



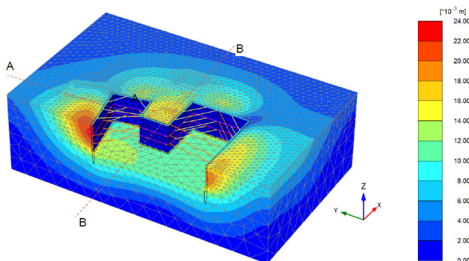
Report for
HG Construction Ltd.

Plymouth Grove, Manchester, M13 9AU

Pile Foundation Design



v1.0



Oasys WALLAP PLAXIS



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Manchester, M13 9AU

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Document Verification

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01	13.11.2025	S. Draghici, PhD MSc CEng MICE Technical Manager	S. Hadley, BEng (Hons) CEng FICE Managing Director	Design approval
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1 Design Brief

Enclosed is the load bearing piles design for Plymouth Grove development, located in Manchester, M13 9AU. The client for the present document and piling works is HG Construction Ltd.

The proposed method for the installation of the piles will be continuous flight auger (CFA) using a Soilmec SF65/SR-75 rig.

The bearing piles are designed to a diameter of 450mm. The pile lengths range from 10.6m to 12.5m, with the length indicative of the distance between the pile platform level (assumed as existing ground level) and pile toes. The design is conducted according to BS EN 1997 (Eurocode 7) and UK NA as the in-force code of practice for pile design.

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	P662-ROS-ZZ-FN-GA-S-1700	P04	05.12.25	Roscoe	Piling general arrangement
Drawing	P662-ROS-ZZ-FN-GA-S-1701	P04	10.12.25	Roscoe	Piling Schedule
Phase 2 Ground Investigation Report	GR000119-GI-1.2	1.2	12.04.24	Ground Risk	

3 Soil Assessment

3.1 Soil Properties

Soil properties have been chosen based upon the data provided in the Ground Risk SI report, but also 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. Design soil profile

Depth from ground level (m)	Levels (mAOD)	Soil Type
0.0...2.0		Made Ground / Ignored depth for shaft resistance
2.0...9.0		Glacial Till (stiff becoming very stiff dark greyish brown Clay)
Below 9.0		Chester Formation (weak Sandstone with bands of Mudstone)

The ground investigations included within the SI report, comprised of two deep boreholes from ground level down to a maximum depth of 19.5mbgl with standard penetration tests carried out within Glacial Till and point load and uniaxial compressive strength testing of rock samples from Chester Formation.

The results obtained from the SPTs and point load tests together with UCS tests were used to obtain most of the geotechnical parameters, based on well-known and generally accepted correlations indicated in the technical literature and values recommended within the Ground Risk report.

Table 3. Soil properties

Soil type	Bulk density kN/m ³	Adhesion factor α	Cohesion ^{a)} kN/m ²	Soil friction angle ^{b)} ϕ
Made Ground	18	-	-	-
Glacial Till Clay	20	0.50	110	-
Chester Formation	20	-	UCS=2MPa	-

^{a)} As per Ground Risk recommended value

^{b)} After Peck et al., 1974, *Foundation Engineering*, 2nd Edition

According to the site investigations, the undrained cohesion for the Glacial Till ranges between 27kPa and 211.5kPa, with a recommended average value of 110kPa adopted for design.

The uniaxial compressive strength (UCS) for the sandstone ranged between 7.1MPa to 13.1MPa, as included in the SI report and shown under Appendix 1. Additional values derived from point load tests correlations are also included. As a conservative approach, the design is based on a lower bound UCS value of 2MPa.

Based on the findings of the Soil Report, the BRE Special Digest 1 - concrete in aggressive ground - recommends a design concrete class of DC-2. Additional details on the calculation of the concrete class can be found in Appendix 8.

3.2 Ground Water Table

The SI report suggested that the groundwater water table was encountered at 7.0mbgl. The calculations reflect this, albeit this does not impact the design, which is based on total stress approach and rock socket into the sandstone.

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 4. Partial resistance factors for pile design

Resistance	Symbol	Partial factor
Model factor	γ_{rd}	1.4
Base	γ_b	2.0
Shaft resistance for compression load	γ_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:

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

Glacial Till	Sandstone/Mudstone
—	$R_{b,k} = A_b \cdot q_b$
$R_{s,k} = A_s \cdot \alpha \cdot c_u$	$R_{s,k} = A_s \cdot q_s = A_s \cdot 0.2 \cdot (\sigma_c)^{0.5}$

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

α - adhesion factor

A_b - base area

A_s - shaft area

q_b - ultimate end bearing resistance, taken as the 5UCS as per CIRIA C181 (10000kPa)

q_s - ultimate shaft friction for rock socket (as per Horvath and Kenney, 1979 relation)

σ_c - design compressive strength

The ultimate shaft friction in the sandstone/mudstone is determined using the relation proposed by Horvath and Kenney (1979), as per CIRIA C181. Based on this relation, the bond stress in the sandstone layer results as 282kPa.

$$0.2 \cdot (\sigma_c)^{0.5} = 0.2 \cdot (2)^{0.5} = 282kPa$$

To be prudent and to limit settlement we have ensured that at the pile depth the working load is accommodated by the pile shaft resistance with a factor of safety of at least 1.2.

4.3 Pile loads

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

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

For the uplift case, the wind uplift is combined with the minimum dead load, as a conservative approach.

Table 5. 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 6. Loads factored as per DA1, C2 – Geotechnical design

Pile diameter (mm)	Factored compression load (kN)	Factored tension load (kN)
450	400 to 1400	0 to 175

Table 7. Loads factored as per DA1, C1 – Structural design

Pile diameter (mm)	Factored compression load (kN)	Factored horizontal load (kN)	Factored tension load (kN)
450	500 to 1800	22.5 to 75	0 to 240

4.4 Load tests

The partial resistance factors allowed for in the pile design, being the highest ones recommended by EC7 (R4 set without explicit verification of serviceability), negate the need for load testing, as per BS EN 1997-1:2004 and UK NA.

