Contract Reference:
F23138

Site Address:
100 Grays Inn Road
London, WC1X 8AL

Client:
Erith Contractors Limited

Design Element:
Bearing Pile Design Calculations

Issue	Date	By	Checked	Comments
1	08/04/2024	Jonathan Chaloner	Jonathan Chaloner	First Issue

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1.0 DESIGN BRIEF

Franki Foundations has been instructed to provide design calculations for the following items below:

- Bearing Piles 450mm Dia. (Mini Auger Bored)

For the contract at 100 Grays Inn Road.

Construction issue drawings and pile specification have been issued to Franki Foundations. The following piles loads have been assessed:

- SLS Axial Loads up to 1355kN*
- 112 - 1442kN Pile Force (F_{cd}) based on DA1: Comb 2 (DL + LL)
- 104 - 650kN Pile Tension Force F_{td} based on DA1: Comb 2 (DL + LL)
- 50kN Pile Horizontal Load SLS

**Note – piles P01 and P02 have a limited value of 1355kN as opposed to (1062kN + 472kN) 1534kN due to limit of maximum pile length for 450mm diameter. Heyne Tillett Steel to review and confirm whether piles P01 and P02 loads (noted in Rev C1 pile schedule) can be revised to suit following initial conversation.*

A piling platform level (PPL) equivalent existing borehole level has been considered for design. Based on this and where proposed piles are to be installed, a PPL of +21.000mOD has been modelled.

2.0 DESIGN DOCUMENTS

Specifications:	In accordance with ICE SPERW, 3rd Edition	
Site Investigation:	By Geotechnical & Environmental Associates Limited	
	Report Ref: J20106, Issue No. 2 dated 27/09/2022.	
Drawings Used:	Heyne Tillett Steel (Ref: 2423)	
	Proposed Piling Layout	2423-HTS-00-XX-DR-S-1070 Rev C1
	Proposed Piling Schedule	2423-HTS-00-XX-DR-S-1071 Rev C1
Reference Documents:	BRE Special Digest 1 Concrete in Aggressive Ground - 3rd Edition 2005	
	BS EN 1997-1:2004 – Geotechnical Design	
	UK National Annex to BS EN 1997-1:2004	
	BS EN 1992 – Design of Concrete Structures	
	BS 8500 – Concrete : 2002	
	BS 8666 – Reinforcement for Concrete : 2005	
	BS EN 206 – Concrete : 2000	
	BS EN 1536 – Execution of geotechnical work – Bored piles : 2010	

3.0 GEOTECHNICAL REVIEW

The design uses the ground strata profile outlined below, based on the findings within the site investigation and the soil strength profile (Appendix A). We have assumed that the site investigation is an accurate representation of the ground conditions.

Perched Groundwater was generally recorded at a level of +15.000mOD, and has been modelled as such for design purposes.

From (mOD) [mbgl]		**To (mOD)** [mbgl]	**Stratum**
+21.000 [0.00]	-	+17.000 [4.00]	Made Ground (Ignored)
+17.000 [4.00]	-	+14.800 [6.20]	Lynch Hill Gravel
+14.800 [6.20]	-	+0.000 [21.00]	London Clay i
+0.000 [21.00]	-	-1.000 [22.00]	London Clay ii
-1.000 [22.00]	-	-	Lambeth Group (Clay)

Soil parameters have been established from the test data where relevant tests have been carried out within the geotechnical investigation works. A profile of the soil strength to depth is shown in Appendix A.

Soil	**γ** (kN/m^3)	**Cu** (kN/m^2)	**Cu Inc** (kN/m^2 per m)	**ϕ** (Degrees)
Made Ground (Ignored)	17.0	-	-	28
Lynch Hill Gravel	20.0	-	-	35
London Clay i	19.0	120	10.135	-
London Clay ii	19.0	270	-	-
Lambeth Group (Clay)	19.5	320	-	-

4.0 CONCRETE ASSESSMENT

The site investigation notes (section 8.6) design sulphate class DS-2. We therefore propose to use a design chemical class of DC-2. We would need to be advised if this should be any different.

5.0 PILE SELECTION

The general site and ground conditions found on this project lend itself to auger bored piles with temporary casing in to the London Clay formation.

6.0 GEOTECHNICAL PILE CAPACITY (BEARING)

The axial capacity of circular concrete piles is determined using the ground profile and geotechnical soil parameters found in Appendix A.

Eurocode 7 Part 1 allows limit the states GEO and STR to be verified according to one of three Design Approaches, DA1, DA2 and DA3. The UK National Annex states that *"only Design Approach 1 is to be used in the UK"* from this approach, two combinations are used.

Pile lengths have been established from the following criterion; $E_d \leq R_d$

Where, E_d = Design Value of the effect of actions

R_d = Design Resistance

$R_{c;d}$ = Design compressive resistance of the pile in ULS

$R_{c;k}$ = Characteristic total compressive resistance of the pile

$R_{s;k}$ = Characteristic value of shaft resistance

$R_{b;k}$ = Characteristic value of base resistance

γ_s and γ_b = Partial factors of safety for shaft and base resistance respectively

γ_t = Partial factor of safety for the total resistance of the pile

Therefore the compressive resistance is calculated from the following equation:

$$R_{c;d} = \min\left(\frac{R_{sk}}{\gamma_s} + \frac{R_{bk}}{\gamma_b}; \frac{R_{sk}}{1.2}\right)$$

Based on Design Approach 1: Combination 2, where there is no explicit SLS check to the constructed piles the following resistance factors may be chosen:

Base Resistance, $\gamma_b = 2.00$

Shaft Resistance, $\gamma_s = 1.60$

The above partial factors are subject to a model factor (γ_{rd}) which is 1.40 when no explicit SLS check is carried out. This yields the following factors used within the design:

Base Resistance, $\gamma_b = 2.00 \times 1.40 = 2.80$

Shaft Resistance, $\gamma_s = 1.60 \times 1.40 = 2.24$

Factored Compression Pile Loads based on DA1: Comb 2 have been calculated using the greater value of:-

(DL x 1.0) + (LL x 1.3) + (WL x 1.3 x 0.5) ***OR*** (DL x 1.0) + (LL x 1.3 x 0.7) + (WL x 1.3)

It has been assumed that all piles will be spaced at a minimum of 3.0 x pile diameter, and as such no group analysis is required.

The pile capacity output is outlined in Appendix B

7.0 STRUCTURAL PILE CAPACITY

The maximum compression load has been analysed based on the pile supporting the DA1: Comb 1 [STR] Pile Force ($Fcd_{comb\,1}$). The resultant Pile Force obtained is therefore already factored by 1.35-1.5 (DA1: Comb 1 partial Dead Load and Live Load factors). To consider maximum SLS load that is allowable on a pile, the [STR] DA1:C1 load is therefore divided by the more conservative partial factor of 1.5 to reveal the unfactored maximum pile section capacity.

The following formula has been considered:-

$$Fcd_{comb1} = \frac{\alpha_{cc}}{\gamma_c \times k_f} \times f_{ck} \times A_b$$

Where:

- α_{cc} 0.85 Coefficient for concrete pile section (as per UK National Annex)
- γ_c 1.5
- k_f 1.1 for cast in-situ piles without permanent casing
- f_{ck} Cylinder compressive strength at 28 days
- A_b Base Area of pile

Therefore consider $\frac{\alpha_{cc}}{\gamma_c \times k_f} = 0.515$

Check for C30/37 concrete:

Concrete Grade	Pile Dia.	Max Capacity of Pile Section [STR] (DA1: Comb 1)	Max (STR) Load determined from pile schedule
C30/37	450mm	2457kN	**1872kN***

*Based on Pile P01 & P02, with a max *Qk Vert Load of 292kN* (limited) to give;

(1062kN x 1.35) + (**292kN** x 1.5) = 1872kN

7.1 MINIMUM REINFORCEMENT

Reinforcement cage will be selected in accordance with BS EN 1536:2010 section 7.5.2.2, Table 3:

Table 3 — Minimum longitudinal reinforcement

Nominal bored pile cross section A_C	Area of longitudinal reinforcement A_S
$A_C \leq 0{,}5\ m^2$	$A_S \geq 0{,}5\ \%\ A_C$
$0{,}5\ m^2 < A_C \leq 1{,}0\ m^2$	$A_S \geq 0{,}002\ 5\ m^2$
$A_C > 1{,}0\ m^2$	$A_S \geq 0{,}25\ \%\ A_C$

- For 450mm diameter piles 795mm^2 – propose minimum 6 B16 (1206mm^2)

7.2 TENSION (HEAVE)

Tension due to heave is not considered as this is not deemed to be applicable

7.3 TENSION

Tension acts on certain piles within the scheme; check the required length of steel to cater for said tension load. This tension load has been considered as a variable load and has therefore multiplied by 1.3 (DA1:C2) for GEO load; to calculate length of reinforcement required (pile cage or centre bar) and 1.5 (DA1:C1) for STR load; to calculate minimum area of steel (for pile cage).

Tension Load Case	SLS Tensile Load	Max. GEO Tensile Force F_{td} (DA1:C2)	Max. STR Tensile Force F_{td} (DA1:C1)
A (affected piles: P23 & P25)	Up to -82kN	(91kN x 0.9) + (-95kN x 1.0) + (-28kN x 1.3 x 0.7) + (-50kN x 1.3) = **-104kN**	(91kN x 0.9) + (-95kN x 1.35) + (-28kN x 1.5 x 0.7) + (-50kN x 1.5) = **-151kN**
B (Pile P03 only)	-631kN	(-371kN x 1.0) + (-186kN x 1.3) + (-50kN x 1.3 x 0.5) = **-650kN**	(-371kN x 1.35) + (-186kN x 1.5) + (-50kN x 1.5 x 0.5) = **-817kN**

Tension Load Case	Dia.	Proposed Toe Level	Shaft Friction, Qs	Tensile Resistance, [Against GEO] Rtd
A	450mm	+12.000 (9.0m long cage)	370kN	132kN
B		+1.500 (19.5m long centre bar)	1866kN	666kN

Tensile Resistance of pile, R_{td};

$R_{td} = Qs / \gamma_{st} \cdot \gamma_{Rd}$

Where;
γ_{st} = Partial resistance factor for shaft in tension (2.0)
γ_{Rd} = Model Factor (1.4)
R_{td} is to be checked against '**GEO**' tension load (DA1:C2)

The required area of steel to accommodate the tension force is calculated as follows:

A_S = [Fv . 1000] / fyd

Where;
Fv = Tensile Force; F_{td}
fyd = [fy / γm] = (500N/mm² / 1.15) = 435N/mm^2
A_s is to be checked against '**STR**' tension load (DA1:C1)

Tension Load Case	Pile Dia. (mm)	A_S [Against STR Load] (mm^2)	Required Pile Cage
A	450	347	6 B16 x 9.0m + B10 helical x 200mm c/c (1206mm^2)
B		1878	6 B25 x 8.0m + B10 helical x 200mm c/c (2945mm^2) + 1No. 40mm Dywidag x 19.5m

7.4 HORIZONTAL LOADING

The horizontal/lateral design has been carried out in general in accordance with Eurocode (BS EN 1997-1:2004) with reference made to the UK National Annex.
This is an ultimate limit state design approach with partial factors applied to actions (A), materials (M) and resistances (R).

