	97.142	2 N.A. N.A.	2
10.700	10.700	278.90	278.90	199.21	99.606	2 N.A. N.A.	2
10.800	10.800	285.84	285.84	204.17	102.09	2 N.A. N.A.	2
10.900	10.900	292.82	292.82	209.16	104.58	2 N.A. N.A.	2
11.000	11.000	299.85	299.85	214.18	107.09	2 N.A. N.A.	2
11.100	11.100	306.91	306.91	219.22	109.61	2 N.A. N.A.	2
11.200	11.200	314.02	314.02	224.30	112.15	2 N.A. N.A.	2
11.300	11.300	321.17	321.17	229.41	114.70	2 N.A. N.A.	2
11.400	11.400	328.37	328.37	234.55	117.27	2 N.A. N.A.	2
11.500	11.500	335.60	335.60	239.71	119.86	2 N.A. N.A.	2
11.600	11.600	342.88	342.88	244.91	122.46	2 N.A. N.A.	2
11.700	11.700	350.20	350.20	250.14	125.07	2 N.A. N.A.	2
11.800	11.800	357.56	357.56	255.40	127.70	2 N.A. N.A.	2
11.900	11.900	364.96	364.96	260.68	130.34	2 N.A. N.A.	2
12.000	12.000	372.40	372.40	266.00	133.00	2 N.A. N.A.	2
12.100	12.100	379.89	379.89	271.35	135.67	2 N.A. N.A.	2
12.200	12.200	387.42	387.42	276.73	138.36	2 N.A. N.A.	2
12.300	12.300	394.99	394.99	282.13	141.07	2 N.A. N.A.	2

Job No.	Sheet No.	Rev.
<b>40631A3</b>		
<b>Dr. Ref.</b>		
<b>Made by</b> <b>AM</b>	<b>Date</b>	<b>Checked</b>

Depth	Pile length	Cumulative external Friction	Net ultimate resistance	Design resistance	Combination resistance	Factored load* with least resistance	#
12.400	12.400	402.60	402.60	287.57	143.79	2 N.A. N.A.	2
12.500	12.500	410.25	410.25	293.04	146.52	2 N.A. N.A.	2
12.600	12.600	417.95	417.95	298.54	149.27	2 N.A. N.A.	2
12.700	12.700	425.69	425.69	304.06	152.03	2 N.A. N.A.	2
12.800	12.800	433.47	433.47	309.62	154.81	2 N.A. N.A.	2
12.900	12.900	441.29	441.29	315.21	157.60	2 N.A. N.A.	2
13.000	13.000	449.15	449.15	320.82	160.41	2 N.A. N.A.	2
13.100	13.100	457.06	457.06	326.47	163.24	2 N.A. N.A.	2
13.200	13.200	465.01	465.01	332.15	166.07	2 N.A. N.A.	2
13.300	13.300	473.00	473.00	337.86	168.93	2 N.A. N.A.	2
13.400	13.400	481.03	481.03	343.59	171.80	2 N.A. N.A.	2
13.500	13.500	489.10	489.10	349.36	174.68	2 N.A. N.A.	2
13.600	13.600	497.22	497.22	355.16	177.58	2 N.A. N.A.	2
13.700	13.700	505.38	505.38	360.98	180.49	2 N.A. N.A.	2
13.800	13.800	513.58	513.58	366.84	183.42	2 N.A. N.A.	2
13.900	13.900	521.82	521.82	372.73	186.36	2 N.A. N.A.	2
14.000	14.000	530.10	530.10	378.64	189.32	2 N.A. N.A.	2
14.100	14.100	538.43	538.43	384.59	192.30	2 N.A. N.A.	2
14.200	14.200	546.80	546.80	390.57	195.28	2 N.A. N.A.	2
14.300	14.300	555.20	555.20	396.57	198.29	2 N.A. N.A.	2
14.400	14.400	563.66	563.66	402.61	201.31	2 N.A. N.A.	2
14.500	14.500	572.15	572.15	408.68	204.34	2 N.A. N.A.	2
14.600	14.600	580.68	580.68	414.77	207.39	2 N.A. N.A.	2
14.700	14.700	589.26	589.26	420.90	210.45	2 N.A. N.A.	2
14.800	14.800	597.88	597.88	427.06	213.53	2 N.A. N.A.	2
14.900	14.900	606.54	606.54	433.24	216.62	2 N.A. N.A.	2
15.000	15.000	615.25	615.25	439.46	219.73	2 N.A. N.A.	2
15.100	15.100	623.99	623.99	445.71	222.85	2 N.A. N.A.	2
15.200	15.200	632.78	632.78	451.98	225.99	2 N.A. N.A.	2
15.300	15.300	641.61	641.61	458.29	229.15	2 N.A. N.A.	2
15.400	15.400	650.48	650.48	464.63	232.31	2 N.A. N.A.	2
15.500	15.500	659.39	659.39	470.99	235.50	2 N.A. N.A.	2
15.600	15.600	668.35	668.35	477.39	238.69	2 N.A. N.A.	2
15.700	15.700	677.34	677.34	483.82	241.91	2 N.A. N.A.	2
15.800	15.800	686.38	686.38	490.27	245.14	2 N.A. N.A.	2
15.900	15.900	695.46	695.46	496.76	248.38	2 N.A. N.A.	2
16.000	16.000	704.58	704.58	503.27	251.64	2 N.A. N.A.	2
16.100	16.100	713.75	713.75	509.82	254.91	2 N.A. N.A.	2
16.200	16.200	722.96	722.96	516.40	258.20	2 N.A. N.A.	2
16.300	16.300	732.20	732.20	523.00	261.50	2 N.A. N.A.	2
16.400	16.400	741.50	741.50	529.64	264.82	2 N.A. N.A.	2
16.500	16.500	750.83	750.83	536.31	268.15	2 N.A. N.A.	2
16.600	16.600	760.20	760.20	543.00	271.50	2 N.A. N.A.	2
16.700	16.700	769.62	769.62	549.73	274.86	2 N.A. N.A.	2
16.800	16.800	779.08	779.08	556.48	278.24	2 N.A. N.A.	2
16.900	16.900	788.58	788.58	563.27	281.63	2 N.A. N.A.	2
17.000	17.000	798.12	798.12	570.09	285.04	2 N.A. N.A.	2
17.100	17.100	807.70	807.70	576.93	288.47	2 N.A. N.A.	2
17.200	17.200	817.33	817.33	583.81	291.90	2 N.A. N.A.	2
17.300	17.300	827.00	827.00	590.71	295.36	2 N.A. N.A.	2
17.400	17.400	836.71	836.71	597.65	298.82	2 N.A. N.A.	2
17.500	17.500	846.46	846.46	604.61	302.31	2 N.A. N.A.	2
17.600	17.600	856.25	856.25	611.61	305.81	2 N.A. N.A.	2
17.700	17.700	866.09	866.09	618.64	309.32	2 N.A. N.A.	2
17.800	17.800	875.97	875.97	625.69	312.85	2 N.A. N.A.	2
17.900	17.900	885.89	885.89	632.78	316.39	2 N.A. N.A.	2
18.000	18.000	895.85	895.85	639.89	319.95	2 N.A. N.A.	2
18.100	18.100	905.85	905.85	647.04	323.52	2 N.A. N.A.	2
18.200	18.200	915.90	915.90	654.21	327.11	2 N.A. N.A.	2
18.300	18.300	925.99	925.99	661.42	330.71	2 N.A. N.A.	2
18.400	18.400	936.12	936.12	668.66	334.33	2 N.A. N.A.	2
18.500	18.500	946.29	946.29	675.92	337.96	2 N.A. N.A.	2
18.600	18.600	956.50	956.50	683.22	341.61	2 N.A. N.A.	2
18.700	18.700	966.76	966.76	690.54	345.27	2 N.A. N.A.	2
18.800	18.800	977.05	977.05	697.90	348.95	2 N.A. N.A.	2
18.900	18.900	987.39	987.39	705.28	352.64	2 N.A. N.A.	2
19.000	19.000	997.78	997.78	712.70	356.35	2 N.A. N.A.	2
19.100	19.100	1008.2	1008.2	720.14	360.07	2 N.A. N.A.	2
19.200	19.200	1018.7	1018.7	727.62	363.81	2 N.A. N.A.	2
19.300	19.300	1029.2	1029.2	735.12	367.56	2 N.A. N.A.	2
19.400	19.400	1039.7	1039.7	742.66	371.33	2 N.A. N.A.	2
19.500	19.500	1050.3	1050.3	750.22	375.11	2 N.A. N.A.	2
19.600	19.600	1060.9	1060.9	757.82	378.91	2 N.A. N.A.	2
19.700	19.700	1071.6	1071.6	765.44	382.72	2 N.A. N.A.	2
19.800	19.800	1082.3	1082.3	773.10	386.55	2 N.A. N.A.	2
19.900	19.900	1093.1	1093.1	780.78	390.39	2 N.A. N.A.	2
20.000	20.000	1103.9	1103.9	788.50	394.25	2 N.A. N.A.	2