All bearing piles are to be integrity tested. This will need to be coordinated by the client, as Central Piling will no longer be on site at the time of testing. Once the piles have been trimmed, we can organise an integrity testing visit by an independent company.

4.5 Pile dimensions

Total number of bearing piles is 199 with a diameter of 450mm. The pile lengths range from 10.6m to 12.5m, with the length indicative of the distance between the pile platform level and pile toes, embedded into the sandstone layer for 1.6m to 3.5m.

In case that practical refusal into the mudstone/sandstone layer occurs sooner than reaching the design depth, the capacity of the piles will need to be reassessed.

4.6 Materials

The materials used in the design are as follows:

- Concrete: C28/35 strength class and DC-2 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/mm² (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:

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

Thus the maximum design vertical load is as follows:

$$N_{450} = A1 \cdot DL + A1 \cdot (LL + \psi_0 \cdot WL) = 1.35 \cdot 1110 + 1.5 \cdot (180 + 0.5 \cdot 0) = 1769kN$$

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

$$\sigma_{c,450mm \max} = \frac{N}{A_c} = \frac{1769 \cdot 10^3 N}{159 \cdot 10^3 mm^2} = 11.2MPa$$

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

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

$$f_{cd} = 14.4MPa > \sigma_{c,450} = 11.2MPa$$

Where:

- f_{cd} design compressive strength of the concrete
- α_{cc} coefficient taking account of long-term effects on the compressive strength with a value of 0.85
- γ_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. This is checked based on concrete resistance only. The combination of axial load and bending moment due to lateral loading, also including the steel's capacity, was checked using Oasys Adsec software, all results being satisfactory (see N-M charts included under Appendix 4). The concrete cover is 75mm.

4.8 Reinforcement design

The structural reinforcement is designed for the horizontal and uplift loads specified by the structural engineer. The pile head has been assumed as unrestrained/pinned.

The main cage reinforcement has been specified as a nominal 6B16 x 8.0m in a B10 helical with a 200mm pitch for majority of bearing piles. Piles with higher shear required 6B20 x 8.0m and 6B25 x 9.0m cages, as shown in the calculations included under Appendix 4. The bending moment and axial load (N-M curve) was checked using specialised software Oasys Adsec (see Appendix 4).

A lateral load of 15kN to 50kN has been specified for the piles design. The design of the reinforcement is based on Brom's theory for free pile head, considering the mobilisation of the ultimate soil resistance. Detailed calculations, including the relations used, are presented in Appendix 4 (Structural Design).

The reinforcement has also been designed for the residual tension from wind uplift in accordance with BS EN 1992-1-1:2004 and the National Annex, allowing for the appropriate partial factors of DA1, Combination 1 as per BS EN 1997-1:2004.

The piles have also been checked for potential of heave induced tension load on the pile shaft. The tension force is calculated as per the following relation, allowing for a minimum FOS of 2.0:

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

Where

α – adhesion factor

c_u – undrained cohesion

B – diameter of pile

D – depth of desiccation

Detailed calculations are presented in Appendix 4.

The minimum anchorage length typically adopted 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.

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 Mindlin method was used to calculate the settlement of individual piles based on relative displacements across a stratum directly from the applied loads. The pile settlement has been calculated for the maximum working load with the estimated pile head movement within expected performance criteria.

Table 8. Settlement summary

Pile diameter (mm)	Working compression load (kN)	Pile Depth (m)	Pile settlement (mm)
450	1350	12.5	5.5

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 plus 1 in 75 verticality tolerance. This tolerance should be allowed in the structural design of the pile caps. No cost associated with remedial works will be accepted for piles found to be within the installation tolerance of 75mm + 1/75 x (commencing level – cut-off level).

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.

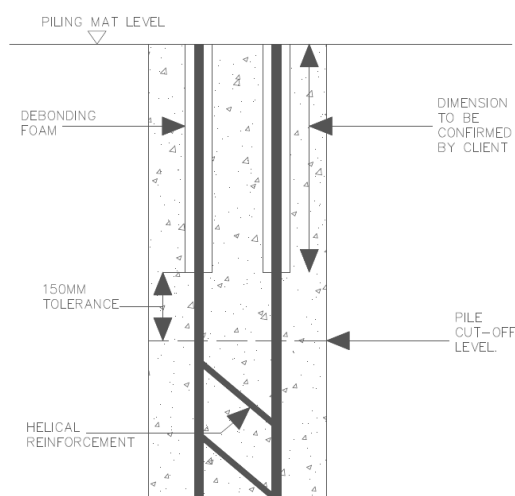


Figure 1 De-bonding detail

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 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 ready-mix 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.

7 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.

8 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.

9 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.