DA1:C2 will usually dictate pile lengths due to Resistance Set R4 however, there is no clear Resistance partial factor values to use that cater for a lateral force, therefore the following is considered against DA1:C2 and DA1:C1 as detailed below:

Design Approach 1 - Combination 1

Take as sets A1 + M1 + R1

For set A1, a partial factor of 1.5 has been applied to the [variable] horizontal load.

For sets M1 and R1, a partial factor of 1.0 is applied.

Design Approach 1 - Combination 2

Take as sets A2 + M2 + R1

For set A2, a partial factor of 1.3 has been applied to the [variable] horizontal load.

For set M2, a partial factor of 1.25 for drained soils and 1.4 for undrained soils has been applied.

For set R1, a partial factor of 1.0 is applied.

For the above A1 and A2 actions, a possible lateral load of 50kN is given for **all** piles and taken as a variable action. Please see below tabulated summary and Appendix C for various horizontal load cases considered.

Horizontal Design Case	Unfactored Horizontal Loads to consider (SLS)	DA1:C1 [STR] Horiz Force	DA1:C2 [GEO] Horiz Force
1	50kN (wind)	75kN	65kN
2			

Horizontal Design Case	Design Approach	Pile Force Considered (For axial load check)		Horiz Force (from above table)	Max Moment obtained from 'ALP'
1	DA1 : Comb' 1	Min Load	-151kN	75kN	56.4kNm
		Max Load	1872kN		
	DA1 : Comb' 2	Min Load	-104kN	65kN	51.4kNm
		Max Load	1442kN		
2	DA1 : Comb' 1	Min Load	-817kN	75kN	56.4kNm
		Max Load	708kN		
	DA1 : Comb' 2	Min Load	-650kN	65kN	51.4kNm
		Max Load	548kN		

From the above table, the minimum and maximum axial loads have been considered against the resultant moments in Oasys ADC to check the pile cage capacity within the pile section. Please see below table showing cage summary. ADC section outputs can be seen in Appendix D.

Horizontal Design Case	Axial Load Considered [input]	Moment used [input]	ADC Ult Moment Capacity [output]	Proposed Pile Cage
1	Min = -151kN	56.4kNm	61.7kNm	6 B16 x 8.0m + B10 helical x 200mm c/c (1206mm^2)
	Max = 1872kN		137.3kNm	
2	Min = -817kN		71.8kNm	6 B25 x 8.0m + B10 helical x 200mm c/c (2945mm^2)
	Max = 708kN		192.3kNm	

7.5 REBAR ANCHORAGE

This is to be checked and confirmed by the Consulting Engineer as the pile cap/ground beam construction detail is beyond our remit.

For design assumption we have assumed that longitudinal pile steel shall be carried into the pile cap by a distance as noted in BS EN 1992-1-1:2004 clause 8.7.3. For the purposes of our design we have *assumed* 38 bar diameters.

- B16 = 580mm
- B25 = 900mm

The engineers sub-structure needs to have sufficient depth to cater for the required anchorage.

Unless noted otherwise and agreed in advance, all pile cages will be installed to Pile Platform Level (PPL) or below, where feasible. Pile cages will not protrude above PPL therefore the difference between PPL and Pile Cut off Level (PCOL) must be considered prior to commencement of piling works.

Lastly, we would suggest the use of de-bonding foam to aid pile trimming.

8.0 CONSTRUCTION DETAILS

Construct the piles in accordance with the pile schedule, issued separately.

All Piles to be 450mm dia. reinforced as below:

50kN Horiz (SLS) & Nil Tension (≤ -60kN nominal) = 6 B16 x 8.0m + B10 helical x 200mm c/c (1206mm^2)

50kN Horiz (SLS) & Tension ≤ -105kN GEO = 6 B16 x 9.0m + B10 helical x 200mm c/c (1206mm^2)

50kN Horiz (SLS) & Tension ≤ -650kN GEO =
6 B25 x 8.0m + B10 helical x 200mm c/c (2945mm^2) + 1 D40 centre bar x 19.5m

9.0 CLIENT ACTIONS FOR DESIGN REALISATION

Acceptance of the design and its associated qualifications

Acceptance of Design Class DC-2 in conjunction with concrete strength of C30/37N/mm^2

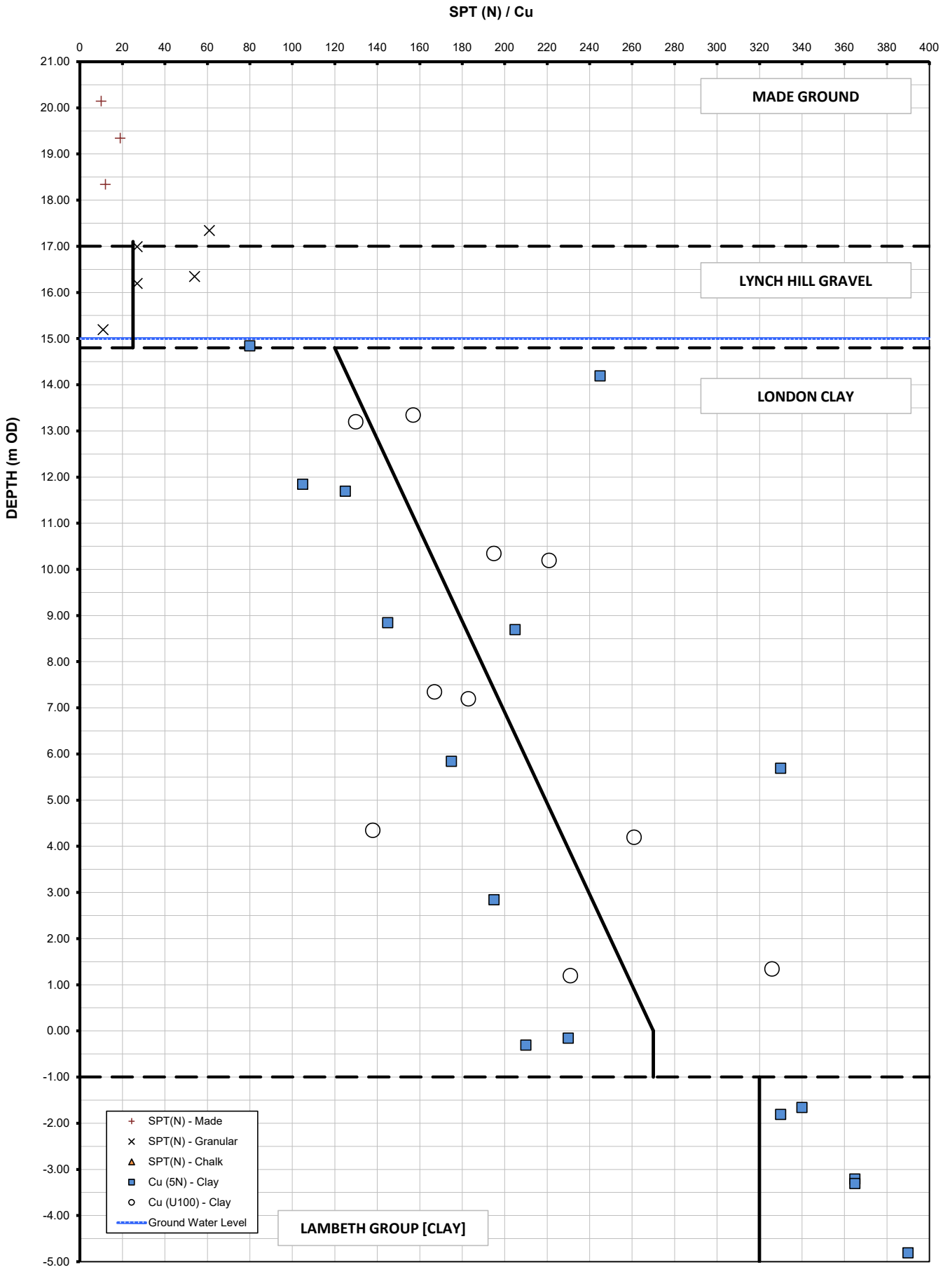
Provide attendance items and Working Platform in accordance with the FPS schedule of attendances

Provide revised Construction Issue Drawings which details revised load to Piles P01 & P02.

APPENDIX A – SOIL PROFILE & GEOTECHNICAL PARAMETERS

Contract Title:	100 Grays Inn Road, London, WC1X 8AL				
Element:	Shear Strength Vs. Depth Plot (Level)				
Contract No:	F23138	**By:**	JC	**Date:**	08/04/24

Franki Foundations



APPENDIX B – GEOTECHNICAL PILE CAPACITY (OASYS PILE)

Analysis Options

Design approach:	DA1(C1 + C2)
Pile type:	Bored
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
Is BS8004 SLS check enabled?	Yes
Shaft only FoS (Compression):	1.20
Shaft only FoS (Tension):	0.00
Is pile capacity limited by pile material compressive strength?	No
Pile material compressive strength calculation type	Grade based
Limiting pile material compressive strength[kPa]	0.000000
Datum type	Elevation based
Effective stress profile	Calculated

Pile Properties

Pile type	Solid
Material type	User-defined
Pile cross-section	Circular
Under-ream	No
Calculation profile	Range
Minimum pile length	8.0000 m
Maximum pile length	25.000 m
Increment size	0.50000

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	0.45000				

Undrained Materials - General Data

No.	Material description	Bulk unit weight [kN/m³]	Cu material factor	Top Cu [kPa]	Base Cu [kPa]
1	London Clay i	19.000	NA	120.00	270.00
2	London Clay ii	19.000	NA	270.00	270.00
3	Lambeth	19.500	NA	320.00	320.00

Undrained Materials - Skin Friction Data

No.	Material description	Skin friction computation	Alpha	q_s Top [kPa]	q_s Base [kPa]	$q_{s,lim}$ Spec.	$q_{s,lim}$ Value [kPa]		
1	London Clay i	Alpha specified	0.50000	NA	NA	Peak	140.00	No	NA
2	London Clay ii	Alpha specified	0.50000	NA	NA	Peak	140.00	No	NA
3	Lambeth	Alpha specified	0.50000	NA	NA	Peak	140.00	No	NA

Undrained Materials - End Bearing Data

No.	Material description	End bearing computation	Nc	q_b Top [kPa]	q_b Base [kPa]	$q_{b,lim}$ Spec.	$q_{b,lim}$ Value [kPa]
1	London Clay i	Nc specified	9.0000	NA	NA	No	NA
2	London Clay ii	Nc specified	9.0000	NA	NA	No	NA
3	Lambeth	Nc specified	9.0000	NA	NA	No	NA

Undrained Materials - Material Factors (Code Based)