Job No.	Sheet No.	Rev.
<b>40631A3</b>		
<b>Dr. Ref.</b>		
<b>Made by</b> <b>AM</b>	<b>Date</b>	<b>Checked</b>

Depth	Pile length	Cumulative external Friction	Net ultimate resistance	Design resistance	Combination resistance	Factored load* with least resistance	#		
20.100	20.100	1114.7	1114.7	796.24	398.12	2	N.A.	N.A.	
20.200	20.200	1125.6	1125.6	804.02	402.01	2	N.A.	N.A.	
20.300	20.300	1136.6	1136.6	811.82	405.91	2	N.A.	N.A.	
20.400	20.400	1147.5	1147.5	819.66	409.83	2	N.A.	N.A.	
20.500	20.500	1158.5	1158.5	827.52	413.76	2	N.A.	N.A.	
20.600	20.600	1169.6	1169.6	835.42	417.71	2	N.A.	N.A.	
20.700	20.700	1180.7	1180.7	843.34	421.67	2	N.A.	N.A.	
20.800	20.800	1191.8	1191.8	851.30	425.65	2	N.A.	N.A.	
20.900	20.900	1203.0	1203.0	859.28	429.64	2	N.A.	N.A.	
21.000	21.000	1214.2	1214.2	867.30	433.65	2	N.A.	N.A.	
21.100	21.100	1225.5	1225.5	875.34	437.67	2	N.A.	N.A.	
21.200	21.200	1236.8	1236.8	883.42	441.71	2	N.A.	N.A.	
21.300	21.300	1248.1	1248.1	891.52	445.76	2	N.A.	N.A.	
21.400	21.400	1259.5	1259.5	899.66	449.83	2	N.A.	N.A.	
21.500	21.500	1270.9	1270.9	907.82	453.91	2	N.A.	N.A.	
21.600	21.600	1282.4	1282.4	916.01	458.01	2	N.A.	N.A.	
21.700	21.700	1293.9	1293.9	924.24	462.12	2	N.A.	N.A.	
21.800	21.800	1305.5	1305.5	932.49	466.25	2	N.A.	N.A.	
21.900	21.900	1317.1	1317.1	940.78	470.39	2	N.A.	N.A.	
22.000	22.000	1328.7	1328.7	949.09	474.55	2	N.A.	N.A.	
22.100	22.100	1340.4	1340.4	957.44	478.72	2	N.A.	N.A.	
22.200	22.200	1352.1	1352.1	965.81	482.91	2	N.A.	N.A.	
22.300	22.300	1363.9	1363.9	974.21	487.11	2	N.A.	N.A.	
22.400	22.400	1375.7	1375.7	982.65	491.32	2	N.A.	N.A.	
22.500	22.500	1387.6	1387.6	991.11	495.56	2	N.A.	N.A.	
22.600	22.600	1399.4	1399.4	999.61	499.80	2	N.A.	N.A.	
22.700	22.700	1411.4	1411.4	1008.1	504.07	2	N.A.	N.A.	
22.800	22.800	1423.4	1423.4	1016.7	508.34	2	N.A.	N.A.	
22.900	22.900	1435.4	1435.4	1025.3	512.63	2	N.A.	N.A.	
23.000	23.000	1447.4	1447.4	1033.9	516.94	2	N.A.	N.A.	
23.100	23.100	1459.5	1459.5	1042.5	521.26	2	N.A.	N.A.	
23.200	23.200	1471.7	1471.7	1051.2	525.60	2	N.A.	N.A.	
23.300	23.300	1483.9	1483.9	1059.9	529.95	2	N.A.	N.A.	
23.400	23.400	1496.1	1496.1	1068.6	534.32	2	N.A.	N.A.	
23.500	23.500	1508.4	1508.4	1077.4	538.70	2	N.A.	N.A.	
23.600	23.600	1520.7	1520.7	1086.2	543.10	2	N.A.	N.A.	
23.700	23.700	1533.0	1533.0	1095.0	547.51	2	N.A.	N.A.	
23.800	23.800	1545.4	1545.4	1103.9	551.94	2	N.A.	N.A.	
23.900	23.900	1557.9	1557.9	1112.8	556.38	2	N.A.	N.A.	
24.000	24.000	1570.3	1570.3	1121.7	560.84	2	N.A.	N.A.	
24.100	24.100	1582.9	1582.9	1130.6	565.31	2	N.A.	N.A.	
24.200	24.200	1595.4	1595.4	1139.6	569.80	2	N.A.	N.A.	
24.300	24.300	1608.0	1608.0	1148.6	574.30	2	N.A.	N.A.	
24.400	24.400	1620.7	1620.7	1157.6	578.81	2	N.A.	N.A.	
24.500	24.500	1633.4	1633.4	1166.7	583.35	2	N.A.	N.A.	
24.600	24.600	1646.1	1646.1	1175.8	587.89	2	N.A.	N.A.	
24.700	24.700	1658.9	1658.9	1184.9	592.45	2	N.A.	N.A.	
24.800	24.800	1671.7	1671.7	1194.1	597.03	2	N.A.	N.A.	
24.900	24.900	1684.5	1684.5	1203.2	601.62	2	N.A.	N.A.	
25.000	25.000	1697.4	1697.4	1212.5	606.23	2	N.A.	N.A.	

Note - The weight of the pile has not been included in the factored load.

# Limiting criteria :

1 : DA1 C1 [Shaft Tension]

2 : DA1 C2 [Shaft Tension]

\*(C)-> Compression load, (T)-> Tension load

Note: Design resistance does not include any consideration of negative skin friction.