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

CIRIA C181 (1999). *Piled foundations in weak rock*. London, CIRIA

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

Appendix 1

Design Line

Figure 12.1 SPT N value vs Depth in Glacial Till Deposits and Made Ground

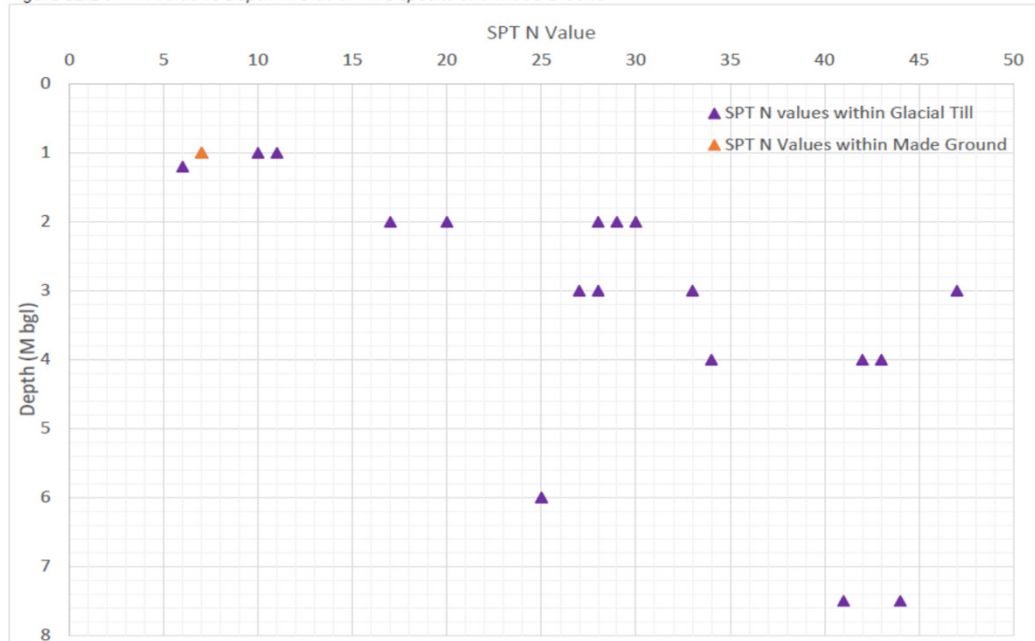
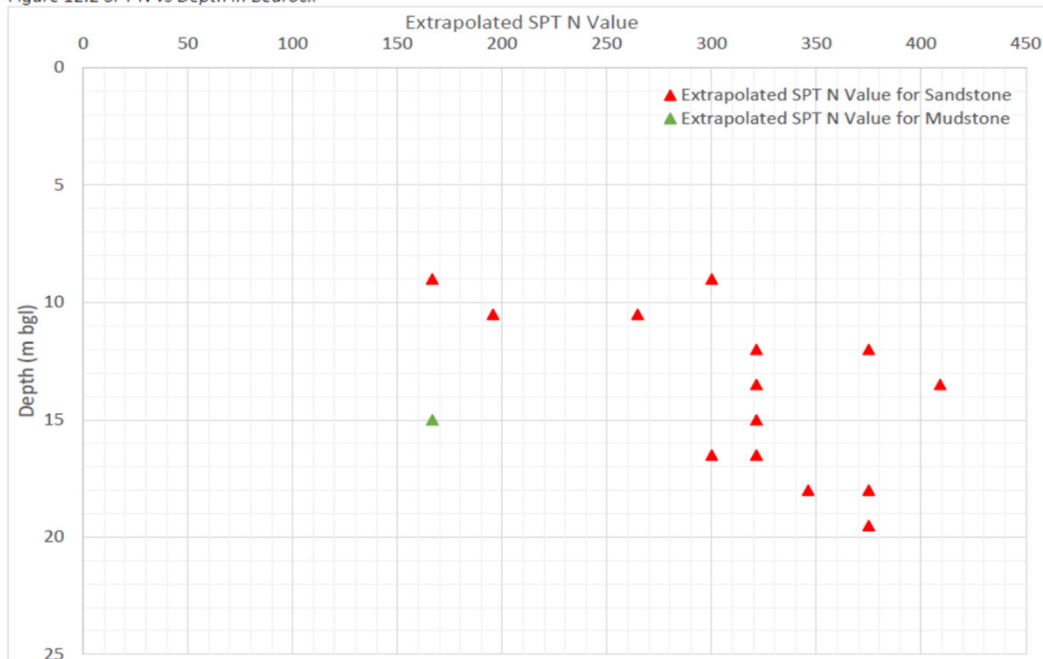