No.	Material description	Qs factors M1	Qs factors M2	Nc factors M1	Nc factors M2	Qb factors M1	Qb factors M2
1	London Clay i	N.A.	N.A.	1.0000	1.0000	N.A.	N.A.
2	London Clay ii	N.A.	N.A.	1.0000	1.0000	N.A.	N.A.
3	Lambeth	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	17.000	NA
2	Lynch Hill Gravel	20.000	NA

Drained Materials - Friction Data

No.	Material description	Skin friction computation	Beta	Delta (δ) [deg]	Coefficient of earth pressure K	q_s Top [kPa]	q_s Base [kPa]	$q_{s,lim}$ Spec.	$q_{s,lim}$ Value [kPa]
1	Made Ground	qs specified	NA	NA	NA	0.0	0.0	No	NA
2	Lynch Hill Gravel	Earth pressure	NA	35.000	0.80000	NA	NA	No	NA

Drained Materials - End Bearing Data

No.	Material description	End bearing computation	Nq	Phi' [deg]	PhiD [deg]	Phicv' [deg]	Id	q_b Top [kPa]	q_b Base [kPa]	$q_{b,lim}$ Spec.	$q_{b,lim}$ Value [kPa]	Nq-Phi curves	Ed [kPa]	Ko
1	Made Ground	qb specified	NA	NA	NA	NA	NA	0.0	0.0	No	NA	NA	NA	NA
2	Lynch Hill Gravel	qb specified	NA	NA	NA	NA	NA	0.0	0.0	No	NA	NA	NA	NA

Drained Materials - Material Factors (Code Based)

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

STAGE SPECIFIC DATA

Stage 0 : Initial Stage

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

Groundwater

No.	Level [m]	Pressure [kPa]	Unit weight of water [kN/m³]
1	15.000	0.0	10.000

Soil Profiles

Soil Profile 1: Soil Profile 1

No.	Level [mOD]	Material description	Contributes to negative skin friction
1	21.000	Air/Void	No
2	19.250	Made Ground	No
3	17.000	Lynch Hill Gravel	No
4	14.800	London Clay i	No
5	0.0	London Clay ii	No
6	-1.0000	Lambeth	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

Level	*	Density	Undrained Cohesion	Nq	Total vertical stress	Porewater pressure	Effective vertical stress	Effective horizontal stress*	Cumulative skin friction per unit

[mOD]		[kN/m³]	[kPa]		[kPa]	[kPa]	[kPa]	[kPa]	perimeter [kN/m]
21.000	H	0.0	0.0	0.0	0.0	0.0	0.0	NA	0.0
19.250	-	0.0	0.0	0.0	0.0	0.0	0.0	NA	0.0
19.250	-	17.000	0.0	N.A.	0.0	0.0	0.0	NA	0.0
17.000	-	17.000	0.0	N.A.	38.250	0.0	38.250	NA	0.0
17.000	-	20.000	0.0	N.A.	38.250	0.0	38.250	30.600	0.0
15.000	-	20.000	0.0	N.A.	78.250	0.0	78.250	62.600	65.259
14.800	-	20.000	0.0	N.A.	82.250	2.0000	80.250	64.200	74.138
14.800	-	19.000	120.00	N.A.	82.250	2.0000	80.250	NA	74.138
13.000	T	19.000	138.24	N.A.	116.45	20.000	96.450	NA	190.35
12.500	T	19.000	143.31	N.A.	125.95	25.000	100.95	NA	225.54
12.000	T	19.000	148.38	N.A.	135.45	30.000	105.45	NA	262.00
11.500	T	19.000	153.45	N.A.	144.95	35.000	109.95	NA	299.73
11.000	T	19.000	158.51	N.A.	154.45	40.000	114.45	NA	338.73
10.500	T	19.000	163.58	N.A.	163.95	45.000	118.95	NA	378.99
10.000	T	19.000	168.65	N.A.	173.45	50.000	123.45	NA	420.52
9.5000	T	19.000	173.72	N.A.	182.95	55.000	127.95	NA	463.31
9.0000	T	19.000	178.78	N.A.	192.45	60.000	132.45	NA	507.37
8.5000	T	19.000	183.85	N.A.	201.95	65.000	136.95	NA	552.70
8.0000	T	19.000	188.92	N.A.	211.45	70.000	141.45	NA	599.30
7.5000	T	19.000	193.99	N.A.	220.95	75.000	145.95	NA	647.16
7.0000	T	19.000	199.05	N.A.	230.45	80.000	150.45	NA	696.29
6.5000	T	19.000	204.12	N.A.	239.95	85.000	154.95	NA	746.69
6.0000	T	19.000	209.19	N.A.	249.45	90.000	159.45	NA	798.35
5.5000	T	19.000	214.26	N.A.	258.95	95.000	163.95	NA	851.28
5.0000	T	19.000	219.32	N.A.	268.45	100.00	168.45	NA	905.48
4.5000	T	19.000	224.39	N.A.	277.95	105.00	172.95	NA	960.95
4.0000	T	19.000	229.46	N.A.	287.45	110.00	177.45	NA	1017.7
3.5000	T	19.000	234.53	N.A.	296.95	115.00	181.95	NA	1075.7
3.0000	T	19.000	239.59	N.A.	306.45	120.00	186.45	NA	1134.9
2.5000	T	19.000	244.66	N.A.	315.95	125.00	190.95	NA	1195.5
2.0000	T	19.000	249.73	N.A.	325.45	130.00	195.45	NA	1257.3
1.5000	T	19.000	254.80	N.A.	334.95	135.00	199.95	NA	1320.3
1.0000	T	19.000	259.86	N.A.	344.45	140.00	204.45	NA	1384.7
0.50000	T	19.000	264.93	N.A.	353.95	145.00	208.95	NA	1450.3
0.0	T	19.000	270.00	N.A.	363.45	150.00	213.45	NA	1517.1
0.0	T	19.000	270.00	N.A.	363.45	150.00	213.45	NA	1517.1
-0.50000	T	19.000	270.00	N.A.	372.95	155.00	217.95	NA	1584.6
-1.0000	T	19.000	270.00	N.A.	382.45	160.00	222.45	NA	1652.1
-1.0000	T	19.500	320.00	N.A.	382.45	160.00	222.45	NA	1652.1
-1.5000	T	19.500	320.00	N.A.	392.20	165.00	227.20	NA	1722.1
-2.0000	T	19.500	320.00	N.A.	401.95	170.00	231.95	NA	1792.1
-2.5000	T	19.500	320.00	N.A.	411.70	175.00	236.70	NA	1862.1
-3.0000	T	19.500	320.00	N.A.	421.45	180.00	241.45	NA	1932.1
-3.5000	T	19.500	320.00	N.A.	431.20	185.00	246.20	NA	2002.1
-4.0000	T	19.500	320.00	N.A.	440.95	190.00	250.95	NA	2072.1

* Annotation:
H: Pile head location
T: Pile toe locations corresponding to different pile lengths

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

Cross-section 1 results:

Uniform pile with top shaft diameter = 0.45 m

Results - Compression

Soil Profile 1: Soil Profile 1

Level [mOD]	Pile length [m]	Ultimate base capacity (Q_b) [kN]	Cumulative external Friction (Q_s) [kN]	Average external Friction (q_s) [kN/m]	Negative skin friction (Q_{nsf}) [kN]	Net ultimate resistance [kN]
13.000	8.0000	197.88	269.10	33.637	0.0	466.98
12.500	8.5000	205.13	318.85	37.512	0.0	523.99

Level	Pile length	Ultimate base capacity (Q_b)	Cumulative external Friction (Q_s)	Average external Friction (q_s)	Negative skin friction (Q_{nsf})	Net ultimate resistance
12.000	9.0000	212.39	370.40	41.155	0.0	582.78
11.500	9.5000	219.64	423.73	44.604	0.0	643.38
11.000	10.000	226.89	478.86	47.886	0.0	705.76
10.500	10.500	234.15	535.78	51.027	0.0	769.93
10.000	11.000	241.40	594.49	54.045	0.0	835.89
9.5000	11.500	248.66	654.99	56.956	0.0	903.65
9.0000	12.000	255.91	717.28	59.774	0.0	973.19
8.5000	12.500	263.16	781.37	62.509	0.0	1044.5
8.0000	13.000	270.42	847.24	65.172	0.0	1117.7
7.5000	13.500	277.67	914.91	67.771	0.0	1192.6
7.0000	14.000	284.92	984.36	70.312	0.0	1269.3
6.5000	14.500	292.18	1055.6	72.801	0.0	1347.8
6.0000	15.000	299.43	1128.6	75.243	0.0	1428.1
5.5000	15.500	306.68	1203.5	77.644	0.0	1510.2
5.0000	16.000	313.94	1280.1	80.006	0.0	1594.0
4.5000	16.500	321.19	1358.5	82.334	0.0	1679.7
4.0000	17.000	328.45	1438.7	84.630	0.0	1767.2
3.5000	17.500	335.70	1520.7	86.897	0.0	1856.4
3.0000	18.000	342.95	1604.5	89.138	0.0	1947.4
2.5000	18.500	350.21	1690.1	91.355	0.0	2040.3
2.0000	19.000	357.46	1777.4	93.549	0.0	2134.9
1.5000	19.500	364.71	1866.6	95.722	0.0	2231.3
1.0000	20.000	371.97	1957.5	97.877	0.0	2329.5
0.50000	20.500	379.22	2050.3	100.01	0.0	2429.5
0.0	21.000	386.47	2144.8	102.13	0.0	2531.3
0.0	21.000	386.47	2144.8	102.13	0.0	2531.3
-0.50000	21.500	386.47	2240.2	104.20	0.0	2626.7
-1.0000	22.000	386.47	2335.7	106.17	0.0	2722.1
-1.0000	22.000	458.04	2335.7	106.17	0.0	2793.7
-1.5000	22.500	458.04	2434.6	108.21	0.0	2892.7
-2.0000	23.000	458.04	2533.6	110.16	0.0	2991.6
-2.5000	23.500	458.04	2632.5	112.02	0.0	3090.6
-3.0000	24.000	458.04	2731.5	113.81	0.0	3189.5
-3.5000	24.500	458.04	2830.5	115.53	0.0	3288.5
-4.0000	25.000	458.04	2929.4	117.18	0.0	3387.5