## **Appendix 3**

---

### *Pile Settlement Calculations. Oasys Report*

Job No.	Sheet No.	Rev.
<b>40631A3</b>		
<b>Dr. Ref.</b>		
<b>Made by</b> <b>AM</b>	<b>Date</b>	<b>Checked</b>

## Notes

350mm pile diameter  
SWL: 420kN  
L: 17.9m

## Analysis Options

Datum type	Depth based
Effective stress profile	Calculated
Depth of rigid boundary	30.000 m
Poisson's ratio of soil	0.25000
Young's modulus of soil above toe level of pile	70000. kPa
Young's modulus of soil below toe level of pile	80000. kPa
Number of pile elements	10
Increment type:	Both loads and displacements
Number of load & displacement increments	100
Increment results would be printed once every	100 increments
Include effect of soil above pile base in base displacement calculation	Yes

## Pile Properties

Pile type	Solid
Pile cross-section	Circular
Under-ream	No
Use different values of Young's modulus for compression and tension	No
Young's modulus of pile	20.000E+6 kPa
Is fixed head boundary condition active?	No
Calculation profile	Single
Pile length	17.900 m

Cross-section	Number of cross sections	Top Diameter [m]	Second Diameter location [m]	Second Diameter [m]	Third Diameter location [m]	Third Diameter [m]
Cross-section 1	1	0.35000				

## Undrained Materials - General Data

No.	Material description	Bulk unit weight [kN/m <sup>3</sup> ]	Cu material factor	Top Cu [kPa]	Base Cu [kPa]
1	London Clay 1	20.000	NA	70.000	235.00
2	London Clay 2	20.000	NA	90.000	235.00
3	London Clay Base	20.000	NA	235.00	235.00

## Undrained Materials - Skin Friction Data

No.	Material description	Skin friction computation	Alpha	q <sub>s</sub> Top [kPa]	q <sub>s</sub> Base [kPa]	Spec. Value	q <sub>s,lim</sub> Value [kPa]
1	London Clay 1	Alpha specified	0.50000	NA	NA	Yes	140.00
2	London Clay 2	Alpha specified	0.50000	NA	NA	Yes	140.00
3	London Clay Base	Alpha specified	0.50000	NA	NA	Yes	140.00

## Undrained Materials - End Bearing Data

No.	Material description	End bearing computation	Nc	q <sub>b</sub> Top [kPa]	q <sub>b</sub> Base [kPa]	Spec. Value	q <sub>b,lim</sub> Value [kPa]
-----	----------------------	-------------------------	----	--------------------------	---------------------------	-------------	--------------------------------

Job No.	Sheet No.	Rev.
40631A3		
Drg. Ref.		
Made by AM	Date	Checked

No.	Material description	End bearing computation	Nc	Q <sub>b</sub>	Q <sub>b, lim</sub>
				Top [kPa]	Base Spec. Value [kPa]
1	London Clay 1	Nc specified	9.0000	NA	NA Yes 2500.0
2	London Clay 2	Nc specified	9.0000	NA	NA Yes 2500.0
3	London Clay Base	Nc specified	9.0000	NA	NA Yes 2500.0

## Undrained Materials - Material Factors (Code Based)

No.	Material description	Qs factors		Nc factors		Qb factors	
		M1	M2	M1	M2	M1	M2
1	London Clay 1	N.A.	N.A.	1.0000	1.0000	N.A.	N.A.
2	London Clay 2	N.A.	N.A.	1.0000	1.0000	N.A.	N.A.
3	London Clay Base	N.A.	N.A.	1.0000	1.0000	N.A.	N.A.

## Drained Materials - General Data

No.	Material description	Bulk unit weight [kN/m <sup>3</sup> ]	Tan(δ) material factor
1	Made Ground	18.000	NA

## Drained Materials - Friction Data

No.	Material description	Skin friction computation	Beta	Delta (δ) [deg]	Coefficient of earth pressure K	Q <sub>s</sub>	Q <sub>s, lim</sub>
						Top [kPa]	Base Spec. Value [kPa]
1	Made Ground	qs specified	NA	NA	NA	0.0	0.0 No NA

## Drained Materials - End Bearing Data

No.	Material description	End bearing computation	Nq	Phi'	PhiD	Phicv'	Ir	Q <sub>b</sub>	Q <sub>b, lim</sub>	Nq-Phi curves
				[deg]	[deg]	[deg]		Top [kPa]	Base Spec. Value [kPa]	
1	Made Ground	qb specified	NA	NA	NA	NA	NA	0.0	0.0 No NA	NA NA

## Drained Materials - Material Factors (Code Based)

No.	Material description	Qs factors		Nq factors		Qb factors	
		M1	M2	M1	M2	M1	M2
1	Made Ground	1.0000	1.0000	N.A.	N.A.	1.0000	1.0000

## Nq-Phi curve data

Curve 1 : Nq-Phi Curve 1

Nq Phi'  
[deg]

## Convergence Control Data

Maximum number of iterations	1000
Tolerance for displacement	0.010000 mm
Tolerance for skin friction	1.0000 kPa
Damping coefficient	1.0000

## STAGE SPECIFIC DATA

### Stage 0 : Initial Stage

Nq Phi'  
[deg]

## Groundwater

No.	Level [m]	Pressure [kPa]	Unit weight of water [kN/m³]
1	9.5000	0.0	10.000

## Soil Profiles

### Soil Profile 1: Soil Profile 1 - Low Level

No.	Depth [m]	Material description	Contributes to negative skin friction
1	0.0	Made Ground	No
2	6.0000	London Clay 1	No
3	25.000	London Clay Base	No

## Soil Profile - Groundwater Map

No.	Soil Profile	Groundwater
1	Soil Profile 1 - Low Level	Groundwater Profile 1

## Static Loads & Displacements

Depth [m]	Applied load [kN]	Prescribed soil displacement [mm]	Load factor A1	A2
0.0	420.00	0.0	1.0000	1.0000

## Calculated Limiting shaft skin friction

### Soil Profile 1: Soil Profile 1 - Low Level

#### Cross Section 1

Depth [m]	Limiting shaft skin friction [kPa]
0.0	0.0
6.0000	0.0
6.0000	35.000
17.900	86.671

## Stage specific warnings

- 1 - Stage 0 - The bottom most layer in Soil Profile 1 - Low Level is assigned "Total stress" material. For this layer the cohesion is assumed to be constant at "Cu-Top", i.e cohesion specified at the top of this layer. The user specified value of cohesion at the bottom of this layer, "Cu-Bottom" is ignored. (Material Properties)

## SETTLEMENT RESULTS

### Soil Profile 1: Soil Profile 1 - Low Level

Results for Length 17.900 [m] Cross-section 1 Load & Displacement increment 100

Job No.	Sheet No.	Rev.
<b>40631A3</b>		
<b>Drg. Ref.</b>		
<b>Made by</b> <b>AM</b>	<b>Date</b>	<b>Checked</b>

**Depth Limiting shaft  
skin friction**  
**[m] [kPa]**

Load applied to pile = 420.00 kN  
Converged at iteration number = 3  
Maximum displacement = 2.5977 mm at node 1  
Displacement error = 0.0049293 mm  
Skin friction error = 0.52686 kPa

**Stresses and Displacements along Pile**

Depth	Shaft skin	Pile	Pile
	friction	stress	displacement
[m]	[kPa]	[kPa]	[mm]
-0.89500	0.0	4365.4	2.5977
-2.6850	0.0	4365.4	2.2077
-4.4750	0.0	4365.4	1.8187
-6.2650	36.151	3995.6	1.4306
-8.0550	43.923	3176.6	1.1094
-9.8450	37.589	2342.8	0.86909
-11.635	25.498	1697.5	0.69762
-13.425	19.645	1235.8	0.57283
-15.215	16.460	866.50	0.48401
-17.005	18.587	508.02	0.42532