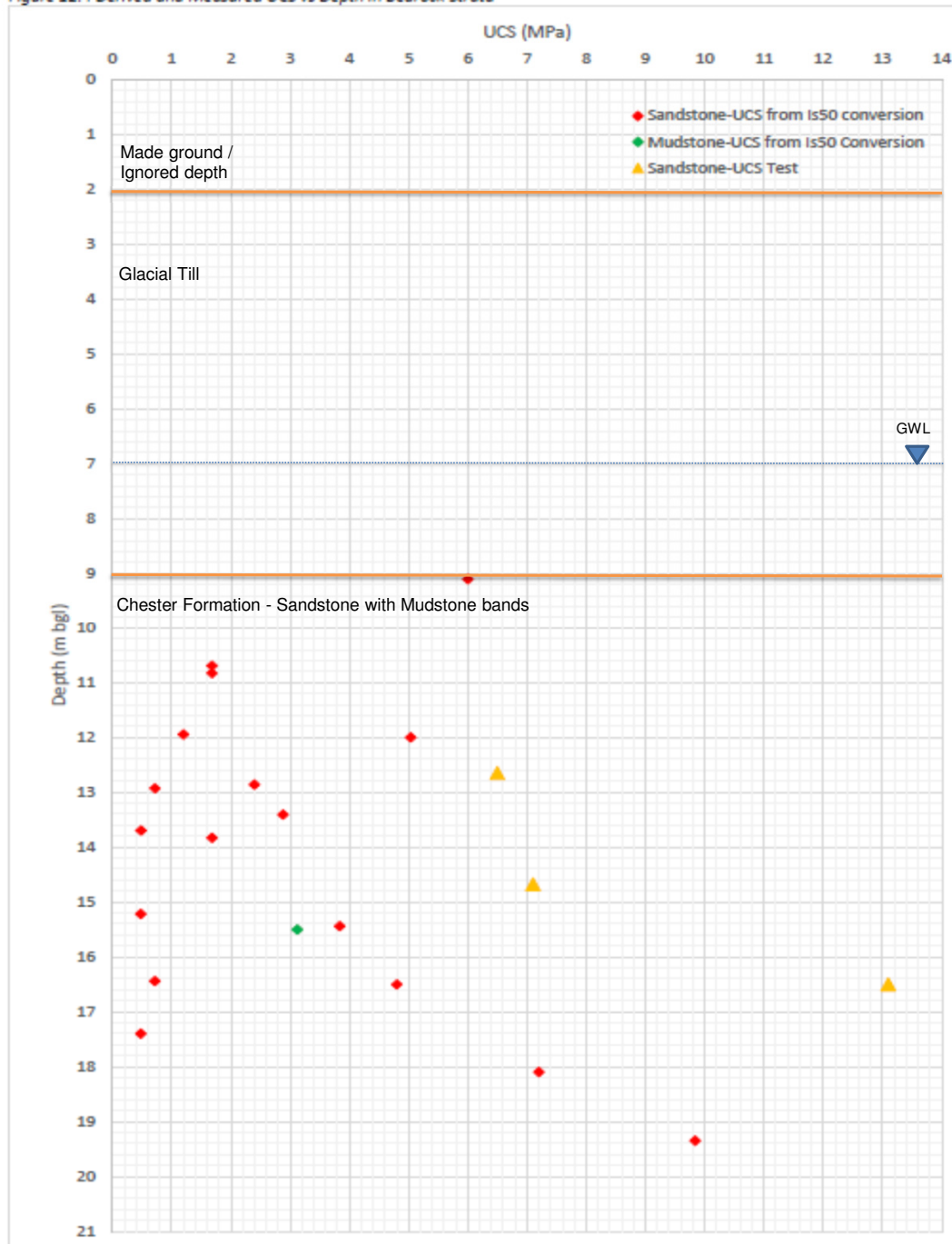
Figure 12.2 SPT N vs Depth in Bedrock



Notes:

Extract from Ground Risk SI report GR000119-GI-1.2

Figure 12.4 Derived and Measured UCS vs Depth in Bedrock Strata



Notes:

Extract from Ground Risk SI report GR000119-GI-1.2

Appendix 2

Pile Calculations

Job No.	Sheet No.	Rev.
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Drg. Ref.		
Made by SD	Date	Checked

Notes

BS EN 1997
No load tests

Analysis Options

Design approach:	DA1 (C1 + C2)
Pile 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 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	6.0000 m
Maximum pile length	20.000 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	0.45000				

Undrained Materials - General Data

No. Material description	Bulk unit weight [kN/m ³]	Cu material factor	Top Cu [kPa]	Base Cu [kPa]
1 Glacial Till	20.000	NA	110.00	110.00

Undrained Materials - Skin Friction Data

No. Material description	Skin friction computation	Alpha	q _s Top [kPa]	q _s Base [kPa]	q _{s,lim} Spec. Value [kPa]
1 Glacial Till	Alpha specified	0.50000	NA	NA	Yes 100.00

Undrained Materials - End Bearing Data

No. Material description	End bearing computation	Nc	q _b Top [kPa]	q _b Base [kPa]	q _{b,lim} Spec. Value [kPa]
1 Glacial Till	Nc specified	9.0000	NA	NA	Yes 2500.0

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 Glacial Till	N.A.	N.A.	1.0000	1.0000	N.A.	N.A.

Drained Materials - General Data

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No.	Material description	Bulk unit weight [kN/m ³]	Tan(δ) material factor
1	Made Ground	18.000	NA
2	Chester Formation	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,lim} Base [kPa]	Spec. Value
1	Made Ground	qs specified	NA	NA	NA	0.0	0.0	No
2	Chester Formation	qs specified	NA	NA	NA	282.00	282.00	No

Drained Materials - End Bearing Data

No.	Material description	End bearing computation	Nq	Phi' [deg]	PhiD [deg]	Phicv' [deg]	Ir	q _b Top [kPa]	q _{b,lim} Base [kPa]	Spec. Value	Nq-Phi curves
1	Made Ground	qb specified	NA	NA	NA	NA	NA	0.0	0.0	No	NA NA
2	Chester Formation	qb specified	NA	NA	NA	NA	NA	10000.	10000.	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
2	Chester Formation	1.0000	1.0000	N.A.	N.A.	1.0000	1.0000

STAGE SPECIFIC DATA

Stage 0 : Initial Stage

Groundwater

No.	Level [m]	Pressure [kPa]	Unit weight of water [kN/m ³]
1	7.0000	0.0	10.000

Soil Profiles

Soil Profile 1: Soil Profile 1

No.	Depth [m]	Material description	Contributes to negative skin friction
1	0.0	Made Ground	No
2	2.0000	Glacial Till	No
3	9.0000	Chester Formation	No