Level	Pile length	Design resistance			Combination with least resistance #	Factored load*			
		DA1-C1	DA1-C2	BS8004-SLS		DA1-C1	DA1-C2	BS8004-SLS	
[mOD]	[m]	[kN]	[kN]	[kN]	[kN]		[kN]	[kN]	[kN]
13.000	8.0000	333.56	190.80	224.25	2	0.0(C)	0.0(C)	0.0(C)	
12.500	8.5000	374.28	215.61	265.71	2	0.0(C)	0.0(C)	0.0(C)	
12.000	9.0000	416.27	241.21	308.66	2	0.0(C)	0.0(C)	0.0(C)	
11.500	9.5000	459.55	267.61	353.11	2	0.0(C)	0.0(C)	0.0(C)	
11.000	10.000	504.11	294.81	399.05	2	0.0(C)	0.0(C)	0.0(C)	
10.500	10.500	549.95	322.81	446.48	2	0.0(C)	0.0(C)	0.0(C)	
10.000	11.000	597.07	351.61	495.41	2	0.0(C)	0.0(C)	0.0(C)	
9.5000	11.500	645.46	381.21	545.83	2	0.0(C)	0.0(C)	0.0(C)	
9.0000	12.000	695.14	411.61	597.74	2	0.0(C)	0.0(C)	0.0(C)	
8.5000	12.500	746.09	442.81	651.14	2	0.0(C)	0.0(C)	0.0(C)	
8.0000	13.000	798.33	474.81	706.03	2	0.0(C)	0.0(C)	0.0(C)	
7.5000	13.500	851.84	507.61	762.42	2	0.0(C)	0.0(C)	0.0(C)	
7.0000	14.000	906.63	541.21	820.30	2	0.0(C)	0.0(C)	0.0(C)	
6.5000	14.500	962.70	575.60	879.67	2	0.0(C)	0.0(C)	0.0(C)	
6.0000	15.000	1020.1	610.80	940.54	2	0.0(C)	0.0(C)	0.0(C)	
5.5000	15.500	1078.7	646.80	1002.9	2	0.0(C)	0.0(C)	0.0(C)	
5.0000	16.000	1138.6	683.59	1066.7	2	0.0(C)	0.0(C)	0.0(C)	
4.5000	16.500	1199.8	721.19	1132.1	2	0.0(C)	0.0(C)	0.0(C)	
4.0000	17.000	1262.3	759.58	1198.9	2	0.0(C)	0.0(C)	0.0(C)	
3.5000	17.500	1326.0	798.78	1267.3	2	0.0(C)	0.0(C)	0.0(C)	
3.0000	18.000	1391.0	838.77	1337.1	2	0.0(C)	0.0(C)	0.0(C)	
2.5000	18.500	1457.3	879.57	1408.4	2	0.0(C)	0.0(C)	0.0(C)	
2.0000	19.000	1524.9	921.16	1481.2	2	0.0(C)	0.0(C)	0.0(C)	
1.5000	19.500	1593.8	963.55	1555.5	2	0.0(C)	0.0(C)	0.0(C)	
1.0000	20.000	1663.9	1006.7	1631.3	2	0.0(C)	0.0(C)	0.0(C)	
0.50000	20.500	1735.4	1050.7	1708.6	2	0.0(C)	0.0(C)	0.0(C)	
0.0	21.000	1808.1	1095.5	1787.3	2	0.0(C)	0.0(C)	0.0(C)	
0.0	21.000	1808.1	1095.5	1787.3	2	0.0(C)	0.0(C)	0.0(C)	
-0.50000	21.500	1876.2	1138.1	1866.9	2	0.0(C)	0.0(C)	0.0(C)	

Level	Pile length	Design resistance		Combination with least resistance #	Factored load*		
-1.0000	22.000	1944.4	1180.7	1946.4	2	0.0(C)	0.0(C)	0.0(C)
-1.0000	22.000	1995.5	1206.3	1946.4	2	0.0(C)	0.0(C)	0.0(C)
-1.5000	22.500	2066.2	1250.5	2028.8	2	0.0(C)	0.0(C)	0.0(C)
-2.0000	23.000	2136.9	1294.6	2111.3	2	0.0(C)	0.0(C)	0.0(C)
-2.5000	23.500	2207.6	1338.8	2193.8	2	0.0(C)	0.0(C)	0.0(C)
-3.0000	24.000	2278.2	1383.0	2276.2	2	0.0(C)	0.0(C)	0.0(C)
-3.5000	24.500	2348.9	1427.2	2358.7	2	0.0(C)	0.0(C)	0.0(C)
-4.0000	25.000	2419.6	1471.4	2441.2	2	0.0(C)	0.0(C)	0.0(C)

Limiting criteria :
1 : DA1 C1
2 : DA1 C2
3 : BS8004:2015 SLS
*(C)-> Compression load, (T)-> Tension load
Note: Design resistance does not include any consideration of negative skin friction.

Level	Pile length	Factored Shaft Resistance		Factored Base Resistance	
		DA1-C1	DA1-C2	DA1-C1	DA1-C2
[mOD]	[m]	[kN]	[kN]	[kN]	[kN]
13.000		192.21	120.13	141.34	70.671
12.500		227.75	142.34	146.52	73.262
12.000		264.57	165.36	151.71	75.853
11.500		302.67	189.17	156.89	78.443
11.000		342.04	213.78	162.07	81.034
10.500		382.70	239.19	167.25	83.624
10.000		424.64	265.40	172.43	86.215
9.5000		467.85	292.41	177.61	88.805
9.0000		512.35	320.22	182.79	91.396
8.5000		558.12	348.82	187.97	93.987
8.0000		605.17	378.23	193.15	96.577
7.5000		653.50	408.44	198.34	99.168
7.0000		703.12	439.45	203.52	101.76
6.5000		754.01	471.25	208.70	104.35
6.0000		806.18	503.86	213.88	106.94
5.5000		859.63	537.27	219.06	109.53
5.0000		914.35	571.47	224.24	112.12
4.5000		970.36	606.48	229.42	114.71
4.0000		1027.6	642.28	234.60	117.30
3.5000		1086.2	678.88	239.79	119.89
3.0000		1146.1	716.29	244.97	122.48
2.5000		1207.2	754.49	250.15	125.07
2.0000		1269.6	793.49	255.33	127.66
1.5000		1333.3	833.30	260.51	130.25
1.0000		1398.2	873.90	265.69	132.85
0.50000	-	1464.5	915.30	270.87	135.44
0.0		1532.0	957.50	276.05	138.03
0.0		1532.0	957.50	276.05	138.03
-0.50000		1600.2	1000.1	276.05	138.03
-1.0000		1668.3	1042.7	276.05	138.03
-1.0000		1668.3	1042.7	327.17	163.59
-1.5000		1739.0	1086.9	327.17	163.59
-2.0000		1809.7	1131.1	327.17	163.59
-2.5000		1880.4	1175.2	327.17	163.59
-3.0000		1951.1	1219.4	327.17	163.59
-3.5000		2021.8	1263.6	327.17	163.59
-4.0000		2092.4	1307.8	327.17	163.59

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

Level	Pile length	Factored Shaft Resistance		Factored Base Resistance	
		DA1-C1	DA1-C2	DA1-C1	DA1-C2

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

APPENDIX C – HORIZONTAL LOAD CALCULATION (OASYS ALP)

Titles

Job No.: F23138
Job Title: 100 Grays Inn Road
Sub-title: Shear Check
Calculation Heading: 50kN - Comb1
Initials: JC
Checker:
Date Saved: 22-Mar-2024
Date Checked:
Notes:
File Name: 240408_F23138_Oasys Alp_50kN_C1.alw
File Path: E:\Company\~Jobs\F23138 100 Grays Inn Road, Holborn, London\6. Technical\Design\Docs

General Data

Number of increments = 1
Increment applied loads only
Standard analysis type

Convergence Control

Maximum number of iterations = 300
Maximum displacement error [mm] = 0.0010000
Maximum pressure error [kN/m²] = 0.10000
Damping coefficient = 1.0000
Maximum incremental deflection [m] = 2.0000

Partial Factors

Partial Factor Set	Variable Load (Rest./Dist.)	Permanent Load (Rest./Dist.)	Unit Weight	Drained Cohesion	Undrained Cohesion	Shear Angle
BS EN 1997-1:2004 (EC7 - UK) DA1-1	0.000000/ 1.500000	1.000000/ 1.350000	1.000000	1.000000	1.000000	1.000000

Soil Data

Elastic-plastic soils
Factor on soil E value: 0.8000

No.	Level [m]	E [kN/m²]	Unit wt. [kN/m³]	Phi [deg]	Factored Kq	Factored Kc	c(top) [kN/m²]	dc/dz [kN/m²/m]
1	-1.750000	15000.	17.000	28.000	-	-	0.0	0.0
2	-4.000000	37500.	20.000	35.000	-	-	0.0	0.0
3	-6.200000	60000.	19.000	0.010000	-	-	120.00	10.100

Calculated K_q and K_c Values

Node	Z/D	K_q	K_c
1	0.0	4.0943	6.3808
2	1.4286	5.5424	17.830
3	2.8571	6.6171	24.448
4	4.2857	7.4464	28.761
5	5.7143	14.992	58.427
6	7.4286	16.574	65.580
7	9.1429	17.927	71.204
8	10.635	899.72E-6	7.4295
9	12.345	900.10E-6	7.5155
10	14.055	900.47E-6	7.5827
11	15.765	900.84E-6	7.6365
12	17.475	901.22E-6	7.6807
13	19.185	901.59E-6	7.7176
14	20.895	901.96E-6	7.7488
15	22.605	902.34E-6	7.7757
16	24.315	902.71E-6	7.7989

Node	Z/D	K_q	K_c
17	26.025	903.08E-6	7.8193
18	27.734	903.45E-6	7.8373
19	29.444	903.82E-6	7.8533

Sections

Name	Input Type	Description	Material	Class	Effective Width [m]	EI [kNm²]
Section 1	Wizard Generated	STD%C%450	Concrete		0.45000	66097.

Pile Properties

Level [m]	Section
-1.7500	Section 1

Pile base at -15.000000 m

Applied Loads and Displacements

No.	Level [m]	Force [kN]	Moment [kNm]	Displacement [mm]
1	-1.7500	50.000	0.0	0.0

Restraints

No.	Node	Lateral Stiffness [kN/m]	Rotational Stiffness [kNm/rad]
1	1	0.0	25000.

