



Pile Design Calculations

For:

Compression force bearing piles

Project / Site Address:

4 The Chine
London
N10 3QA

Client:

KHB Piling
5 Hazel Grove
London
HA0 1LH

Project Ref: 19759

Revision: 0

Date: 05 August 2022



Date: 05/08/2022

Rev: 0

Designed By: AM

Project Ref:

Design Ref: 19759

This development is known as No. 4 The Chine and can be located in the area of London. Post Code N10 3QA. National Grid Reference TQ 29072 89094.

These pile design calculations cover the installation of 6 No. 350mm diameter piles which will later form the foundations at the above address.

Please note that the individual pile positions and loads that were used within this design have been taken from Drawing Number 1910 PCA.

The ground conditions that were utilised for this pile design have been taken from a combination of our knowledge of ground conditions within the local area, nearby borehole records provided by the British Geological Survey materials © NERC [2022], and published geology; British Geological Survey, 1:50 000 Scale, Solid and Drift Edition, Sheet No. 256 (North London). Our proposed design has been summarised on Figure 1 – Appendix A1.

The above confirmed the site soil profile as consisting of a nominal mantle of made ground underlain by firm to stiff brown silty clay which is considered to be representative of weathered clay from the London Clay Formation. At depth, this graded to a dark brown and grey stiff to very stiff silty clay which is anticipated to continue to depth and is no longer considered to be weathered.

Ground water level has been taken as a depth of 2.0 metres below ground for design purposes.

Due to the limited soils information used within this design we would respectfully request that our parameters be confirmed through the use of trial bores on site. Should the encountered soils vary from those assumed then said findings should be reported back to the design team for the appropriate comment / action.

As no piling platform level has been given, we are assuming that the platform level is 0.000mSD, which is taken as being representative of the existing ground level / average borehole level.

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These pile design calculations have been carried out in accordance with the requirements of Eurocode 7 - the UK national annex to Eurocode Design. Subsequently this design utilises the main design approaches of DA 1-1 and DA 1-2, determining the required pile depths by taking the results of the worst-case analysis.

0.00m^	_____	density taken as 18 kN/m ³ Qs discounted for positive skin friction
	Discounted Soil	
3.00m^	_____	density taken as 20 kN/m ³
	London Clay Formation (Clay)	shear strength taken as 65 kN/m ² and increasing at the rate of 12.3 kN/m ² per metre run
		an adhesion of 40 kN/m ² is taken for heave

Table 1 – Soil Densities

Propose 350mm diameter Continuous Flight Auger Bored Piles where;

As, surface area = 1.099 m per metre length

Ab, base area = 0.096 m²



CALCULATING SHAFT FRICTION

$$C_u * \alpha * A_s$$

used for bored piles in cohesive soils

where:

C_u = Average shear strength taken from Fig 1 attached

α = Adhesion factor taken as 0.50

A_s = Surface area of pile

CALCULATING END BEARING

$$C_b * N_c * A_b$$

used for bored piles in cohesive soils

where:

C_b = shear strength at pile base taken from Fig 1

N_c = bearing capacity factor, taken as 9 for cohesive soils

A_b = base area of pile

Calculation for Clay Heave to a depth of 3.0 m below ground level.

For Uplift use;

$$C_d * \pi * D * (L - l)$$

where;

C_d = desiccated adhesion taken as 40 kN/m²

D = pile diameter taken as 350 mm

L = desiccated zone

l = ignored depth allowing cut off level

Uplift GL – 3.0 m

$$40 \text{ kN/m}^2 * 1.099 \text{ m} * (3.0 \text{ m} - 1.0 \text{ m}) = 88 \text{ kN}$$

Area of reinforcement for tension condition, A_{st} , check

use:

$$A_{st} = \frac{T_e * 1000 * F_s}{0.87 * F_y}$$

where:

A_{st} = area of reinforcement

T_e = direct tension force - taken as 88 kN

F_s = safety factor, taken as 1.5

0.87 = material safety factor

F_y = grade of reinforcement, taken as 500MN/m²

therefore:

$$A_{st} = \frac{88 \text{ kN} * 1000 * 1.5}{0.87 * 500 \text{ N/mm}^2} = 303 \text{ mm}^2$$

Anchorage Length (Heave Case)

Propose minimum 4.0-metre-long reinforcement

Taking the shaft friction, Q_s , of a 7.0-metre-long pile = 197 kN (see page B3 - Appendix B)

$$\text{Factor of Safety against anchorage} \quad \frac{197}{88} = \underline{2.23 +}$$

As the anchorage safety factor is more than 1.5, the heave condition is deemed satisfactory.