Soil Profile - Groundwater Map

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

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Made by SD	Date	Checked

No. Soil Profile Groundwater

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 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
2.0000	18.000	0.0	N.A.	36.000	0.0	36.000	NA	0.0
2.0000	20.000	110.00	N.A.	36.000	0.0	36.000	NA	0.0
6.0000	20.000	110.00	N.A.	116.00	0.0	116.00	NA	220.00
6.1000	20.000	110.00	N.A.	118.00	0.0	118.00	NA	225.50
6.2000	20.000	110.00	N.A.	120.00	0.0	120.00	NA	231.00
6.3000	20.000	110.00	N.A.	122.00	0.0	122.00	NA	236.50
6.4000	20.000	110.00	N.A.	124.00	0.0	124.00	NA	242.00
6.5000	20.000	110.00	N.A.	126.00	0.0	126.00	NA	247.50
6.6000	20.000	110.00	N.A.	128.00	0.0	128.00	NA	253.00
6.7000	20.000	110.00	N.A.	130.00	0.0	130.00	NA	258.50
6.8000	20.000	110.00	N.A.	132.00	0.0	132.00	NA	264.00
6.9000	20.000	110.00	N.A.	134.00	0.0	134.00	NA	269.50
7.0000	20.000	110.00	N.A.	136.00	0.0	136.00	NA	275.00
7.1000	20.000	110.00	N.A.	138.00	1.0000	137.00	NA	280.50
7.2000	20.000	110.00	N.A.	140.00	2.0000	138.00	NA	286.00
7.3000	20.000	110.00	N.A.	142.00	3.0000	139.00	NA	291.50
7.4000	20.000	110.00	N.A.	144.00	4.0000	140.00	NA	297.00
7.5000	20.000	110.00	N.A.	146.00	5.0000	141.00	NA	302.50
7.6000	20.000	110.00	N.A.	148.00	6.0000	142.00	NA	308.00
7.7000	20.000	110.00	N.A.	150.00	7.0000	143.00	NA	313.50
7.8000	20.000	110.00	N.A.	152.00	8.0000	144.00	NA	319.00
7.9000	20.000	110.00	N.A.	154.00	9.0000	145.00	NA	324.50
8.0000	20.000	110.00	N.A.	156.00	10.000	146.00	NA	330.00
8.1000	20.000	110.00	N.A.	158.00	11.000	147.00	NA	335.50
8.2000	20.000	110.00	N.A.	160.00	12.000	148.00	NA	341.00
8.3000	20.000	110.00	N.A.	162.00	13.000	149.00	NA	346.50
8.4000	20.000	110.00	N.A.	164.00	14.000	150.00	NA	352.00
8.5000	20.000	110.00	N.A.	166.00	15.000	151.00	NA	357.50
8.6000	20.000	110.00	N.A.	168.00	16.000	152.00	NA	363.00
8.7000	20.000	110.00	N.A.	170.00	17.000	153.00	NA	368.50
8.8000	20.000	110.00	N.A.	172.00	18.000	154.00	NA	374.00
8.9000	20.000	110.00	N.A.	174.00	19.000	155.00	NA	379.50
9.0000	20.000	110.00	N.A.	176.00	20.000	156.00	NA	385.00
9.0000	20.000	0.0	N.A.	176.00	20.000	156.00	NA	385.00
9.1000	20.000	0.0	N.A.	178.00	21.000	157.00	NA	413.20
9.2000	20.000	0.0	N.A.	180.00	22.000	158.00	NA	441.40
9.3000	20.000	0.0	N.A.	182.00	23.000	159.00	NA	469.60
9.4000	20.000	0.0	N.A.	184.00	24.000	160.00	NA	497.80
9.5000	20.000	0.0	N.A.	186.00	25.000	161.00	NA	526.00
9.6000	20.000	0.0	N.A.	188.00	26.000	162.00	NA	554.20
9.7000	20.000	0.0	N.A.	190.00	27.000	163.00	NA	582.40
9.8000	20.000	0.0	N.A.	192.00	28.000	164.00	NA	610.60
9.9000	20.000	0.0	N.A.	194.00	29.000	165.00	NA	638.80
10.000	20.000	0.0	N.A.	196.00	30.000	166.00	NA	667.00