Geometry and Initial state

Node	Level [m]	Soil	EI [kNm2]	Effective Width [m]	Water Pressure [kN/m²]	Soil Disp [mm]
1	-1.7500	1	66097.	0.45000	0.0	0.0
2	-2.3929	1	66097.	0.45000	0.0	0.0
3	-3.0357	1	66097.	0.45000	0.0	0.0
4	-3.6786	1	66097.	0.45000	0.0	0.0
5	-4.3214	2	66097.	0.45000	0.0	0.0
6	-5.0929	2	66097.	0.45000	0.0	0.0
7	-5.8643	2	66097.	0.45000	0.0	0.0
8	-6.5357	3	66097.	0.45000	5.3571	0.0
9	-7.3052	3	66097.	0.45000	13.052	0.0
10	-8.0747	3	66097.	0.45000	20.747	0.0
11	-8.8442	3	66097.	0.45000	28.442	0.0
12	-9.6136	3	66097.	0.45000	36.136	0.0
13	-10.383	3	66097.	0.45000	43.831	0.0
14	-11.153	3	66097.	0.45000	51.526	0.0
15	-11.922	3	66097.	0.45000	59.221	0.0
16	-12.692	3	66097.	0.45000	66.916	0.0
17	-13.461	3	66097.	0.45000	74.610	0.0
18	-14.231	3	66097.	0.45000	82.305	0.0
19	-15.000	3	66097.	0.45000	90.000	0.0

Output for load increment 1

Iteration	Max Inc Disp [mm]	at node	Disp error [mm]	Pressure error [kN/m²]
12	6.51	1	0.0009	0.02

Node	Level	Defl	Rotation	Soil Pressure	Bending	Shear

	[m]	[mm]	[rad]		[kN/m²]	[kNm]	[kN]	
1	-1.7500	-6.5139	-0.0020995	1	-11.186	0.0	0.0	P
1	-1.7500					-52.487	-75.000	
2	-2.3929	-5.0493	-0.0023806	1	-60.570	-5.3127	-64.621	P
3	-3.0357	-3.5397	-0.0022577	1	-94.392	30.597	-42.207	
4	-3.6786	-2.2031	-0.0018709	1	-58.750	48.953	-20.056	
5	-4.3214	-1.1611	-0.0013588	2	-77.408	56.383	0.75823	
6	-5.0929	-0.35149	-759.88E-6	2	-23.432	46.297	17.142	
7	-5.8643	0.050969	-315.36E-6	2	3.3980	29.936	20.657	
8	-6.5357	0.17608	-80.190E-6	3	18.782	16.436	17.061	
9	-7.3052	0.18046	47.890E-6	3	19.249	5.6511	10.684	
10	-8.0747	0.12695	80.184E-6	3	13.542	-0.0055141	5.0068	
11	-8.8442	0.068580	67.548E-6	3	7.3152	-2.0541	1.3958	
12	-9.6136	0.026226	42.330E-6	3	2.7974	-2.1536	-0.35505	
13	-10.383	0.0026404	20.213E-6	3	0.28165	-1.5077	-0.88814	
14	-11.153	-0.0069016	5.9738E-6	3	-0.73617	-0.78675	-0.80945	
15	-11.922	-0.0083926	-1.0934E-6	3	-0.89522	-0.26197	-0.52700	
16	-12.692	-0.0064096	-3.5185E-6	3	-0.68369	0.024285	-0.25364	
17	-13.461	-0.0035403	-3.7504E-6	3	-0.37764	0.12837	-0.069888	
18	-14.231	-778.19E-6	-3.4352E-6	3	-0.083007	0.13184	0.0098647	
19	-15.000	0.0017892	-3.2872E-6	3	0.19085	0.11319	-0.0088061	

- The letter "P" next to a result indicates that the effective earth pressure is greater than 0.99 times the passive limit, but within the convergence pressure limit.

EXTREME values so far:-

Deflections		Rotations		Moments		Shears	
Min	Max	Min	Max	Min	Max	Min	Max
[mm]	[mm]	[rad]	[rad]	[kNm]	[kNm]	[kN]	[kN]
-6.5139	0.18046	-0.0023806	80.184E-6	-52.487	56.383	-75.000	20.657

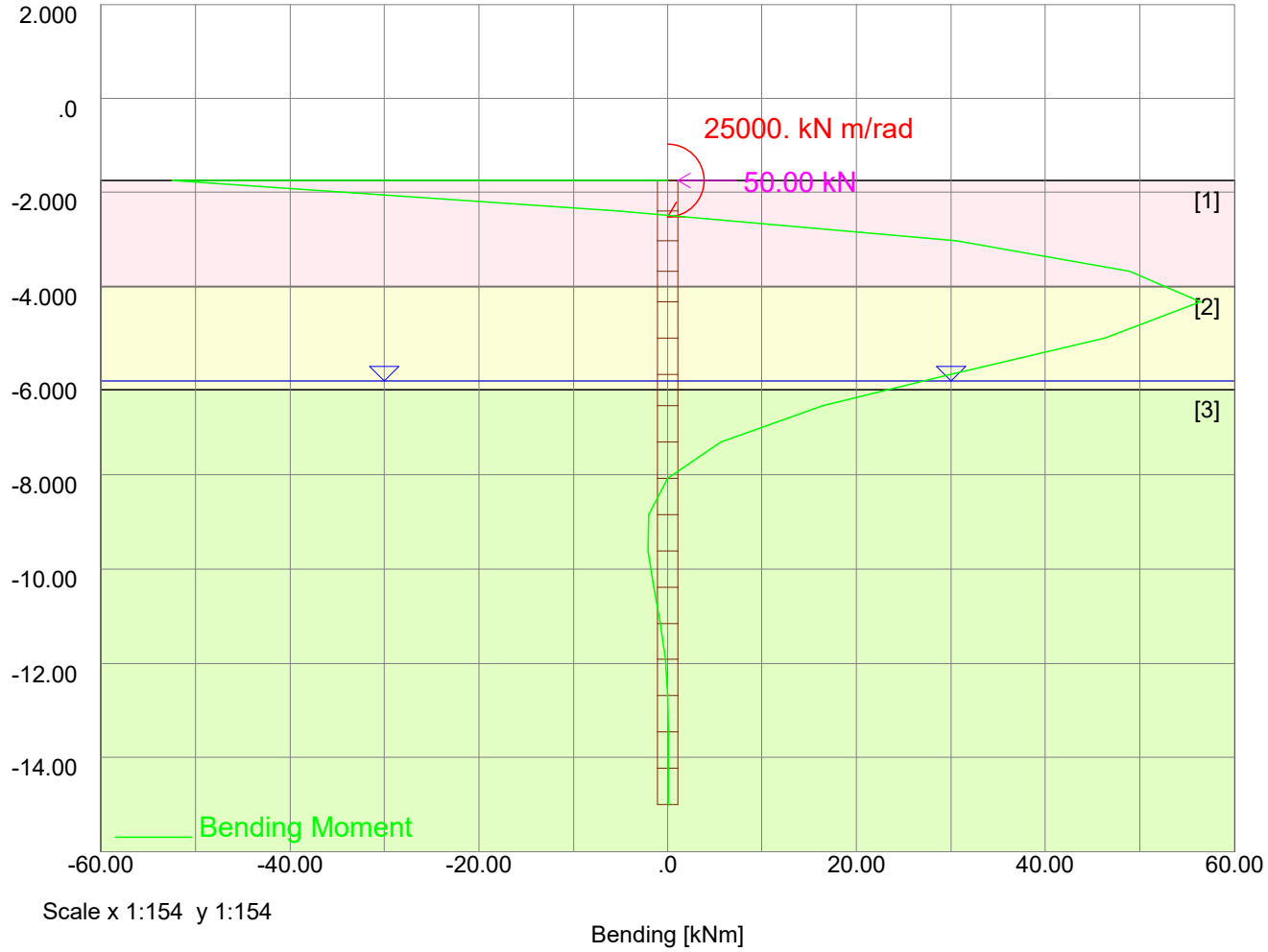
RESTRAINT FORCES

No.	Node	Lateral force	Moment
		[kN]	[kNm]
1	1	0.0	52.487

Oasys

100 Grays Inn Road
Shear Check
50kN - Comb1

Job No.	Sheet No.	Rev.
F23138		
Drg. Ref.		
Made by JC	Date 22-Mar-2024	Checked / Date



Output for load increment 1

Titles

Job No.: F23138
Job Title: 100 Grays Inn Road
Sub-title: Shear Check
Calculation Heading: 50kN - Comb2
Initials: JC
Checker:
Date Saved: 22-Mar-2024
Date Checked:
Notes:
File Name: 240408_F23138_Oasys Alp_50kN_C2.alw
File Path: E:\Company\~Jobs\F23138 100 Grays Inn Road, Holborn, London\6. Technical\Design\Docs

General Data

Number of increments = 1
Increment applied loads only
Standard analysis type

Convergence Control

Maximum number of iterations = 300
Maximum displacement error [mm] = 0.0010000
Maximum pressure error [kN/m²] = 0.10000
Damping coefficient = 1.0000
Maximum incremental deflection [m] = 2.0000

Partial Factors

Partial Factor Set	Variable Load (Rest./Dist.)	Permanent Load (Rest./Dist.)	Unit Weight	Drained Cohesion	Undrained Cohesion	Shear Angle
BS EN 1997-1:2004 (EC7 - UK) DA1-2	0.000000/ 1.300000	1.000000/ 1.000000	1.000000	1.250000	1.400000	1.250000

Soil Data

Elastic-plastic soils
Factor on soil E value: 0.8000

No.	Level [m]	E [kN/m²]	Unit wt. [kN/m³]	Phi [deg]	Factored Kq	Factored Kc	c(top) [kN/m²]	dc/dz [kN/m²/m]
1	-1.750000	15000.	17.000	28.000	-	-	0.0	0.0
2	-4.000000	37500.	20.000	35.000	-	-	0.0	0.0
3	-6.200000	60000.	19.000	0.010000	-	-	120.00	10.100

Calculated K_q and K_c Values

Node	Z/D	K_q	K_c
1	0.0	2.8504	5.2205
2	1.4286	3.8002	13.614
3	2.8571	4.4556	17.888
4	4.2857	4.9353	20.477
5	5.7143	9.0340	35.153
6	7.4286	9.7779	38.262
7	9.1429	10.381	40.575
8	10.635	719.40E-6	7.4289
9	12.345	719.64E-6	7.5149
10	14.055	719.88E-6	7.5820
11	15.765	720.12E-6	7.6359
12	17.475	720.36E-6	7.6800
13	19.185	720.60E-6	7.7169
14	20.895	720.84E-6	7.7482
15	22.605	721.08E-6	7.7750
16	24.315	721.32E-6	7.7982

Node	Z/D	K_q	K_c
17	26.025	721.56E-6	7.8186
18	27.734	721.80E-6	7.8366
19	29.444	722.03E-6	7.8526

Sections

Name	Input Type	Description	Material	Class	Effective Width [m]	EI [kNm²]
Section 1	Wizard Generated	STD%C%450	Concrete		0.45000	66097.

Pile Properties

Level [m]	Section
-1.7500	Section 1

Pile base at -15.000000 m

Applied Loads and Displacements

No.	Level [m]	Force [kN]	Moment [kNm]	Displacement [mm]
1	-1.7500	50.000	0.0	0.0

Restraints

No.	Node	Lateral Stiffness [kN/m]	Rotational Stiffness [kNm/rad]
1	1	0.0	25000.