Appendix A

Site Address: 4 The Chine, London, N10 3QA

Date: 05/08/2022

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APPENDIX A

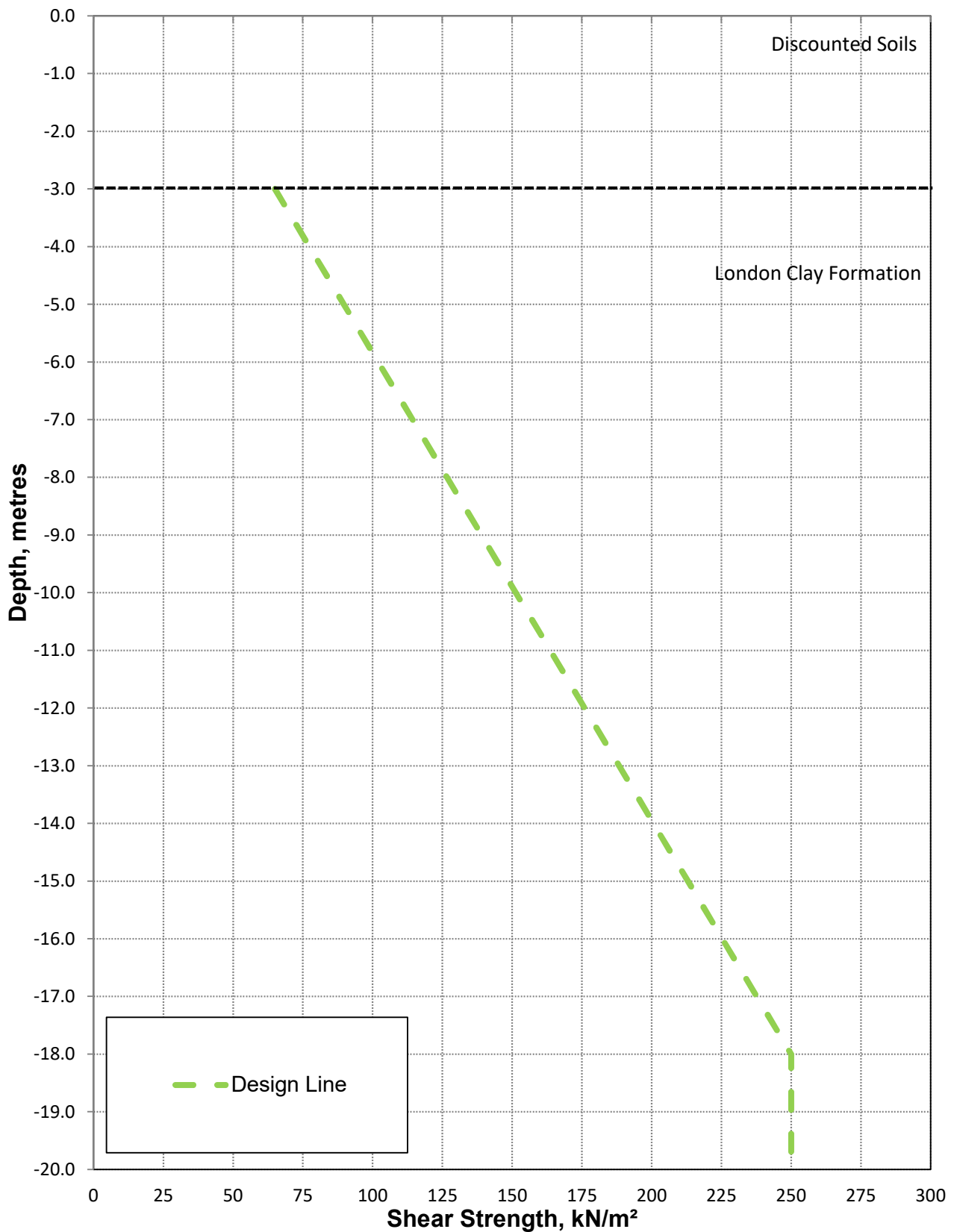
Ref No

Description

A1

Shear Strength v Depth Plot

4 The Chine, London. N10 3QA Shear Strength v Depth Plot





Appendix B

Site Address: 4 The Chine, London, N10 3QA

Date: 05/08/2022

Rev: 0

Designed By: AM

Project Ref:

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APPENDIX B

Ref No

Description

B1 – B5

Results of Pile Oasys 19.7 analysis for 350mm diameter bearing piles with a piling platform level of 0.000mSD and a discounted level of -3.000mSD.

Oasys 4 The Chine London, N10 3QA Vertical Calculation	Job No.		Sheet No.		Rev.	
	19759		B1			
	Drg. Ref.					
	Made by AM		Date		Checked Date	

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)

No

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?

Resistance verified by a maintained load test taken to the

No

calculated, unfactored, ultimate resistance?

Is BS8004 SLS check enabled?

No

Datum type

Depth based

Effective stress profile

Calculated

Pile Properties

File type

Solid

Pile cross-section

Circular

Under-ream

No

Calculation profile

Range

Minimum pile length

7.0000 m

Maximum pile length

20.000 m

Increment size

0.50000

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/m³]	Cu material factor	Top Cu [kPa]	Base Cu [kPa]
1	Discounted Soil	18.000	NA	0.0	0.0
2	Clay	20.000	NA	65.000	250.00
3	Clay 2	20.000	NA	250.00	250.00

Undrained Materials - Skin Friction Data