CENTRAL PILING LIMITED

Plymouth Grove, Manchester

Bearing piles

Capacity check

Job No.	Sheet No.	Rev.
46887A1		
Drg. Ref.		
Made by SD	Date	Checked

Depth	Density	Undrained Cohesion	Nq	Total vertical stress	Porewater pressure	Effective vertical stress	Effective horizontal stress*	Cumulative skin friction per unit
10.100	20.000	0.0	N.A.	198.00	31.000	167.00	NA	695.20
10.200	20.000	0.0	N.A.	200.00	32.000	168.00	NA	723.40
10.300	20.000	0.0	N.A.	202.00	33.000	169.00	NA	751.60
10.400	20.000	0.0	N.A.	204.00	34.000	170.00	NA	779.80
10.500	20.000	0.0	N.A.	206.00	35.000	171.00	NA	808.00
10.600	20.000	0.0	N.A.	208.00	36.000	172.00	NA	836.20
10.700	20.000	0.0	N.A.	210.00	37.000	173.00	NA	864.40
10.800	20.000	0.0	N.A.	212.00	38.000	174.00	NA	892.60
10.900	20.000	0.0	N.A.	214.00	39.000	175.00	NA	920.80
11.000	20.000	0.0	N.A.	216.00	40.000	176.00	NA	949.00
11.100	20.000	0.0	N.A.	218.00	41.000	177.00	NA	977.20
11.200	20.000	0.0	N.A.	220.00	42.000	178.00	NA	1005.4
11.300	20.000	0.0	N.A.	222.00	43.000	179.00	NA	1033.6
11.400	20.000	0.0	N.A.	224.00	44.000	180.00	NA	1061.8
11.500	20.000	0.0	N.A.	226.00	45.000	181.00	NA	1090.0
11.600	20.000	0.0	N.A.	228.00	46.000	182.00	NA	1118.2
11.700	20.000	0.0	N.A.	230.00	47.000	183.00	NA	1146.4
11.800	20.000	0.0	N.A.	232.00	48.000	184.00	NA	1174.6
11.900	20.000	0.0	N.A.	234.00	49.000	185.00	NA	1202.8
12.000	20.000	0.0	N.A.	236.00	50.000	186.00	NA	1231.0
12.100	20.000	0.0	N.A.	238.00	51.000	187.00	NA	1259.2
12.200	20.000	0.0	N.A.	240.00	52.000	188.00	NA	1287.4
12.300	20.000	0.0	N.A.	242.00	53.000	189.00	NA	1315.6
12.400	20.000	0.0	N.A.	244.00	54.000	190.00	NA	1343.8
12.500	20.000	0.0	N.A.	246.00	55.000	191.00	NA	1372.0
12.600	20.000	0.0	N.A.	248.00	56.000	192.00	NA	1400.2
12.700	20.000	0.0	N.A.	250.00	57.000	193.00	NA	1428.4
12.800	20.000	0.0	N.A.	252.00	58.000	194.00	NA	1456.6
12.900	20.000	0.0	N.A.	254.00	59.000	195.00	NA	1484.8
13.000	20.000	0.0	N.A.	256.00	60.000	196.00	NA	1513.0
13.100	20.000	0.0	N.A.	258.00	61.000	197.00	NA	1541.2
13.200	20.000	0.0	N.A.	260.00	62.000	198.00	NA	1569.4
13.300	20.000	0.0	N.A.	262.00	63.000	199.00	NA	1597.6
13.400	20.000	0.0	N.A.	264.00	64.000	200.00	NA	1625.8
13.500	20.000	0.0	N.A.	266.00	65.000	201.00	NA	1654.0
13.600	20.000	0.0	N.A.	268.00	66.000	202.00	NA	1682.2
13.700	20.000	0.0	N.A.	270.00	67.000	203.00	NA	1710.4
13.800	20.000	0.0	N.A.	272.00	68.000	204.00	NA	1738.6
13.900	20.000	0.0	N.A.	274.00	69.000	205.00	NA	1766.8
14.000	20.000	0.0	N.A.	276.00	70.000	206.00	NA	1795.0
14.100	20.000	0.0	N.A.	278.00	71.000	207.00	NA	1823.2
14.200	20.000	0.0	N.A.	280.00	72.000	208.00	NA	1851.4
14.300	20.000	0.0	N.A.	282.00	73.000	209.00	NA	1879.6
14.400	20.000	0.0	N.A.	284.00	74.000	210.00	NA	1907.8
14.500	20.000	0.0	N.A.	286.00	75.000	211.00	NA	1936.0
14.600	20.000	0.0	N.A.	288.00	76.000	212.00	NA	1964.2
14.700	20.000	0.0	N.A.	290.00	77.000	213.00	NA	1992.4
14.800	20.000	0.0	N.A.	292.00	78.000	214.00	NA	2020.6
14.900	20.000	0.0	N.A.	294.00	79.000	215.00	NA	2048.8
15.000	20.000	0.0	N.A.	296.00	80.000	216.00	NA	2077.0
15.100	20.000	0.0	N.A.	298.00	81.000	217.00	NA	2105.2
15.200	20.000	0.0	N.A.	300.00	82.000	218.00	NA	2133.4
15.300	20.000	0.0	N.A.	302.00	83.000	219.00	NA	2161.6
15.400	20.000	0.0	N.A.	304.00	84.000	220.00	NA	2189.8
15.500	20.000	0.0	N.A.	306.00	85.000	221.00	NA	2218.0
15.600	20.000	0.0	N.A.	308.00	86.000	222.00	NA	2246.2
15.700	20.000	0.0	N.A.	310.00	87.000	223.00	NA	2274.4
15.800	20.000	0.0	N.A.	312.00	88.000	224.00	NA	2302.6
15.900	20.000	0.0	N.A.	314.00	89.000	225.00	NA	2330.8
16.000	20.000	0.0	N.A.	316.00	90.000	226.00	NA	2359.0
16.100	20.000	0.0	N.A.	318.00	91.000	227.00	NA	2387.2
16.200	20.000	0.0	N.A.	320.00	92.000	228.00	NA	2415.4
16.300	20.000	0.0	N.A.	322.00	93.000	229.00	NA	2443.6
16.400	20.000	0.0	N.A.	324.00	94.000	230.00	NA	2471.8
16.500	20.000	0.0	N.A.	326.00	95.000	231.00	NA	2500.0
16.600	20.000	0.0	N.A.	328.00	96.000	232.00	NA	2528.2
16.700	20.000	0.0	N.A.	330.00	97.000	233.00	NA	2556.4
16.800	20.000	0.0	N.A.	332.00	98.000	234.00	NA	2584.6
16.900	20.000	0.0	N.A.	334.00	99.000	235.00	NA	2612.8
17.000	20.000	0.0	N.A.	336.00	100.00	236.00	NA	2641.0
17.100	20.000	0.0	N.A.	338.00	101.00	237.00	NA	2669.2
17.200	20.000	0.0	N.A.	340.00	102.00	238.00	NA	2697.4
17.300	20.000	0.0	N.A.	342.00	103.00	239.00	NA	2725.6
17.400	20.000	0.0	N.A.	344.00	104.00	240.00	NA	2753.8
17.500	20.000	0.0	N.A.	346.00	105.00	241.00	NA	2782.0
17.600	20.000	0.0	N.A.	348.00	106.00	242.00	NA	2810.2
17.700	20.000	0.0	N.A.	350.00	107.00	243.00	NA	2838.4

Plymouth Grove, Manchester
Bearing piles
Capacity check

Job No.	Sheet No.	Rev.
46887A1		
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Made by SD	Date	Checked

Depth	Density	Undrained Cohesion	Nq	Total vertical stress	Porewater pressure	Effective vertical stress	Effective horizontal stress*	Cumulative skin friction per unit
17.800	20.000	0.0	N.A.	352.00	108.00	244.00	NA	2866.6
17.900	20.000	0.0	N.A.	354.00	109.00	245.00	NA	2894.8
18.000	20.000	0.0	N.A.	356.00	110.00	246.00	NA	2923.0
18.100	20.000	0.0	N.A.	358.00	111.00	247.00	NA	2951.2
18.200	20.000	0.0	N.A.	360.00	112.00	248.00	NA	2979.4
18.300	20.000	0.0	N.A.	362.00	113.00	249.00	NA	3007.6
18.400	20.000	0.0	N.A.	364.00	114.00	250.00	NA	3035.8
18.500	20.000	0.0	N.A.	366.00	115.00	251.00	NA	3064.0
18.600	20.000	0.0	N.A.	368.00	116.00	252.00	NA	3092.2
18.700	20.000	0.0	N.A.	370.00	117.00	253.00	NA	3120.4
18.800	20.000	0.0	N.A.	372.00	118.00	254.00	NA	3148.6
18.900	20.000	0.0	N.A.	374.00	119.00	255.00	NA	3176.8
19.000	20.000	0.0	N.A.	376.00	120.00	256.00	NA	3205.0
19.100	20.000	0.0	N.A.	378.00	121.00	257.00	NA	3233.2
19.200	20.000	0.0	N.A.	380.00	122.00	258.00	NA	3261.4
19.300	20.000	0.0	N.A.	382.00	123.00	259.00	NA	3289.6
19.400	20.000	0.0	N.A.	384.00	124.00	260.00	NA	3317.8
19.500	20.000	0.0	N.A.	386.00	125.00	261.00	NA	3346.0
19.600	20.000	0.0	N.A.	388.00	126.00	262.00	NA	3374.2
19.700	20.000	0.0	N.A.	390.00	127.00	263.00	NA	3402.4
19.800	20.000	0.0	N.A.	392.00	128.00	264.00	NA	3430.6
19.900	20.000	0.0	N.A.	394.00	129.00	265.00	NA	3458.8
20.000	20.000	0.0	N.A.	396.00	130.00	266.00	NA	3487.0