Geometry and Initial state

Node	Level [m]	Soil	EI [kNm2]	Effective Width [m]	Water Pressure [kN/m²]	Soil Disp [mm]
1	-1.7500	1	66097.	0.45000	0.0	0.0
2	-2.3929	1	66097.	0.45000	0.0	0.0
3	-3.0357	1	66097.	0.45000	0.0	0.0
4	-3.6786	1	66097.	0.45000	0.0	0.0
5	-4.3214	2	66097.	0.45000	0.0	0.0
6	-5.0929	2	66097.	0.45000	0.0	0.0
7	-5.8643	2	66097.	0.45000	0.0	0.0
8	-6.5357	3	66097.	0.45000	5.3571	0.0
9	-7.3052	3	66097.	0.45000	13.052	0.0
10	-8.0747	3	66097.	0.45000	20.747	0.0
11	-8.8442	3	66097.	0.45000	28.442	0.0
12	-9.6136	3	66097.	0.45000	36.136	0.0
13	-10.383	3	66097.	0.45000	43.831	0.0
14	-11.153	3	66097.	0.45000	51.526	0.0
15	-11.922	3	66097.	0.45000	59.221	0.0
16	-12.692	3	66097.	0.45000	66.916	0.0
17	-13.461	3	66097.	0.45000	74.610	0.0
18	-14.231	3	66097.	0.45000	82.305	0.0
19	-15.000	3	66097.	0.45000	90.000	0.0

Output for load increment 1

Iteration	Max Inc Disp [mm]	at node	Disp error [mm]	Pressure error [kN/m²]
12	5.95	1	0.0009	0.02

Node	Level	Defl	Rotation	Soil Pressure	Bending	Shear

	[m]	[mm]	[rad]		[kN/m²]	[kNm]	[kN]	
1	-1.7500	-5.9468	-0.0018966	1	-7.7877	0.0	0.0	P
1	-1.7500					-47.416	-65.000	
2	-2.3929	-4.6221	-0.0021581	1	-41.530	-6.3542	-57.866	P
3	-3.0357	-3.2496	-0.0020578	1	-86.655	26.984	-39.325	
4	-3.6786	-2.0289	-0.0017118	1	-54.105	44.207	-18.966	
5	-4.3214	-1.0741	-0.0012471	2	-71.608	51.368	0.25370	
6	-5.0929	-0.32972	-700.30E-6	2	-21.982	42.383	15.462	
7	-5.8643	0.042150	-292.76E-6	2	2.8100	27.512	18.822	
8	-6.5357	0.15903	-76.282E-6	3	16.963	15.181	15.616	
9	-7.3052	0.16470	42.329E-6	3	17.568	5.2805	9.8245	
10	-8.0747	0.11648	72.852E-6	3	12.425	0.061167	4.6318	
11	-8.8442	0.063244	61.805E-6	3	6.7460	-1.8477	1.3127	
12	-9.6136	0.024403	38.919E-6	3	2.6030	-1.9591	-0.30590	
13	-10.383	0.0026664	18.694E-6	3	0.28441	-1.3769	-0.80580	
14	-11.153	-0.0061980	5.6089E-6	3	-0.66111	-0.71896	-0.74058	
15	-11.922	-0.0076469	-921.26E-9	3	-0.81567	-0.23717	-0.48490	
16	-12.692	-0.0058741	-3.1867E-6	3	-0.62657	0.027287	-0.23520	
17	-13.461	-0.0032628	-3.4242E-6	3	-0.34804	0.12480	-0.066468	
18	-14.231	-736.77E-6	-3.1453E-6	3	-0.078589	0.12958	0.0073945	
19	-15.000	0.0016150	-3.0118E-6	3	0.17226	0.11342	-0.0088239	

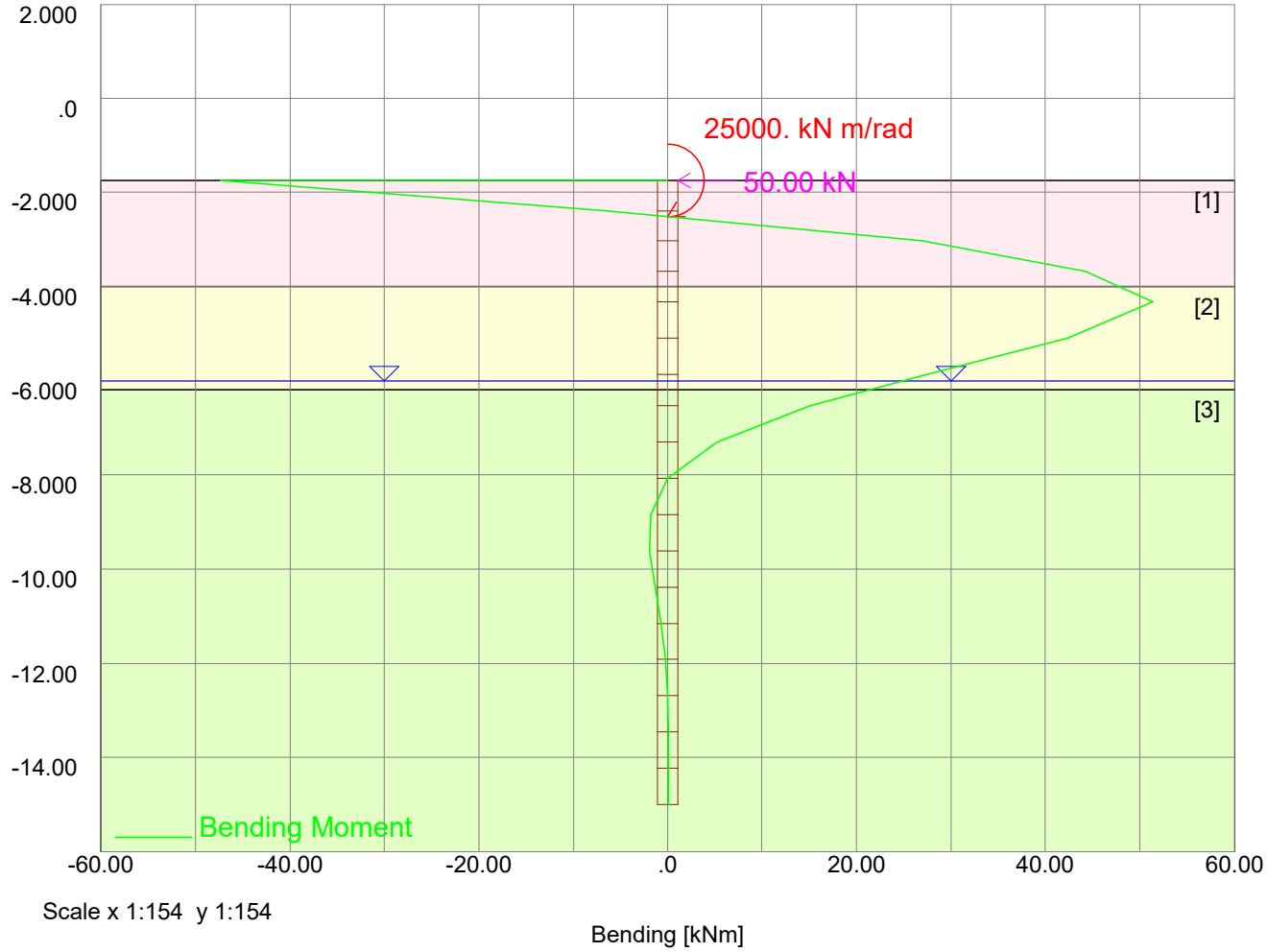
- The letter "P" next to a result indicates that the effective earth pressure is greater than 0.99 times the passive limit, but within the convergence pressure limit.

EXTREME values so far:-

Deflections		Rotations		Moments		Shears	
Min	Max	Min	Max	Min	Max	Min	Max
[mm]	[mm]	[rad]	[rad]	[kNm]	[kNm]	[kN]	[kN]
-5.9468	0.16470	-0.0021581	72.852E-6	-47.416	51.368	-65.000	18.822

RESTRAINT FORCES

No.	Node	Lateral force	Moment
		[kN]	[kNm]
1	1	0.0	47.416



Output for load increment 1

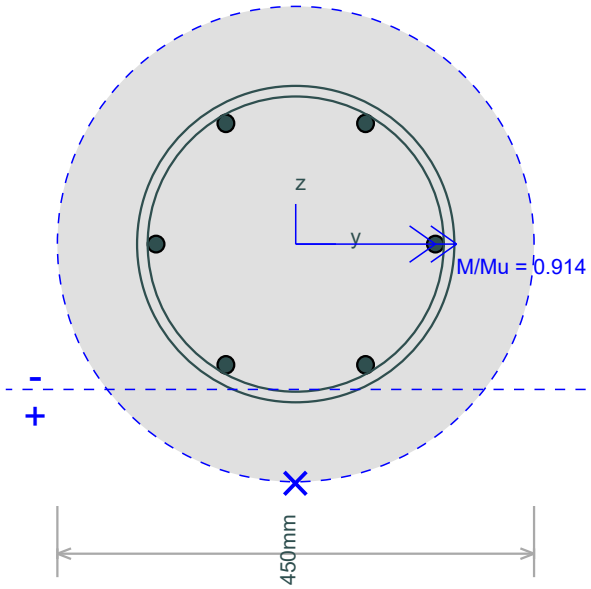
APPENDIX D – STRUCTURAL DESIGN (OASYS ADC)

Reinforcement Details

Bar Arrangement	1 ring(s)/6 bars per ring
Diameter of main bars	16mm
Area of reinforcement	1206.37mm²
Nominal Cover (outer)	75mm

Design Results

Analysis Case Name	Analysis Case 1 (min)
Axial Design Force	-151kN
Axial Capacity	3165.77kN
Design Moment 'M'	56.4kNm
Ultimate Moment 'Mu'	61.7238kNm
Neutral Axis	- - - - - - -
Comp./Tens. Side	+/-
Governing Node/Bar	X



Section 1

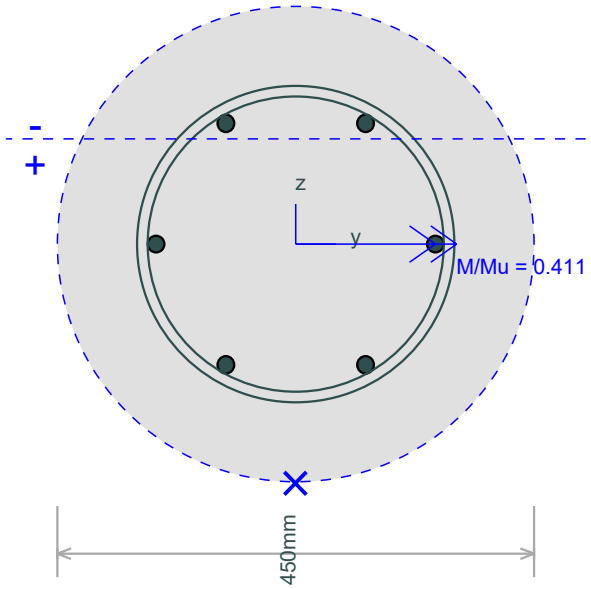
Analysis Case 1

Reinforcement Details

Bar Arrangement	1 ring(s)/6 bars per ring
Diameter of main bars	16mm
Area of reinforcement	1206.37mm²
Nominal Cover (outer)	75mm

Design Results

Analysis Case Name	Analysis Case 1 (max)
Axial Design Force	1872kN
Axial Capacity	3165.77kN
Design Moment 'M'	56.4kNm
Ultimate Moment 'Mu'	137.253kNm
Neutral Axis	- - - - - - -
Comp./Tens. Side	+/-
Governing Node/Bar	X