No.	Material description	Skin friction computation	Alpha	qs	qs,lim
				Top [kPa]	Base Spec. Value [kPa]
1	Discounted Soil	Alpha specified	0.0	NA	NA No NA
2	Clay	Alpha specified	0.50000	NA	NA No NA
3	Clay 2	Alpha specified	0.50000	NA	NA No NA

Undrained Materials - End Bearing Data

No.	Material description	End bearing computation	Nc	qb	qb,lim
				Top [kPa]	Base Spec. Value [kPa]
1	Discounted Soil	Nc specified	9.0000	NA	NA No NA
2	Clay	Nc specified	9.0000	NA	NA No NA
3	Clay 2	Nc specified	9.0000	NA	NA No NA

Undrained Materials - Material Factors (Code Based)

No.	Material description	Qs factors	Nc factors	Qb factors	
		M1	M2	M1	M2

Oasys 4 The China London, N10 3QA Vertical Calculation	Job No.		Sheet No.		Rev.	
	19759		B2			
	Drg. Ref.					
	Made by AM		Date		Checked Date	

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

STAGE SPECIFIC DATA

Stage 0 : Initial Stage

Groundwater

No.	Level	Pressure	Unit weight
	[m]	[kPa]	of water [kN/m³]
1	2.0000	0.0	10.000

Soil Profiles

Soil Profile 1: Soil Profile 1

No.	Depth	Material description	Contributes to negative skin friction
	[m]		
1	0.0	Discounted Soil	No
2	3.0000	Clay	No
3	18.000	Clay 2	No

Soil Profile - Groundwater Map

No.	Soil Profile	Groundwater
1	Soil Profile 1	Groundwater Profile 1

Stage specific warnings

1 - Stage 0 - The bottom most layer in Soil Profile 1 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

Depth	Density	Undrained Cohesion	Nq	Total vertical	Porewater pressure	Effective vertical	Effective horizontal	Cumulative skin
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Vertical Calculation