Base pressure = 283.42 kPa    Base displacement = 0.40850 mm

Job No.	Sheet No.	Rev.
<b>40631A3</b>		
<b>Dr. Ref.</b>		
<b>Made by</b> <b>AM</b>	<b>Date</b>	<b>Checked</b>

## Notes

350mm diameter pile  
SWL: 725kN  
L: 24.5m

## Analysis Options

Datum type	Depth based
Effective stress profile	Calculated
Depth of rigid boundary	30.000 m
Poisson's ratio of soil	0.25000
Young's modulus of soil above toe level of pile	80000. kPa
Young's modulus of soil below toe level of pile	90000. kPa
Number of pile elements	10
Increment type:	Both loads and displacements
Number of load & displacement increments	100
Increment results would be printed once every	100 increments
Include effect of soil above pile base in base displacement calculation	Yes

## Pile Properties

Pile type	Solid
Pile cross-section	Circular
Under-ream	No
Use different values of Young's modulus for compression and tension	No
Young's modulus of pile	20.000E+6 kPa
Is fixed head boundary condition active?	No
Calculation profile	Single
Pile length	24.500 m

Cross-section	Number of cross sections	Top Diameter [m]	Second Diameter location [m]	Second Diameter [m]	Third Diameter location [m]	Third Diameter [m]
Cross-section 1	1	0.35000				

## Undrained Materials - General Data

No.	Material description	Bulk unit weight [kN/m <sup>3</sup> ]	Cu material factor	Top Cu [kPa]	Base Cu [kPa]
1	London Clay 1	20.000	NA	70.000	235.00
2	London Clay 2	20.000	NA	90.000	235.00
3	London Clay Base	20.000	NA	235.00	235.00

## Undrained Materials - Skin Friction Data

No.	Material description	Skin friction computation	Alpha	q <sub>s</sub> Top [kPa]	q <sub>s</sub> Base [kPa]	Spec. Value	q <sub>s,lim</sub> Value [kPa]
1	London Clay 1	Alpha specified	0.50000	NA	NA	Yes	140.00
2	London Clay 2	Alpha specified	0.50000	NA	NA	Yes	140.00
3	London Clay Base	Alpha specified	0.50000	NA	NA	Yes	140.00

## Undrained Materials - End Bearing Data

No.	Material description	End bearing computation	Nc	q <sub>b</sub> Top [kPa]	q <sub>b</sub> Base [kPa]	Spec. Value	q <sub>b,lim</sub> Value [kPa]
-----	----------------------	-------------------------	----	--------------------------	---------------------------	-------------	--------------------------------

Job No.	Sheet No.	Rev.
<b>40631A3</b>		
<b>Dr. Ref.</b>		
<b>Made by</b> <b>AM</b>	<b>Date</b>	<b>Checked</b>

No.	Material description	End bearing computation	Nc	Q <sub>b</sub>	Q <sub>b, lim</sub>
				Top [kPa]	Base Spec. Value [kPa]
1	London Clay 1	Nc specified	9.0000	NA	NA Yes 2500.0
2	London Clay 2	Nc specified	9.0000	NA	NA Yes 2500.0
3	London Clay Base	Nc specified	9.0000	NA	NA Yes 2500.0

## Undrained Materials - Material Factors (Code Based)

No.	Material description	Qs factors		Nc factors		Qb factors	
		M1	M2	M1	M2	M1	M2
1	London Clay 1	N.A.	N.A.	1.0000	1.0000	N.A.	N.A.
2	London Clay 2	N.A.	N.A.	1.0000	1.0000	N.A.	N.A.
3	London Clay Base	N.A.	N.A.	1.0000	1.0000	N.A.	N.A.

## Drained Materials - General Data

No.	Material description	Bulk unit weight [kN/m <sup>3</sup> ]	Tan(δ) material factor
1	Made Ground	18.000	NA

## Drained Materials - Friction Data

No.	Material description	Skin friction computation	Beta	Delta (δ) [deg]	Coefficient of earth pressure K	Q <sub>s</sub>	Q <sub>s, lim</sub>
						Top [kPa]	Base Spec. Value [kPa]
1	Made Ground	qs specified	NA	NA	NA	0.0	0.0 No NA

## Drained Materials - End Bearing Data

No.	Material description	End bearing computation	Nq	Phi'	PhiD	Phicv'	Ir	Q <sub>b</sub>	Q <sub>b, lim</sub>	Nq-Phi curves
				[deg]	[deg]	[deg]		Top [kPa]	Base Spec. Value [kPa]	
1	Made Ground	qb specified	NA	NA	NA	NA	NA	0.0	0.0 No NA	NA NA

## Drained Materials - Material Factors (Code Based)

No.	Material description	Qs factors		Nq factors		Qb factors	
		M1	M2	M1	M2	M1	M2
1	Made Ground	1.0000	1.0000	N.A.	N.A.	1.0000	1.0000

## Nq-Phi curve data

Curve 1 : Nq-Phi Curve 1

Nq Phi'  
[deg]

## Convergence Control Data

Maximum number of iterations	1000
Tolerance for displacement	0.010000 mm
Tolerance for skin friction	1.0000 kPa
Damping coefficient	1.0000

## STAGE SPECIFIC DATA

### Stage 0 : Initial Stage



Nq Phi'  
[deg]

## Groundwater

No.	Level [m]	Pressure [kPa]	Unit weight of water [kN/m³]
1	9.5000	0.0	10.000

## Soil Profiles

### Soil Profile 1: Soil Profile 2 - Low Level

No.	Depth [m]	Material description	Contributes to negative skin friction
1	0.0	Made Ground	No
2	6.0000	London Clay 2	No
3	25.000	London Clay Base	No

## Soil Profile - Groundwater Map

No.	Soil Profile	Groundwater
1	Soil Profile 2 - Low Level	Groundwater Profile 1

## Static Loads & Displacements

Depth [m]	Applied load [kN]	Prescribed soil displacement [mm]	Load factor A1	Load factor A2
0.0	725.00	0.0	1.0000	1.0000

## Calculated Limiting shaft skin friction

### Soil Profile 1: Soil Profile 2 - Low Level

#### Cross Section 1

Depth [m]	Limiting shaft skin friction [kPa]
0.0	0.0
6.0000	0.0
6.0000	45.000
24.500	115.59

## Stage specific warnings

- 1 - Stage 0 - The bottom most layer in Soil Profile 2 - Low Level is assigned "Total stress" material. For this layer the cohesion is assumed to be constant at "Cu-Top", i.e cohesion specified at the top of this layer. The user specified value of cohesion at the bottom of this layer, "Cu-Bottom" is ignored. (Material Properties)

## SETTLEMENT RESULTS

### Soil Profile 1: Soil Profile 2 - Low Level

Results for Length 24.500 [m] Cross-section 1 Load & Displacement increment 100

Job No.	Sheet No.	Rev.
<b>40631A3</b>		
<b>Drg. Ref.</b>		
<b>Made by</b> <b>AM</b>	<b>Date</b>	<b>Checked</b>

**Depth**   **Limiting shaft**  
              **skin friction**  
**[m]**                **[kPa]**

Load applied to pile = 725.00 kN  
Converged at iteration number = 3  
Maximum displacement = 4.3948 mm at node 1  
Displacement error = 0.0081937 mm  
Skin friction error = 0.75941 kPa