Section 1

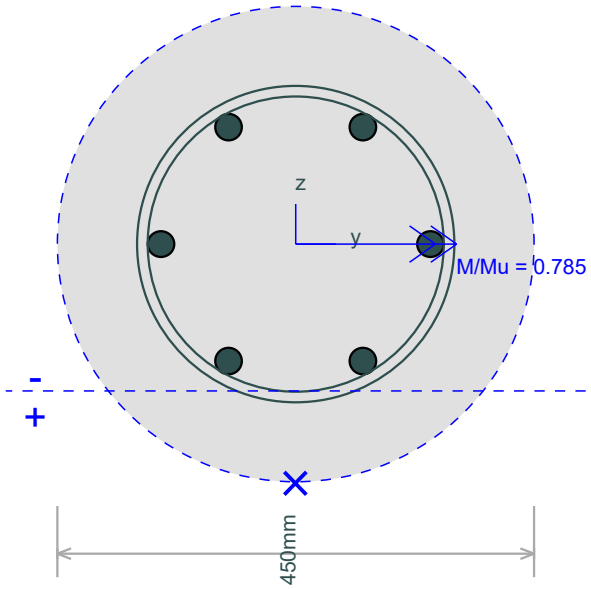
Analysis Case 2

Reinforcement Details

Bar Arrangement	1 ring(s)/6 bars per ring
Diameter of main bars	25mm
Area of reinforcement	2945.24mm²
Nominal Cover (outer)	75mm

Design Results

Analysis Case Name	Analysis Case 2 (min)
Axial Design Force	-817kN
Axial Capacity	3831.76kN
Design Moment 'M'	56.4kNm
Ultimate Moment 'Mu'	71.8073kNm
Neutral Axis	- - - - - - -
Comp./Tens. Side	+/-
Governing Node/Bar	X



Section 3

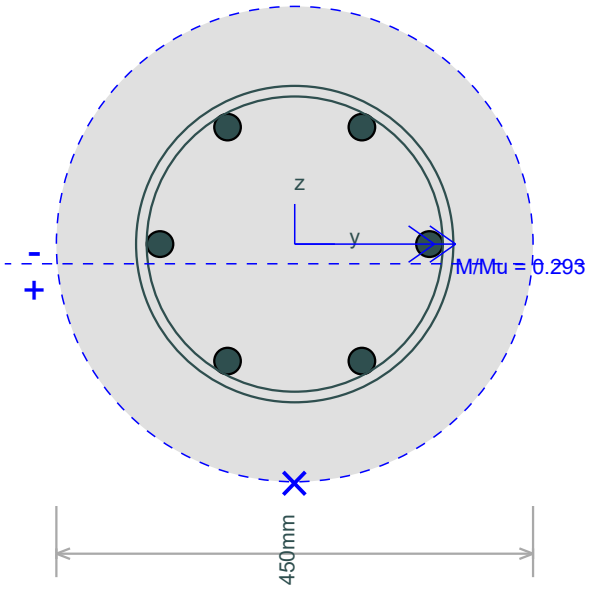
Analysis Case 3

Reinforcement Details

Bar Arrangement	1 ring(s)/6 bars per ring
Diameter of main bars	25mm
Area of reinforcement	2945.24mm²
Nominal Cover (outer)	75mm

Design Results

Analysis Case Name	Analysis Case 2 (max)
Axial Design Force	708kN
Axial Capacity	3831.76kN
Design Moment 'M'	56.4kNm
Ultimate Moment 'Mu'	192.385kNm
Neutral Axis	- - - - - - -
Comp./Tens. Side	+/-
Governing Node/Bar	X



Section 3

Analysis Case 4

100 Grays Inn Road

Erith Contractors Ltd
50kN Shear Check

Notes:

None

History

Date	Time	Name	Note
09-Apr-2024	08:10	jonathan	

Input Data

General Specification

Design code	EN 1992-1-1:2004 Eurocode 2 (GB)
Country	United Kingdom
Bending Axes	Biaxial
Imperfection Moment yy	No
Imperfection Moment zz	No
2nd Order Moments	No
Width to Depth Ratio	Yes
Height to Thickness Ratio	Yes

Pile section

Effective length of pile	8.000
Diameter of pile	450.0
Pile with casing	Yes
Design diameter(EC2 clause 2.3.4.2(2))	450.0

Concrete Material Specification

Prop.	Name	fck	Max. Agg. Size	Tensile Strength	Static E	Gamma c	Maximum Strain
		[N/mm²]	[mm]	[N/mm²]	[N/mm²]		
Column	C30/37	30.00	20.00	1.931	32840.	1.500	0.003500

Reinforcement Specification

Prop.	Name	fy	Bond Coeff. Tension	Bond Coeff. Compr.	Young's Modulus	Gamma s	Maximum Strain
		[N/mm²]			[N/mm²]		
Main	500B	500.0	0.5000	0.6300	200000.	1.150	0.05000
Links	500B	500.0	0.5000	0.6300	200000.	1.150	0.05000

Loads

Load Case	Axial Design Force 'N'	Moments			
		Top		Bottom	
		Myy	Mzz	Myy	Mzz
	[kN]	[kNm]	[kNm]	[kNm]	[kNm]
1	-151.0	56.40	0.0	0.0	0.0
2	1872.	56.40	0.0	0.0	0.0
3	-817.0	56.40	0.0	0.0	0.0
4	708.0	56.40	0.0	0.0	0.0

Analysis Cases

Analysis Case	Name	Description	Moment Ratio(y)	Moment Ratio(z)	Creep Coefficient
1	Analysis Case 1 (min)	L1	0.6500	0.6500	2.000
2	Analysis Case 1 (max)	L2	0.6500	0.6500	2.000
3	Analysis Case 2 (min)	L3	0.6500	0.6500	2.000
4	Analysis Case 2 (max)	L4	0.6500	0.6500	2.000

Covers

Min. Nominal Cover (outer) 75.00 mm

Available Bar Sizes

Name	Size [mm]
0	8.000
1	10.00
2	12.00
3	16.00
4	20.00
5	25.00
6	32.00
7	40.00

Bar Limits

	Minimum [mm]	Maximum [mm]
Main	16.00	25.00
Links	10.00	10.00

Checks and Limits

Max. Area of Reinf.	None
Min. Area of Reinf.	None
Min. Bar Size	None
Min. No of Bars	None
Max. bar spacing (tension)	None
Max. bar spacing (compression)	300.0 mm
Min. Bar Spacing	None
Link size	EN 1992-1-1:2004 Eurocode 2 (GB)
Maximum Link Spacing	EN 1992-1-1:2004 Eurocode 2 (GB)
Top and bottom of column connected	No

	Minimum [mm]	Maximum [mm]

to beams or slabs
Cover check: bar size — EN 1992-1-1:2004 Eurocode 2 (GB)
Cover check: aggregate size — EN 1992-1-1:2004 Eurocode 2 (GB)
Deviation (ΔC_{dev}) — 10.00 mm

Bar Arrangements

Nr of Rings	Nr of Bars per Ring	Ring Diameter
1	6	Cover and min. pitch

Eurocode 2 Nationally Determined Parameters

The following Nationally Determined Parameters (NDPs) are given the default values that are recommended in Eurocode 2.

Clause	Parameter	Default Value
5.2	ϑ_0	1/200
8.2	k_1	1
8.2	k_2	5 mm
9.5.2(2)	As_{min}	$\max(0.10N_{Ed}/f_{yd}, 0.002A_c)$
9.5.2(2)	As_{max}	$0.04A_c$
9.5.2.9	ϕ_{min}	8 mm
9.5.3(3)	$s_{cl,tmax}$	min(20 x dia_{min}, min(width, depth), 400 mm)

The following NDPs are country specific and may found in its National Annex.

Clause	Parameter	Value
3.1.6	α_{cc}	0.8500

Design Results

Pile Design Moment Derivation (for bending about z axis)

Derivation of column/Pile design moments output for the following selection:

Analysis Case All
Capacity All

Sec.	Analysis Case	Axial Design Force 'N'	Init. Top Moment	Init. Bottom Moment	l_0 (E5.14)	λ (E5.14)	A (E5.13)	B (E5.13)	C (E5.13)	n (E5.13)	λ_{lim} (E5.13)	K_r (E5.34)	K_ϕ (E5.34)	d (E5.35)	1/r (E5.33)	e_2 (E5.33)	e_0 (C6.1(4))	e_i (E5.2)	Braced	2nd Order Moment	Imp. Moment	Design Moment
		[kN]	[kNm]	[kNm]	[m]	[m]					[m]			[mm]	[/m]	[mm]	[mm]	[mm]		[kNm]	[kNm]	[kNm]
1	1	-151.0	56.40	0.0	0.0	71.11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Yes	(0.0)	(0.0)	*56.40
1	2	1872.	56.40	0.0	0.0	71.11	0.7937	1.179	1.700	0.6977	38.10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Yes	(0.0)	(0.0)	*56.40
1	3	-817.0	56.40	0.0	0.0	71.11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Yes	(0.0)	(0.0)	*56.40
1	4	708.0	56.40	0.0	0.0	71.11	0.7937	1.179	1.700	0.2639	61.96	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Yes	(0.0)	(0.0)	*56.40
2	1	-151.0	56.40	0.0	0.0	71.11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Yes	(0.0)	(0.0)	*56.40
2	2	1872.	56.40	0.0	0.0	71.11	0.7937	1.270	1.700	0.7007	40.95	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Yes	(0.0)	(0.0)	*56.40
2	3	-817.0	56.40	0.0	0.0	71.11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Yes	(0.0)	(0.0)	*56.40
2	4	708.0	56.40	0.0	0.0	71.11	0.7937	1.270	1.700	0.2650	66.58	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Yes	(0.0)	(0.0)	*56.40
3	1	-151.0	56.40	0.0	0.0	71.11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Yes	(0.0)	(0.0)	*56.40
3	2	1872.	56.40	0.0	0.0	71.11	0.7937	1.402	1.700	0.7054	45.04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Yes	(0.0)	(0.0)	*56.40
3	3	-817.0	56.40	0.0	0.0	71.11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Yes	(0.0)	(0.0)	*56.40
3	4	708.0	56.40	0.0	0.0	71.11	0.7937	1.402	1.700	0.2668	73.23	N/A	N/A	N/A	N/A	N/A	0.0	0.0	Yes	(0.0)	(0.0)	56.40

Notes:
( ) Moments shown thus have been excluded from the final design moment (ref Eurocode Cl 5.8.2(6) or Eurocode 2 Cl 5.8.9(2)).
* Design moments shown thus result from maximum end moment plus imperfection moment - if imperfection moment is to be applied about this axis.