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stress				stress		stress*	friction per unit perimeter
[m]	[kN/m ³]	[kPa]		[kPa]	[kPa]	[kPa]	[kN/m]
0.0	18.000	0.0	N.A.	0.0	0.0	0.0	NA 0.0
2.0000	18.000	0.0	N.A.	36.000	0.0	36.000	NA 0.0
3.0000	18.000	0.0	N.A.	54.000	10.000	44.000	NA 0.0
3.0000	20.000	65.000	N.A.	54.000	10.000	44.000	NA 0.0
7.0000	20.000	114.33	N.A.	134.00	50.000	84.000	NA 179.33
7.5000	20.000	120.50	N.A.	144.00	55.000	89.000	NA 208.69
8.0000	20.000	126.67	N.A.	154.00	60.000	94.000	NA 239.58
8.5000	20.000	132.83	N.A.	164.00	65.000	99.000	NA 272.02
9.0000	20.000	139.00	N.A.	174.00	70.000	104.00	NA 306.00
9.5000	20.000	145.17	N.A.	184.00	75.000	109.00	NA 341.52
10.000	20.000	151.33	N.A.	194.00	80.000	114.00	NA 378.58
10.500	20.000	157.50	N.A.	204.00	85.000	119.00	NA 417.19
11.000	20.000	163.67	N.A.	214.00	90.000	124.00	NA 457.33
11.500	20.000	169.83	N.A.	224.00	95.000	129.00	NA 499.02
12.000	20.000	176.00	N.A.	234.00	100.00	134.00	NA 542.25
12.500	20.000	182.17	N.A.	244.00	105.00	139.00	NA 587.02
13.000	20.000	188.33	N.A.	254.00	110.00	144.00	NA 633.33
13.500	20.000	194.50	N.A.	264.00	115.00	149.00	NA 681.19
14.000	20.000	200.67	N.A.	274.00	120.00	154.00	NA 730.58
14.500	20.000	206.83	N.A.	284.00	125.00	159.00	NA 781.52
15.000	20.000	213.00	N.A.	294.00	130.00	164.00	NA 834.00
15.500	20.000	219.17	N.A.	304.00	135.00	169.00	NA 888.02
16.000	20.000	225.33	N.A.	314.00	140.00	174.00	NA 943.58
16.500	20.000	231.50	N.A.	324.00	145.00	179.00	NA 1000.7
17.000	20.000	237.67	N.A.	334.00	150.00	184.00	NA 1059.3
17.500	20.000	243.83	N.A.	344.00	155.00	189.00	NA 1119.5
18.000	20.000	250.00	N.A.	354.00	160.00	194.00	NA 1181.3
18.000	20.000	250.00	N.A.	354.00	160.00	194.00	NA 1181.3
18.500	20.000	250.00	N.A.	364.00	165.00	199.00	NA 1243.8
19.000	20.000	250.00	N.A.	374.00	170.00	204.00	NA 1306.3
19.500	20.000	250.00	N.A.	384.00	175.00	209.00	NA 1368.8
20.000	20.000	250.00	N.A.	394.00	180.00	214.00	NA 1431.3

* 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

Depth	Pile length	Ultimate base capacity	Cumulative external Friction	Negative skin friction	Net ultimate resistance
		(Q _b)	(Q _s)	(Q _{nsf})	
[m]	[m]	[kN]	[kN]	[kN]	[kN]
7.0000	7.0000	99.001	197.19	0.0	296.19
7.5000	7.5000	104.34	229.46	0.0	333.80
8.0000	8.0000	109.68	263.44	0.0	373.12
8.5000	8.5000	115.02	299.10	0.0	414.12
9.0000	9.0000	120.36	336.46	0.0	456.82
9.5000	9.5000	125.70	375.52	0.0	501.22
10.000	10.000	131.04	416.27	0.0	547.31
10.500	10.500	136.38	458.72	0.0	595.10
11.000	11.000	141.72	502.86	0.0	644.58
11.500	11.500	147.06	548.70	0.0	695.76
12.000	12.000	152.40	596.23	0.0	748.63
12.500	12.500	157.74	645.46	0.0	803.20
13.000	13.000	163.08	696.39	0.0	859.46
13.500	13.500	168.42	749.00	0.0	917.42
14.000	14.000	173.76	803.32	0.0	977.08
14.500	14.500	179.10	859.33	0.0	1038.4
15.000	15.000	184.44	917.03	0.0	1101.5
15.500	15.500	189.78	976.43	0.0	1166.2
16.000	16.000	195.12	1037.5	0.0	1232.6
16.500	16.500	200.46	1100.3	0.0	1300.8
17.000	17.000	205.80	1164.8	0.0	1370.6
17.500	17.500	211.14	1231.0	0.0	1442.1