**Stresses and Displacements along Pile**

Depth	Shaft skin	Pile	Pile
	friction	stress	displacement
[m]	[kPa]	[kPa]	[mm]
-1.2250	0.0	7535.5	4.3948
-3.6750	0.0	7535.5	3.4738
-6.1250	45.477	6898.8	2.5554
-8.5750	54.826	5494.6	1.7952
-11.025	62.596	3850.7	1.2244
-13.475	34.281	2494.4	0.86840
-15.925	22.191	1703.8	0.62995
-18.375	15.368	1177.9	0.46762
-20.825	11.840	797.03	0.35800
-23.275	12.730	453.05	0.28899

Base pressure = 211.65 kPa    Base displacement = 0.27067 mm

## **Appendix 4**

---

### *Reinforcement Calculations*

### Input Parameters

Head fixity	Free
Soil type	Cohesionless
Effective density (kN/m <sup>3</sup> )	<input type="text" value="18"/>
Angle of friction (Φ°)	<input type="text" value="25"/>
Cohesion (C <sub>u</sub> ) (kPa)	<input type="text" value="0"/>
Coefficient of earth pressure, K <sub>p</sub>	<input type="text" value="2.46"/>
Pile diameter, d (m)	<input type="text" value="0.35"/>
Horizontal load, H (kN)	<input type="text" value="20"/> (Service Horizontal Load)
Factor of safety for bending	<input type="text" value="1.5"/>
Ultimate horizontal load, H <sub>u</sub> (kN)	<input type="text" value="30"/> (Ultimate Horizontal Load)

### Calculation Method

F (m) =	$0.82 * \text{SQRT}(H_u / (Y * B * K_p))$	(Point of Zero Shear)
M <sub>u</sub> (kNm) =	$H_u * 2/3 * F$	(Maximum Ultimate Moment)

### Output

Point of zero shear, F (m)	<input type="text" value="1.14"/>
Maximum ultimate moment, M <sub>u</sub> (kN-m)	<input type="text" value="23"/>

### Concrete Parameters

Compression load, P (kN)	<input type="text" value="0"/>
Concrete strength, F <sub>ck</sub> (N/mm <sup>2</sup> )	<input type="text" value="28"/>

### Reinforcement Design

M <sub>u</sub> / (B <sup>3</sup> * F <sub>ck</sub> )	<input type="text" value="0.019"/>	
N / (B <sup>2</sup> * F <sub>ck</sub> )	<input type="text" value="0.000"/>	
(A <sub>s</sub> * F <sub>yk</sub> ) / (A <sub>c</sub> * F <sub>ck</sub> )	<input type="text" value="0.073"/>	(Minimum 0.02) (Steel strength F <sub>yk</sub> = 500 N/mm <sup>2</sup> )
A <sub>c</sub> (mm <sup>2</sup> )	<input type="text" value="96211"/>	
A <sub>s</sub> required (mm <sup>2</sup> )	<input type="text" value="394"/>	

### Steel Requirements

No. bars	<input type="text" value="4"/>
Steel grade	<input type="text" value="H"/>
Bar diameter (mm)	<input type="text" value="20"/>
Depth of cage (m)	<input type="text" value="10"/>
A <sub>sc</sub> allowed (mm <sup>2</sup> )	<input type="text" value="1257"/>

### Notes:

### Shear Forces

Shear force, V (kN)  (Factor of safety on shear force = 1.5)

### Concrete Parameters

Pile diameter, B (m)

Cover (mm)

Concrete strength,  $F_{ck}$  (N/mm<sup>2</sup>)

### Reinforcement Properties

Number of bars

Main bar diameter (mm)

Steel strength,  $F_y$  (N/mm<sup>2</sup>)  (Main bar and helical reinforcement)

Helical bar diameter (mm)

### Area Outputs

$A_c$  (mm<sup>2</sup>)  Main bar  $A_s$  (mm<sup>2</sup>)

### Equivalent Rectangular Section

Rectangular width (mm)  Effective width, b (mm)

Rectangular depth (mm)  Effective depth, z (mm)

### Area of Tension Reinforcement

Length of distance (mm)

Tension  $A_s$  (mm<sup>2</sup>)

$100A_s / b \cdot d$

### Value of Design Concrete Shear Stress

$V_c$  (N/mm<sup>2</sup>) (Table 4.17)

Shear resistance,  $V_{rd}$  (kN)

### Design of Links

$v_w = V / (b \cdot z \cdot (1 - F_{ck} / 250) \cdot F_{ck})$

$A_{sv} / s = V / (F_y \cdot z \cdot \cot(\phi))$

### Shear Requirements

Steel grade   
 Bar diameter (mm)   
 Pitch (mm)   
 $A_{sv} / s$  allowed (mm<sup>2</sup>/mm)  
 (From table 4.20)

### Notes:

Spacing must be less than or equal to  $0.75 \cdot z$

$0.75 \cdot z$

#### Input Parameters

Cohesion ( $C_u$ ) (kPa)	50
Soil softening factor ( $\alpha$ )	0.5
Pile diameter, B (m)	0.35
Ignored depth, h (m)	0.5
Depth of dessication, D (m)	2

#### Calculation Method

$$H_f \text{ (kN)} = C_u * \alpha * B * \pi * (D - h)$$

#### Output

Heave force, $H_f$ (kN)	41
-------------------------	----

#### Reinforcement Design

Steel yield strength ( $N/mm^2$ )	500
Material partial safety factor, $\gamma_m$	1.15
$A_{sc}$ required ( $mm^2$ )	128
USC required (kN)	56
Depth where USC exceeds (m)	10.00
USC at depth (kN)	231

#### Steel Requirements

No. bars	4
Steel grade	H
Bar diameter (mm)	20
Depth of cage (m)	10
$A_{sc}$ allowed ( $mm^2$ )	1257
USC at depth (kN)	231