Pile Design Moment Derivation (for bending about z axis)

Derivation of column/Pile design moments output for the following selection:

Analysis Case All
Capacity All

Sec.	Analysis Case	Axial Design Force 'N'	Init. Top Moment	Init. Bottom Moment	l_0 (E5.14)	λ (E5.14)	A (E5.13)	B (E5.13)	C (E5.13)	n (E5.13)	λ_{lim} (E5.13)	K_r (E5.34)	K_ϕ (E5.34)	d (E5.35)	1/r (E5.33)	e_2 (E5.33)	e_0 (C6.1(4))	e_i (E5.2)	Braced	2nd Order Moment	Imp. Moment	Design Moment
		[kN]	[kNm]	[kNm]	[m]	[m]					[m]			[mm]	[/m]	[mm]	[mm]	[mm]		[kNm]	[kNm]	[kNm]
1	1	-151.0	0.0	0.0	0.0	71.11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Yes	0.0	0.0	0.0
1	2	1872.	0.0	0.0	0.0	71.11	0.7937	1.179	0.7000	0.6977	15.69	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Yes	0.0	0.0	0.0
1	3	-817.0	0.0	0.0	0.0	71.11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Yes	0.0	0.0	0.0
1	4	708.0	0.0	0.0	0.0	71.11	0.7937	1.179	0.7000	0.2639	25.51	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Yes	0.0	0.0	0.0
2	1	-151.0	0.0	0.0	0.0	71.11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Yes	0.0	0.0	0.0
2	2	1872.	0.0	0.0	0.0	71.11	0.7937	1.270	0.7000	0.7007	16.86	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Yes	0.0	0.0	0.0
2	3	-817.0	0.0	0.0	0.0	71.11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Yes	0.0	0.0	0.0
2	4	708.0	0.0	0.0	0.0	71.11	0.7937	1.270	0.7000	0.2650	27.42	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Yes	0.0	0.0	0.0
3	1	-151.0	0.0	0.0	0.0	71.11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Yes	0.0	0.0	0.0
3	2	1872.	0.0	0.0	0.0	71.11	0.7937	1.402	0.7000	0.7054	18.54	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Yes	0.0	0.0	0.0
3	3	-817.0	0.0	0.0	0.0	71.11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Yes	0.0	0.0	0.0
3	4	708.0	0.0	0.0	0.0	71.11	0.7937	1.402	0.7000	0.2668	30.15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Yes	0.0	0.0	0.0

Notes:
( ) Moments shown thus have been excluded from the final design moment (ref Eurocode Cl 5.8.2(6) or Eurocode 2 Cl 5.8.9(2)).
* Design moments shown thus result from maximum end moment plus imperfection moment - if imperfection moment is to be applied about this axis.

Pile Summary Results

Derivation of pile design moments output for the following selection:

Analysis Case All
Capacity All
Sorted By Section

Sec.	Analysis Case	Bar Arrangement	No.of Bars	Bar Size	Area of Reinf.		Link Size	Maximum Spacing of Links	Nominal Cover (outer)	Axial Design Force 'N'	N_{max}	N/N_{max}	Resultant Moment Design 'M'	Moment Angle	M_u	M/M_u
				[mm]	[mm²]	[%]	[mm]	[mm]	[mm]	[kN]	[kN]		[kNm]	[°]	[kNm]	
1	1 Analysis Case 1 (min)	1 ring(s)/6 bars per ring	6	16.00	1206.	0.7585	10.00	320.0	75.00	-151.0	3166.	-0.04770	56.40	0.0	61.72	0.9137
1	2 Analysis Case 1 (max)	1 ring(s)/6 bars per ring	6	16.00	1206.	0.7585	10.00	320.0	75.00	1872.	3166.	0.5913	56.40	0.0	137.3	0.4109
1	3 Analysis Case 2	1 ring(s)/6 bars per ring	6	16.00	1206.	0.7585	10.00	320.0	75.00	-817.0	3166.	-0.2581	56.40	0.0	N/S	N/S !

1	4	Analysis Case 2 (min)	1 ring(s)/6 bars per ring	6	16.00	1206.	0.7585	10.00	320.0	75.00	708.0	3166.	0.2236	56.40	0.0	141.0	0.4001	
2	1	Analysis Case 1 (max)	1 ring(s)/6 bars per ring	6	20.00	1885.	1.185	10.00	400.0	75.00	-151.0	3426.	-0.04408	56.40	0.0	98.10	0.5749	
2	2	Analysis Case 1 (min)	1 ring(s)/6 bars per ring	6	20.00	1885.	1.185	10.00	400.0	75.00	1872.	3426.	0.5465	56.40	0.0	154.4	0.3653	
2	3	Analysis Case 2 (max)	1 ring(s)/6 bars per ring	6	20.00	1885.	1.185	10.00	400.0	75.00	-817.0	3426.	-0.2385	56.40	0.0	9.970	5.657	!
2	4	Analysis Case 2 (min)	1 ring(s)/6 bars per ring	6	20.00	1885.	1.185	10.00	400.0	75.00	708.0	3426.	0.2067	56.40	0.0	161.7	0.3488	
3	1	Analysis Case 1 (max)	1 ring(s)/6 bars per ring	6	25.00	2945.	1.852	10.00	400.0	75.00	-151.0	3832.	-0.03941	56.40	0.0	145.9	0.3866	%
3	2	Analysis Case 1 (min)	1 ring(s)/6 bars per ring	6	25.00	2945.	1.852	10.00	400.0	75.00	1872.	3832.	0.4885	56.40	0.0	178.3	0.3164	%
3	3	Analysis Case 2 (max)	1 ring(s)/6 bars per ring	6	25.00	2945.	1.852	10.00	400.0	75.00	-817.0	3832.	-0.2132	56.40	0.0	71.81	0.7854	%
3	4	Analysis Case 2 (min)	1 ring(s)/6 bars per ring	6	25.00	2945.	1.852	10.00	400.0	75.00	708.0	3832.	0.1848	56.40	0.0	192.4	0.2932	%

Notes:
! Section/analysis case combinations with inadequate axial or bending capacity are marked thus.
% Sections with adequate axial and bending capacity for all analysis cases, with lowest area of longitudinal reinforcement are marked thus.

APPENDIX E – DESIGNERS RISK ASSESSMENT

Franki Foundations | Martello Piling | Able Piling

Designers Risk Assessment

Site:	100 Grays Inn Road, WC1X 8AL	Ref:	F23138	Date:	8/4/2024

							Pre risk				Post risk			
Risk Ref:	Date	Made by	Checked by	Activity	Hazard	Cause	Likelihood	Severity	Rating	Control measure	Likelihood	Severity	Rating	Residual hazards
1	08/04/2024	JC	JC	Pile Design	Incorrect Design	Poor/wrong information/ incorrect design	3	3	Medium	Checking of design & schedule to be undertaken by competent engineer including relevant design codes & factor of safety.	1	3	Low	
2	08/04/2024	JC	JC	Pile Design	Incorrect Design	Incorrect analysis and interpretation of ground conditions	3	3	Medium	Checking of parameter selection/designs to be undertaken by competent engineer	1	3	Low	Unidentified ground conditions (Faults/ pockets of made ground
3	08/04/2024	JC	JC	Design & Construction: Connection & detail of pile cage reinforcement Above PCOL In to substructure	Incorrect anchorage length projecting from top of pile after pile trimming (once pile is trimmed to pile cut off level) Design of connection detail for pile cage reinforcement in to engineer's substructure not checked or carried out by the Consulting Engineer	Insufficient anchorage length of pile cage reinforcement left projecting above the pile's cut off level as a result of no design check for required length and/or no check carried out to determine the difference(s) between Pile Platform Level (PPL) and Pile Cut off Level (PCOL)	3	2	Medium	Main Contractor and Consulting Engineer to be aware that Franki Foundations is not responsible for pile connection detail in to substructure. Consulting Engineer to devise lap length. Main Contractor to establish a suitable PPL that will leave sufficient projection of pile cage reinforcement.	1	2	Low	No liaising between parties (engineer, main contractor, groundworks contractor) may result in Pile Platform Level being installed to incorrect level.
4	08/04/2024	JC	JC	Piling mat design	Incorrect design/installation & maintenance	Incorrect design/poor maintenance & installation/ variable ground conditions	4	4	High	Design of pile mat by competent engineer, installation and maintenance by competent contractor	1	4	Medium	Due to severity of possible consequence medium risk
5	08/04/2024	JC	JC	Pile construction	Damage to underground services	Unidentified or incorrectly marked locations	3	4	High	Investigatory work to be carried out by competent contractor. All services to be located and scheme designed in order to avoid clashes	1	4	Medium	Retained medium risk due to H&S consequences Pile probing is recommended in risk areas

Designers Risk Assessment

Site:	100 Grays Inn Road, WC1X 8AL	Ref:	F23138	Date:	8/4/2024

6	08/04/2024	JC	JC	Pile construction	Ground loss/bore stability	Unsuitable piling method for ground conditions/inadequate monitoring	3	2	Medium	Appropriate selection of pile method & support medium	1	2	Low	
7	08/04/2024	JC	JC	Pile construction	Damage to 3rd party assets/structures	Bore stability/excessive wall deflection/inadequate propping	3	3	Medium	Accurate monitoring of ground movement, installation of monitoring strategy if necessary	1	3	Low	
8	08/04/2024	JC	JC	Pile construction	Variable/different ground conditions to design assumptions	Unidentified geology/stratum level changes/soil conditions	3	3	Medium	Check & review of pile bore records by competent person, deviation in ground conditions to be reported	1	3	Low	Unidentified ground conditions (Faults/ pockets of made ground
9	08/04/2024	JC	JC	Pile cage installation	Cage breakage during lifting, placing or moving.	Cage not adequately tied together on site or fabricated without consideration of self-weight.	2	3	Medium	Pile cages which are typically above 75kg are to be double-strand and cross tied between helical/link and straight bar at regular centres along whole length of pile cage if fabricated on site. For heavier pile cages typically up to 300kg consider need for welded lifting bands or double/triple wrapped helical to increase rigidity and for a lifting point. Cages greater than 300kg (+ ≈10%), exceeding 11.0m length and/or formed with 32mm or greater are to be pre-fabricated.	1	3	Low	
10	08/04/2024	JC	JC	Excavation & Pile Construction	UXO	Risk of UXO being encountered during piling and/or excavation works	2	4	Medium	Ensure that risk mitigation recommendations of UXO survey (carried out by First Line Defence; DA11269-00) are followed	1	4	Medium	Retained medium risk due to H&S consequences

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Designers Risk Assessment	Site:	100 Grays Inn Road, WC1X 8AL	Ref:	F23138	Date:	8/4/2024

Risk Level Action

Risk Level	Action Required
Low	Check that further risk cant be eliminated by revision
Medium	Consider alternative method, if alternatives are not available precautions to be undertaken
High	Seek alternative solutions, if no alternatives available specific precautions to be undetaken

Risk Matrix

Severity/Likelihood score	1	2	3	4	5
1	Low	Low	Low	Medium	Medium
2	Low	Low	Medium	Medium	High
3	Low	Medium	Medium	High	High
4	Medium	Medium	High	High	High
5	Medium	High	High	High	High

Severity indication

Score	Severity indication
1	Minor injury or delay to works/Short term local damage/Design approval required
2	Minor injury/Medium term local damage/ performance specification/ additional cost to rectify
3	Reportable/lost time injury/Long term local damage or regional damage/Complex design solution/additional costs to rectify
4	Major injury & illness/Long term widespread damage/highly variable soil
5	Fatalities/Permanent damage/catastrophic element failure