* 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

Depth	Pile length	Ultimate base capacity	Cumulative external Friction	Negative skin friction	Net ultimate resistance	Design resistance	Combination with least resistance	Factored load*
		(Q _b)	(Q _s)	(Q _{nsf})			#	
[m]	[m]	[kN]	[kN]	[kN]	[kN]	[kN]		[kN]
6.0000	6.0000	157.45	311.02	0.0	468.47	334.62	195.08	2 0.0 (C) 0.0 (C)
6.1000	6.1000	157.45	318.79	0.0	476.25	340.18	198.55	2 0.0 (C) 0.0 (C)
6.2000	6.2000	157.45	326.57	0.0	484.02	345.73	202.02	2 0.0 (C) 0.0 (C)
6.3000	6.3000	157.45	334.34	0.0	491.80	351.28	205.49	2 0.0 (C) 0.0 (C)
6.4000	6.4000	157.45	342.12	0.0	499.57	356.84	208.96	2 0.0 (C) 0.0 (C)
6.5000	6.5000	157.45	349.89	0.0	507.35	362.39	212.44	2 0.0 (C) 0.0 (C)
6.6000	6.6000	157.45	357.67	0.0	515.12	367.94	215.91	2 0.0 (C) 0.0 (C)
6.7000	6.7000	157.45	365.45	0.0	522.90	373.50	219.38	2 0.0 (C) 0.0 (C)
6.8000	6.8000	157.45	373.22	0.0	530.67	379.05	222.85	2 0.0 (C) 0.0 (C)
6.9000	6.9000	157.45	381.00	0.0	538.45	384.61	226.32	2 0.0 (C) 0.0 (C)
7.0000	7.0000	157.45	388.77	0.0	546.22	390.16	229.79	2 0.0 (C) 0.0 (C)
7.1000	7.1000	157.45	396.55	0.0	554.00	395.71	233.26	2 0.0 (C) 0.0 (C)
7.2000	7.2000	157.45	404.32	0.0	561.78	401.27	236.73	2 0.0 (C) 0.0 (C)
7.3000	7.3000	157.45	412.10	0.0	569.55	406.82	240.21	2 0.0 (C) 0.0 (C)
7.4000	7.4000	157.45	419.87	0.0	577.33	412.38	243.68	2 0.0 (C) 0.0 (C)
7.5000	7.5000	157.45	427.65	0.0	585.10	417.93	247.15	2 0.0 (C) 0.0 (C)
7.6000	7.6000	157.45	435.42	0.0	592.88	423.48	250.62	2 0.0 (C) 0.0 (C)
7.7000	7.7000	157.45	443.20	0.0	600.65	429.04	254.09	2 0.0 (C) 0.0 (C)
7.8000	7.8000	157.45	450.98	0.0	608.43	434.59	257.56	2 0.0 (C) 0.0 (C)
7.9000	7.9000	157.45	458.75	0.0	616.20	440.15	261.03	2 0.0 (C) 0.0 (C)
8.0000	8.0000	157.45	466.53	0.0	623.98	445.70	264.50	2 0.0 (C) 0.0 (C)
8.1000	8.1000	157.45	474.30	0.0	631.75	451.25	267.98	2 0.0 (C) 0.0 (C)
8.2000	8.2000	157.45	482.08	0.0	639.53	456.81	271.45	2 0.0 (C) 0.0 (C)
8.3000	8.3000	157.45	489.85	0.0	647.31	462.36	274.92	2 0.0 (C) 0.0 (C)
8.4000	8.4000	157.45	497.63	0.0	655.08	467.91	278.39	2 0.0 (C) 0.0 (C)
8.5000	8.5000	157.45	505.40	0.0	662.86	473.47	281.86	2 0.0 (C) 0.0 (C)
8.6000	8.6000	157.45	513.18	0.0	670.63	479.02	285.33	2 0.0 (C) 0.0 (C)
8.7000	8.7000	157.45	520.95	0.0	678.41	484.58	288.80	2 0.0 (C) 0.0 (C)
8.8000	8.8000	157.45	528.73	0.0	686.18	490.13	292.27	2 0.0 (C) 0.0 (C)
8.9000	8.9000	157.45	536.51	0.0	693.96	495.68	295.74	2 0.0 (C) 0.0 (C)
9.0000	9.0000	157.45	544.28	0.0	701.73	501.24	299.22	2 0.0 (C) 0.0 (C)
9.0000	9.0000	1590.4	544.28	0.0	2134.7	1524.8	810.99	2 0.0 (C) 0.0 (C)
9.1000	9.1000	1590.4	584.15	0.0	2174.6	1553.3	828.79	2 0.0 (C) 0.0 (C)
9.2000	9.2000	1590.4	624.01	0.0	2214.4	1581.7	846.59	2 0.0 (C) 0.0 (C)