#### Notes:

---

**Appendix 5**  
*Pile Schedule*

Pile Ref	Diameter (mm)	Permanent Load G <sub>k</sub> (kN)	Variable Load Q <sub>k</sub> (kN)	Wind Load W <sub>k</sub> (kN)	Total Vertical DA1-C2 (kN)	Total Vertical DA1-C1 (kN)	Horizontal (kN)	Tension (kN)	*Mat Level (m)	Cut-off Level (m)	Rebar Protruding (m)	Pile Depth (m)	No. Bars	Grade	Depth (m)	Helical Grade	Helical Pitch (mm)
P01	350	440	75		550	750	10					18.7	4	H20	10	H10	200
P02	350	440	75		550	750	10					18.7	4	H20	10	H10	200
P03	350	440	75		550	750	10					18.7	4	H20	10	H10	200
P04	350	375	75		500	650	10					17.6	4	H20	10	H10	200
P05	350	375	75		500	650	10					17.6	4	H20	10	H10	200
P06	350	365	80		500	650	20					19.0	4	H20	10	H10	200
P07	350	365	80		500	650	20					19.0	4	H20	10	H10	200
P08	350	365	80		500	650	20					19.0	4	H20	10	H10	200
P09	350	365	80		500	650	20					19.0	4	H20	10	H10	200
P10	350	365	80		500	650	20					19.0	4	H20	10	H10	200
P11	350	365	80		500	650	20					19.0	4	H20	10	H10	200
P12	350	365	80		500	650	20					19.0	4	H20	10	H10	200
P13	350	365	80		500	650	20					19.0	4	H20	10	H10	200
P14	350	365	95		500	650	10					19.0	4	H20	10	H10	200
P15	350	365	95		500	650	10					19.0	4	H20	10	H10	200
P16	350	365	95		500	650	10					19.0	4	H20	10	H10	200
P17	350	365	95		500	650	10					19.0	4	H20	10	H10	200
P18	350	365	120		550	700	10					20.0	4	H20	10	H10	200
P19	350	365	120		550	700	10					20.0	4	H20	10	H10	200
P20	350	365	120		550	700	10					20.0	4	H20	10	H10	200
P21	350	430	100		600	750	10					20.9	4	H20	10	H10	200
P22	350	430	100		600	750	10					20.9	4	H20	10	H10	200
P23	350	430	100		600	750	10					20.9	4	H20	10	H10	200
P24	350	430	100		600	750	10					20.9	4	H20	10	H10	200
P25	350	430	125		600	800	10					20.9	4	H20	10	H10	200
P26	350	430	125		600	800	10					20.9	4	H20	10	H10	200
P27	350	430	125		600	800	10					20.9	4	H20	10	H10	200
P28	350	430	125		600	800	10					20.9	4	H20	10	H10	200
P29	350	495	120		700	850	10					22.8	4	H20	10	H10	200
P30	350	495	120		700	850	10					22.8	4	H20	10	H10	200
P31	350	495	120		700	850	10					22.8	4	H20	10	H10	200
P32	350	330	85		450	600	10					17.9	4	H20	10	H10	200
P33	350	330	85		450	600	10					17.9	4	H20	10	H10	200
P34	350	330	85		450	600	10					17.9	4	H20	10	H10	200
P35	350	370	120		550	700	10					20.0	4	H20	10	H10	200
P36	350	370	120		550	700	10					20.0	4	H20	10	H10	200
P37	350	370	120		550	700	10					20.0	4	H20	10	H10	200
P38	350	370	120		550	700	10					20.0	4	H20	10	H10	200
P39	350	365	90		500	650	10					19.0	4	H20	10	H10	200
P40	350	365	90		500	650	10					19.0	4	H20	10	H10	200
P41	350	365	90		500	650	10					19.0	4	H20	10	H10	200
P42	350	400	75		500	700	20					19.0	4	H20	10	H10	200
P43	350	400	75		500	700	20					19.0	4	H20	10	H10	200
P44	350	400	75		500	700	20					19.0	4	H20	10	H10	200
P45	350	400	75		500	700	20					19.0	4	H20	10	H10	200
P46	350	400	75		500	700	20					19.0	4	H20	10	H10	200
P47	350	400	75		500	700	20					19.0	4	H20	10	H10	200
P48	350	400	75		500	700	20					19.0	4	H20	10	H10	200
P49	350	400	75		500	700	20					19.0	4	H20	10	H10	200
P50	350	385	110		550	700	10					20.0	4	H20	10	H10	200
P51	350	385	110		550	700	10					20.0	4	H20	10	H10	200
P52	350	385	110		550	700	10					20.0	4	H20	10	H10	200
P53	350	360	60		450	600	10					17.9	4	H20	10	H10	200
P54	350	360	60		450	600	10					17.9	4	H20	10	H10	200
P55	350	605	120		800	1000	10					24.5	4	H20	10	H10	200
P56	350	605	120		800	1000	10					24.5	4	H20	10	H10	200
P57	350	370	75		500	650	20					19.0	4	H20	10	H10	200
P58	350	370	75		500	650	20					19.0	4	H20	10	H10	200
P59	350	370	75		500	650	20					19.0	4	H20	10	H10	200
P60	350	370	75		500	650	20					19.0	4	H20	10	H10	200
P61	350	370	75		500	650	20					19.0	4	H20	10	H10	200
P62	350	370	75		500	650	20					19.0	4	H20	10	H10	200
P63	350	370	75		500	650	20					19.0	4	H20	10	H10	200
P64	350	370	75		500	650	20					19.0	4	H20	10	H10	200
P65	350	370	75		500	650	20					19.0	4	H20	10	H10	200
P66	350	370	75		500	650	20					19.0	4	H20	10	H10	200
P67	350	370	75		500	650	20					19.0	4	H20	10	H10	200
P68	350	535	100		700	900	10					22.8	4	H20	10	H10	200
P69	350	535	100		700	900	10					22.8	4	H20	10	H10	200
P70	350	415	135		600	800	10					20.9	4	H20	10	H10	200
P71	350	415	135		600	800	10					20.9	4	H20	10	H10	200
P72	350	415	135		600	800	10					20.9	4	H20	10	H10	200
P73	350	415	135		600	800	10					20.9	4	H20	10	H10	200
P74	350	415	135		600	800	10					20.9	4	H20	10	H10	200
P75	350	415	135		600	800	10					20.9	4	H20	10	H10	200
P76	350	415	135		600	800	10					20.9	4	H20	10	H10	200
P77	350	415	135		600	800	10					20.9	4	H20	10	H10	200
P78	350	415	135		600	800	10					20.9	4	H20	10	H10	200
P79	350	415	135		600	800	10					20.9	4	H20	10	H10	200
P80	350	415	135		600	800	10					20.9	4	H20	10	H10	200
P81	350	415	135		600	800	10					20.9	4	H20	10	H10	200
P82	350	415	135		600	800	10					20.9	4	H20	10	H10	200
P83	350	415	135		600	800	10					20.9	4	H20	10	H10	200
P84	350	415	135		600	800	10					20.9	4	H20	10	H10	200
P85	350	415	135		600	800	10					20.9	4	H20	10	H10	200
P86	350	415	135		600	800	10					20.9	4	H20	10	H10	200
P87	350	415	135		600	800	10					20.9	4	H20	10	H10	200
P88	350	415	135		600	800	10					20.9	4	H20	10	H10	200
P89	350	415	135		600	800	10					20.9	4	H20	10	H10	200
P90	350	415	135		600	800	10					20.9	4	H20	10	H10	200
P91	350	415	135		600	800	10					20.9	4	H20	10	H10	200
P92	350	415	135		600	800	10					20.9	4	H20	10	H10	200
P93	350	415	135		600	800	10					20.9	4	H20	10	H10	200
P94	350	480	110		650	850	10					21.9	4	H20	10	H10	200
P95	350	480	110		650	850	10					21.9	4	H20	10	H10	200
P96	350	480	110		650	850	10					21.9	4	H20	10	H10	200
P97	350	480	110		650	850	10					21.9	4	H20	10	H10	200



[illegible]

## **Appendix 6**

---

### *Pile Loads Summary*

Compression DA1-C2 (kN)	Horizontal (kN)	Tension load DA1-C2 (kN)	Diameter (mm)	PileDepth (m)	Count of Piles
450	10		350	17.9	5
500	10		350	17.6	2
500	10		350	19	7
500	20		350	19	27
550	10		350	18.7	3
550	10		350	20	10
600	10		350	20.9	32
650	10		350	21.9	6
700	10		350	22.8	5
800	10		350	24.5	2
Grand Total					99