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Depth	Pile length	Ultimate base capacity (Q _b)	Cumulative external Friction (Q _s)	Negative skin friction (Q _{nsf})	Net ultimate resistance
18.000	18.000	216.48	1298.9	0.0	1515.3
18.000	18.000	216.48	1298.9	0.0	1515.3
18.500	18.500	216.48	1367.6	0.0	1584.0
19.000	19.000	216.48	1436.3	0.0	1652.8
19.500	19.500	216.48	1505.0	0.0	1721.5
20.000	20.000	216.48	1573.7	0.0	1790.2

Depth	Pile length	Design resistance	Combination with least resistance	Factored load*
			#	
		DA1-C1	DA1-C2	
[m]	[m]	[kN]	[kN]	
7.0000	7.0000	211.56	123.39	2 0.0 (C) 0.0 (C)
7.5000	7.5000	238.43	139.70	2 0.0 (C) 0.0 (C)
8.0000	8.0000	266.51	156.78	2 0.0 (C) 0.0 (C)
8.5000	8.5000	295.80	174.61	2 0.0 (C) 0.0 (C)
9.0000	9.0000	326.30	193.19	2 0.0 (C) 0.0 (C)
9.5000	9.5000	358.02	212.54	2 0.0 (C) 0.0 (C)
10.000	10.000	390.94	232.64	2 0.0 (C) 0.0 (C)
10.500	10.500	425.07	253.49	2 0.0 (C) 0.0 (C)
11.000	11.000	460.42	275.11	2 0.0 (C) 0.0 (C)
11.500	11.500	496.97	297.48	2 0.0 (C) 0.0 (C)
12.000	12.000	534.74	320.60	2 0.0 (C) 0.0 (C)
12.500	12.500	573.72	344.49	2 0.0 (C) 0.0 (C)
13.000	13.000	613.90	369.13	2 0.0 (C) 0.0 (C)
13.500	13.500	655.30	394.53	2 0.0 (C) 0.0 (C)
14.000	14.000	697.91	420.68	2 0.0 (C) 0.0 (C)
14.500	14.500	741.73	447.59	2 0.0 (C) 0.0 (C)
15.000	15.000	786.76	475.26	2 0.0 (C) 0.0 (C)
15.500	15.500	833.00	503.68	2 0.0 (C) 0.0 (C)
16.000	16.000	880.46	532.86	2 0.0 (C) 0.0 (C)
16.500	16.500	929.12	562.80	2 0.0 (C) 0.0 (C)
17.000	17.000	979.00	593.50	2 0.0 (C) 0.0 (C)
17.500	17.500	1030.1	624.95	2 0.0 (C) 0.0 (C)
18.000	18.000	1082.4	657.16	2 0.0 (C) 0.0 (C)
18.000	18.000	1082.4	657.16	2 0.0 (C) 0.0 (C)
18.500	18.500	1131.5	687.84	2 0.0 (C) 0.0 (C)
19.000	19.000	1180.6	718.52	2 0.0 (C) 0.0 (C)
19.500	19.500	1229.6	749.20	2 0.0 (C) 0.0 (C)
20.000	20.000	1278.7	779.88	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 - Material Factor Set - 1

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

Soil Profile 1: Soil Profile 1 - Material Factor Set - 2

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

Results - Tension

Soil Profile 1: Soil Profile 1

Depth	Pile length	Cumulative external Friction (Q _s)	Net ultimate resistance	Design resistance	Combination with least resistance	Factored load*
					#	
		DA1-C1	DA1-C2			
[m]	[m]	[kN]	[kN]	[kN]	[kN]	[kN]
7.0000	7.0000	197.19	197.19	140.85	70.424	2 N.A. N.A.
7.5000	7.5000	229.46	229.46	163.90	81.951	2 N.A. N.A.
8.0000	8.0000	263.44	263.44	188.17	94.084	2 N.A. N.A.
8.5000	8.5000	299.10	299.10	213.64	106.82	2 N.A. N.A.

Depth	Pile length	Cumulative external Friction	Net ultimate resistance	Design resistance	Combination resistance with least resistance	Factored load*
9.0000	9.0000	336.46	336.46	240.33	120.17	2 N.A. N.A.
9.5000	9.5000	375.52	375.52	268.23	134.11	2 N.A. N.A.
10.000	10.000	416.27	416.27	297.34	148.67	2 N.A. N.A.
10.500	10.500	458.72	458.72	327.66	163.83	2 N.A. N.A.
11.000	11.000	502.86	502.86	359.19	179.59	2 N.A. N.A.
11.500	11.500	548.70	548.70	391.93	195.97	2 N.A. N.A.
12.000	12.000	596.23	596.23	425.88	212.94	2 N.A. N.A.
12.500	12.500	645.46	645.46	461.05	230.52	2 N.A. N.A.
13.000	13.000	696.39	696.39	497.42	248.71	2 N.A. N.A.
13.500	13.500	749.00	749.00	535.00	267.50	2 N.A. N.A.
14.000	14.000	803.32	803.32	573.80	286.90	2 N.A. N.A.
14.500	14.500	859.33	859.33	613.81	306.90	2 N.A. N.A.
15.000	15.000	917.03	917.03	655.02	327.51	2 N.A. N.A.
15.500	15.500	976.43	976.43	697.45	348.72	2 N.A. N.A.
16.000	16.000	1037.5	1037.5	741.09	370.54	2 N.A. N.A.
16.500	16.500	1100.3	1100.3	785.94	392.97	2 N.A. N.A.
17.000	17.000	1164.8	1164.8	832.00	416.00	2 N.A. N.A.
17.500	17.500	1231.0	1231.0	879.27	439.63	2 N.A. N.A.
18.000	18.000	1298.9	1298.9	927.75	463.88	2 N.A. N.A.
18.000	18.000	1298.9	1298.9	927.75	463.88	2 N.A. N.A.
18.500	18.500	1367.6	1367.6	976.84	488.42	2 N.A. N.A.
19.000	19.000	1436.3	1436.3	1025.9	512.96	2 N.A. N.A.
19.500	19.500	1505.0	1505.0	1075.0	537.51	2 N.A. N.A.
20.000	20.000	1573.7	1573.7	1124.1	562.05	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 C

Site Address: 4 The Chine, London, N10 3QA

Date: 05/08/2022

Rev: 0

Designed By: AM

Project Ref:

Design Ref: 19759

APPENDIX C

Ref No

Description

C1

Pile installation schedule covering the require pile diameters, depths and reinforcement cages for 6 No. 350mm diameter load bearing piles.



Site Address: 4 The Chine, London. N10 3QA

Drawings: 1910 PCA

Project Ref:

Rev: 0

Design By: BAB

Date: x/x/2022

PILE REF	PPL (mAOD)	COL (mAOD)	COMPRESSION					DIA (mm)	DESIGN DEPTH (M)	REINFORCEMENT	NOTES	REV
			SLS (kN)	G.ka (kN)	Q.ka (kN)	DA 1 - 1 (kN)	DA 1 - 2 (kN)					
P1	TBC	TBC	120	84.0	36.0	167.4	130.8	350	7.5	4 B12 x 4.0m/R6 Helical		
P2	TBC	TBC	120	84.0	36.0	167.4	130.8	350	7.5	4 B12 x 4.0m/R6 Helical		
P3	TBC	TBC	120	84.0	36.0	167.4	130.8	350	7.5	4 B12 x 4.0m/R6 Helical		
P4	TBC	TBC	120	84.0	36.0	167.4	130.8	350	7.5	4 B12 x 4.0m/R6 Helical		
P5	TBC	TBC	120	84.0	36.0	167.4	130.8	350	7.5	4 B12 x 4.0m/R6 Helical		
P6	TBC	TBC	120	84.0	36.0	167.4	130.8	350	7.5	4 B12 x 4.0m/R6 Helical		