## **Appendix 7**

---

### *Design Risk Assessment*

Central Piling Ltd			Risk Assessment				Assessment No: 41713A3	
Activity: <b>Design</b>								
Assessed by: A. Munteanu			Date Assessed: 29/03/2021				Review Date: 29/03/2022	
Hazard	Hazard effect	Severity	x	Probability	=	Initial Degree of Risk and Assessment	Minimise Risk by these Control Measures	Residual Degree of Risk and Assessment
Sequencing of piling work.	Conflict with other parts of the project construction creating unsafe working conditions.	5		3	=	15 High	Plan for safe, practical and economic working, not just for time. Avoid return visits for piling rigs if possible.	5 Low
Inadequately designed / constructed / maintained working platforms.	Rig overturning, unsafe working conditions for operatives.	5		3	=	15 High	Ensure working platform is designed, constructed and maintained in accordance with published guidance.	5 Low
CFA auger changes.	Personal injury.	4		2	=	8 Medium	Limit number of pile sizes on one project where possible.	4 Low
Racking of reinforcement cages while lifting.	Injury to operatives from falling steel bars.	4		2	=	8 Medium	Consider design of reinforcement cages to ensure adequate robustness. Lift away from personnel.	4 Low
Underground services.	Personal injury. Loss of amenity.	5		4	=	20 High	Main contractor to arrange positions to avoid services and probe to check position. Instigate permit to dig systems.	5 Low
Immediate environmental impact.	Unacceptable levels and/or vibration, hearing damage to operatives.	3		3	=	9 Medium	Determine acceptable levels and compare these with predicted and measured levels. Enforce hearing protection zones or employ quieter technique.	3 Negligible
Pile trimming to cut-off level and exposing of reinforcement.	Vibration white finger injuries.	3		2	=	6 Low	Correct use of mechanical pile croppers and/or use of debonding.	3 Negligible
Exposed end of reinforcement after pile trimming.	Personal injury.	4		2	=	8 Medium	Use protection caps on the bars after pile trimming and before placing foundation concrete.	4 Low
Inadequate access to piles for integrity testing.	Personal injury.	4		1	=	4 Low	Ensure safe access to pile head - avoid steep sides of excavations for pile caps.	4 Low
Congested reinforcement in pile caps around head of pile during integrity tests.	Inability to test piles.	3		2	=	6 Low	Ensure beam/cap reinforcement is not placed prior to integrity testing.	3 Negligible
Flighting of soils during pile installation.	Damage to/instability of adjacent buildings.	4		2	=	8 Medium	Consider the susceptibility of soils to flighting due to piling method or plant employed. Implement suitable monitoring/construction controls or alternative piling methods or plant.	4 Low
Working in close proximity to TfL tunnels	Drilling in wrong location to the wrong depth could result in an interface between the tunnels and the pile, causing a potential major incident.	5		4	=	20 High	All pile locations must be set out by a qualified setting out engineer to ensure the piles are located outside the exclusion zone. The pile schedule must be checked by at least 2 operatives before any boring works can be started.	6 Low
Calculation or scheduling error	Damage/instability of adjacent structures	4		2	=	8 Medium	All designs and schedules to be checked by a MICE qualified Engineer. Very complex designs to be checked by MICE CEng or suitably qualified external consultant.	6 Low
		Maximum Initial Degree of Risk				20	Maximum Residual Degree of Risk	6
		Initial Risk Assessment				High	Residual Risk Assessment	Low

## **Appendix 8**

---

### *ACEC Concrete class*

**Concrete in aggressive ground BRE Special Digest 1:2005**

Part D: Specifying concrete and additional protective measures

Table D1 Selection of the DC Class and the number of APM's for concrete elements where the hydraulic gradient due to groundwater is 5 or less: for general in-situ use of concrete.		
ACEC Class from General Brownfield or Pyrite sheets	Intended working life	
	At least 50 years	At least 100 years
AC-1	DC-1	DC-1
AC-1s	DC-1	DC-1
AC-2	DC-2	DC-2
AC-2s	DC-2	DC-2
AC-2z	DC-2z	DC-2z
AC-3	DC-3	DC-3 + one APM of choice
AC-3s	DC-3	DC-3
AC-3z	DC-3z	DC-3z
AC-4	DC-4	DC-4 + one APM of choice
AC-4s	DC-4	DC-4
AC-4z	DC-4z	DC-4z
AC-4m	DC-4m	DC-4m + one APM of choice
AC-4ms	DC-4m	DC-4m
AC-5	DC-4 + APM3 <sup>f</sup>	DC-4 + APM3 <sup>f</sup>
AC-5m	DC-4m + APM3 <sup>f</sup>	DC-4m + APM3 <sup>f</sup>
AC-5z	DC-4z + APM3 <sup>f</sup>	DC-4z + APM3 <sup>f</sup>

**Notes**

[a] Where the hydraulic gradient across a concrete element is greater than 5, one step in DC Class or one APM over and above the number indicated in this table should be applied except where the original provisions included APM3 is already required, or has been selected, an extra APM is not needed

[b] A section thickness of 140mm or less should be avoided in in-situ construction but, where this is not practical, apply one step higher DC Class or an extra APM except where the original provisions included APM3. Where APM3 is already required, or has been selected, an extra APM is not necessary

[c] Where a section thickness greater than 450mm is used and some surface chemical attack is acceptable, a relaxation of one step in DC Class may be applied For reinforced concrete, the cover should be sufficiently thick to allow for estimated surface degradation during the intended working life.

[d] Foundation of low rise housing that have an intended working life of at least 100 years may be constructed with concrete selected from the column headed At least 50 years' (Section D7)

[e] Structures with an intended working life of at least 50 years but for which the consequences of failure would be relatively serious, should be classed as having an intended working life of at least 100 years for the selection of the DC Class and APM (Section D7)

[f] Where APM3 is not practical, see Section D6.1 for guidance.

**Explanation of suffix symbols to ACEC Class number**

- Concrete placed in ACEC Classes that include the suffix 'z' primarily must be resist acid conditions and may be made with any of the cements listed in Table D2
- Suffix **m** relates to the higher levels of magnesium in Sulfate Classes 4 and 5.

**Concrete in aggressive ground BRE Special Digest 1:2005**

This General Sheet applies to all sites except those subject to brownfield development or pyritic oxidation

Part C5: Assessing the aggressive chemical environment

**Table C1 & C2 Aggressive Chemical Environment for Concrete (ACEC) site classification**

Sulfate and magnesium						Natural soil		Brownfield (3)		
Design Sulfate Class	2:1 Water/Soil Extract		Groundwater		Total Potential Sulfate (2)	Static Water	Mobile Water	Static Water	Mobile Water	ACEC Class
1	2	3	4	5	6	7	8	9	10	11
	SO4 g/l	Mg g/l	SO4 g/l	Mg g/l	SO4 %	pH	pH	pH (4)	pH (4)	
DS-1	<0.5		<0.4		<0.24	>=2.5		>=2.5		AC-1s
							>5.5		>6.5	AC-1
							2.5-5.5		5.5-6.5	AC-2z
									4.5-5.5	AC-3z
									2.5-4.5	AC-4z
DS-2	0.5-1.5		0.4-1.4		0.24-0.6	>3.5		>5.5		AC-1s
							>5.5		>6.5	AC-2
						2.5-3.5		2.5-5.5		AC-2s
							2.5-5.5		5.5-6.5	AC-3z
									4.5-5.5	AC-4z
									2.5-5.5	AC-5z
DS-3	1.6-3.0		1.5-3.0		0.7-1.2	>3.5		>5.5		AC-2s
							>5.5		>6.5	AC-3
						2.5-3.5		2.5-5.5		AC-3s
							2.5-5.5		5.5-6.5	AC-4
									2.5-5.5	AC-5
DS-4	3.1-6.0	<=1.2	3.1-6.0	<=1.0	1.3-2.4	>3.5		>5.5		AC-3s
							>5.5		>6.5	AC-4
						2.5-3.5		2.5-5.5		AC-4s
							2.5-5.5		2.5-6.5	AC-5
DS-4m	3.8-6.7	>1.2 (1)	3.1-6.0	>1.0 (1)	1.3-2.4	>3.5		>5.5		AC-3s
							>5.5		>6.5	AC-4m
						2.5-3.5		2.5-5.5		AC-4ms
							2.5-5.5		2.5-6.5	AC-5m
DS-5	>6.0	<=1.2	>6.0	<=1.0	>2.4	>3.5		>5.5		AC-4s
						2.5-3.5	>=2.5	2.5-5.5	>=2.5	AC-5
DS-5m	>6.7	>1.2 (1)	>6.0	>1.0 (1)	>2.4	>3.5		>5.5		AC-4ms
						2.5-3.5	>=2.5	2.5-5.5	>=2.5	AC-5m

**Notes**

- (1) The limit on water-soluble magnesium does not apply to brackish groundwater (chloride content between 12g/l and 18g/l). This allows **m** to be omitted from the relevant ACEC classification.
- (2) Applies only to sites where concrete will be exposed to sulfate ions (SO<sub>4</sub>) which may result from the oxidation of sulfides such as pyrite, following ground disturbance.
- (3) 'Brownfield' is defined as sites which may contain chemical wastes remaining from previous industrial use or from imported wastes.
- (4) An additional account is taken of hydrochloric and nitric acids by adjustment to sulfate content - see section C5.1.3.

**Explanation of suffix symbols to ACEC Class number**

- Suffix **s** indicates that, as the water has been classified as Static, no Additional Protective Measures are generally necessary.
- Concrete placed in ACEC Classes which include the suffix **z** have primarily to resist acid conditions and may be made with any of the cement in Table D2 on page 42
- Suffix **m** relates to the higher levels of magnesium in Sulfate Classes 4 and 5.



## **Appendix 9**

---

### *Piling Mat Design*

# BRE 470 - Working Platforms for Tracked Plant

Sheet

1

**Site Address:** 115-119 Premier Inn, Camden High Street, London  
**Contract Number:** 41713A3  
**Rig Type:** SF-50

**Designed by:** AM  
**Checked by:** SD

## Rig track dimensions and bearing pressures:

$W_d = W_k =$  0.7 m  
 $L_{1d} = L_{1k} =$  2.52 m  
 $L_{2d} = L_{2k} =$  1.59 m

$q_{1k} =$  135 kPa  
 $q_{2k} =$  216 kPa

## Design for working platform on cohesionless subgrade

### Design values for ground properties:

#### Subgrade

$\phi'_{sd} = \phi'_{sk} =$  30  
 $N_{ys} =$  22.4  
 $\gamma_{sd} = \gamma_{pd} =$  18 kN/m<sup>3</sup>

#### Working platform

$\phi'_{pd} = \phi'_{pk} =$  45 °  
 $\gamma_{pd} = \gamma_{pk} =$  21 kN/m<sup>3</sup>  
 $N_{yp} =$  272 (From table A1)  
 $k_{ptan\delta} =$  10  
 $sc_1 = 1 + 0.2[W/L] =$  1.06  
 $sc_1 = 1 + 0.2[W/L] =$  1.09  
 $sy_1 = 1 - 0.3[W/L] =$  0.92  
 $sy_2 = 1 - 0.3[W/L] =$  0.87  
 $sp_1 = 1 + [W/L] =$  1.28  
 $sp_2 = 1 + [W/L] =$  1.44

Table A1. Design values for granular material

$\phi'_{sd}$	$N_{ys}$
25°	10.9
30°	22.4
35°	48
40°	109
45°	272
50°	763

Table A2. Design punching shearing resistance coefficient

$\phi'_{sd}$	$k_{ptan\delta}$
35°	3.1
40°	5.5
45°	10

## Check that subgrade cannot provide bearing resistance without a working platform

$R_d = 0.5 \times \gamma_s \times W_d \times N_{ys} \times sy =$  129.36 kPa

Design loading is calculated for two loading conditions.

case 1 loading:  $q_{1d} = 2 \times q_{1k} =$  270 kPa  
case 2 loading:  $q_{2d} = 1.5 \times q_{2k} =$  324 kPa

Working platform is required for plant support

## Check that platform material is stronger than subgrade

Platform material is stronger than subgrade

## Check that platform material can provide required bearing resistance

$q_{1d} = 1.6 \times q_{1k} =$  216 kPa  
 $q_{2d} = 1.2 \times q_{2k} =$  259.2 kPa  
 $0.5 \times \gamma \times W_d \times N_{yp} \times sy =$  1833 kPa

Platform material can provide the required bearing resistance

**Calculate required thickness of platform**

$$D1 = \{Wd[q1d - (0.5 \times \gamma_s \times Nys \times sy1)] / [\gamma_p \times Kp \times \tan \delta \times sp1]\}^{0.5} = 0.48 \text{ m}$$

$$D2 = \{Wd[q2d - (0.5 \times \gamma_s \times Nys \times sy2)] / [\gamma_p \times Kp \times \tan \delta \times sp2]\}^{0.5} = 0.56 \text{ m}$$

**0.56** platform required

**Use of geosynthetic reinforcement**

$$T_{ult} = 30 \text{ kN/m}$$

$$T_d = T_{ult}/2 = 15 \text{ kN/m}$$

**Calculate required thickness of platform with geosynthetic reinforcement**

$$D1 = \{Wd[q1d - (0.5 \times \gamma_s \times Wd \times Nys \times sy1) - (2 \times T_d/Wd)] / [\gamma_p \times Kp \times \tan \delta \times sp1]\}^{0.5} = 0.34 \text{ m}$$

$$D2 = \{Wd[q2d - (0.5 \times \gamma_s \times Wd \times Nys \times sy2) - (2 \times T_d/Wd)] / [\gamma_p \times Kp \times \tan \delta \times sp2]\}^{0.5} = 0.47 \text{ m}$$

**0.47** minimum necessary thickness of platform

**Checking conditions**

$$q1d = 1.25 \times q1k = 169 \text{ kPa}$$

$$q2d = 1.05 \times q2k = 227 \text{ kPa}$$

$$Rd1 = 0.5 \times \gamma_s \times Nys \times sy1 + (D^2/Wd) \times \gamma_p \times Kp \times \tan \delta \times sp1 = 268 \text{ kPa}$$

$$Rd2 = 0.5 \times \gamma_s \times Nys \times sy2 + (D^2/Wd) \times \gamma_p \times Kp \times \tan \delta \times sp2 = 269 \text{ kPa}$$

Conditions are satisfied for designed thickness of platform

**Summary**

A 470mm thick piling mat (with geogrid  $T_{ult}=30\text{kN/m}$ ) or 560mm without geogrid is required to support the piling rig.

The piling mat should be compacted in layers in accordance with the Highways Agency method for compaction of earthworks materials.

Platform material to conform to Type 1 or 6F1 type fill material. Other good quality granular material can be adopted but please note they must be:

- Free from organic material, contamination or substances hazardous to health
- Have less than 15% fines
- Free draining and durable
- Particle size should be less than 2/3 of the layers in which the mat is installed and not greater than 75mm

Plate load testing on the piling mat will be required to verify the installation and quality of the piling mat.

The specification for testing is indicated in the Working Platform Certificate.

The design is based on a granular subgrade. If subgrade is found to be different please contact Central Piling.

Topsoil should be removed prior to placement of mat material and in the event that made ground is encountered it will need to be vibrocompacted prior to it going down to improve its bearing capacity to that of a medium dense sand/gravel.