CENTRAL PILING LIMITED

Plymouth Grove, Manchester

Bearing piles

Capacity check

Job No.	Sheet No.	Rev.
46887A1		
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Made by SD	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*
							#	
9.3000	9.3000	1590.4	663.88	0.0	2254.3	1610.2	864.39	2 0.0 (C) 0.0 (C)
9.4000	9.4000	1590.4	703.75	0.0	2294.2	1638.7	882.18	2 0.0 (C) 0.0 (C)
9.5000	9.5000	1590.4	743.61	0.0	2334.0	1667.2	899.98	2 0.0 (C) 0.0 (C)
9.6000	9.6000	1590.4	783.48	0.0	2373.9	1695.7	917.78	2 0.0 (C) 0.0 (C)
9.7000	9.7000	1590.4	823.35	0.0	2413.8	1724.1	935.58	2 0.0 (C) 0.0 (C)
9.8000	9.8000	1590.4	863.22	0.0	2453.6	1752.6	953.38	2 0.0 (C) 0.0 (C)
9.9000	9.9000	1590.4	903.08	0.0	2493.5	1781.1	971.17	2 0.0 (C) 0.0 (C)
10.000	10.000	1590.4	942.95	0.0	2533.4	1809.6	988.97	2 0.0 (C) 0.0 (C)
10.100	10.100	1590.4	982.82	0.0	2573.2	1838.0	1006.8	2 0.0 (C) 0.0 (C)
10.200	10.200	1590.4	1022.7	0.0	2613.1	1866.5	1024.6	2 0.0 (C) 0.0 (C)
10.300	10.300	1590.4	1062.5	0.0	2653.0	1895.0	1042.4	2 0.0 (C) 0.0 (C)
10.400	10.400	1590.4	1102.4	0.0	2692.8	1923.5	1060.2	2 0.0 (C) 0.0 (C)
10.500	10.500	1590.4	1142.3	0.0	2732.7	1951.9	1078.0	2 0.0 (C) 0.0 (C)
10.600	10.600	1590.4	1182.2	0.0	2772.6	1980.4	1095.8	2 0.0 (C) 0.0 (C)
10.700	10.700	1590.4	1222.0	0.0	2812.4	2008.9	1113.6	2 0.0 (C) 0.0 (C)
10.800	10.800	1590.4	1261.9	0.0	2852.3	2037.4	1131.4	2 0.0 (C) 0.0 (C)
10.900	10.900	1590.4	1301.8	0.0	2892.2	2065.8	1149.1	2 0.0 (C) 0.0 (C)
11.000	11.000	1590.4	1341.6	0.0	2932.0	2094.3	1166.9	2 0.0 (C) 0.0 (C)
11.100	11.100	1590.4	1381.5	0.0	2971.9	2122.8	1184.7	2 0.0 (C) 0.0 (C)
11.200	11.200	1590.4	1421.4	0.0	3011.8	2151.3	1202.5	2 0.0 (C) 0.0 (C)
11.300	11.300	1590.4	1461.2	0.0	3051.6	2179.7	1220.3	2 0.0 (C) 0.0 (C)
11.400	11.400	1590.4	1501.1	0.0	3091.5	2208.2	1238.1	2 0.0 (C) 0.0 (C)
11.500	11.500	1590.4	1541.0	0.0	3131.4	2236.7	1255.9	2 0.0 (C) 0.0 (C)
11.600	11.600	1590.4	1580.8	0.0	3171.2	2265.2	1273.7	2 0.0 (C) 0.0 (C)
11.700	11.700	1590.4	1620.7	0.0	3211.1	2293.7	1291.5	2 0.0 (C) 0.0 (C)
11.800	11.800	1590.4	1660.6	0.0	3251.0	2322.1	1309.3	2 0.0 (C) 0.0 (C)
11.900	11.900	1590.4	1700.4	0.0	3290.9	2350.6	1327.1	2 0.0 (C) 0.0 (C)
12.000	12.000	1590.4	1740.3	0.0	3330.7	2379.1	1344.9	2 0.0 (C) 0.0 (C)
12.100	12.100	1590.4	1780.2	0.0	3370.6	2407.6	1362.7	2 0.0 (C) 0.0 (C)
12.200	12.200	1590.4	1820.0	0.0	3410.5	2436.0	1380.5	2 0.0 (C) 0.0 (C)
12.300	12.300	1590.4	1859.9	0.0	3450.3	2464.5	1398.3	2 0.0 (C) 0.0 (C)
12.400	12.400	1590.4	1899.8	0.0	3490.2	2493.0	1416.1	2 0.0 (C) 0.0 (C)
12.500	12.500	1590.4	1939.6	0.0	3530.1	2521.5	1433.9	2 0.0 (C) 0.0 (C)
12.600	12.600	1590.4	1979.5	0.0	3569.9	2549.9	1451.7	2 0.0 (C) 0.0 (C)
12.700	12.700	1590.4	2019.4	0.0	3609.8	2578.4	1469.5	2 0.0 (C) 0.0 (C)
12.800	12.800	1590.4	2059.2	0.0	3649.7	2606.9	1487.3	2 0.0 (C) 0.0 (C)
12.900	12.900	1590.4	2099.1	0.0	3689.5	2635.4	1505.1	2 0.0 (C) 0.0 (C)
13.000	13.000	1590.4	2139.0	0.0	3729.4	2663.8	1522.9	2 0.0 (C) 0.0 (C)
13.100	13.100	1590.4	2178.8	0.0	3769.3	2692.3	1540.7	2 0.0 (C) 0.0 (C)
13.200	13.200	1590.4	2218.7	0.0	3809.1	2720.8	1558.5	2 0.0 (C) 0.0 (C)
13.300	13.300	1590.4	2258.6	0.0	3849.0	2749.3	1576.3	2 0.0 (C) 0.0 (C)
13.400	13.400	1590.4	2298.4	0.0	3888.9	2777.8	1594.1	2 0.0 (C) 0.0 (C)
13.500	13.500	1590.4	2338.3	0.0	3928.7	2806.2	1611.9	2 0.0 (C) 0.0 (C)
13.600	13.600	1590.4	2378.2	0.0	3968.6	2834.7	1629.7	2 0.0 (C) 0.0 (C)
13.700	13.700	1590.4	2418.0	0.0	4008.5	2863.2	1647.5	2 0.0 (C) 0.0 (C)
13.800	13.800	1590.4	2457.9	0.0	4048.3	2891.7	1665.3	2 0.0 (C) 0.0 (C)
13.900	13.900	1590.4	2497.8	0.0	4088.2	2920.1	1683.1	2 0.0 (C) 0.0 (C)
14.000	14.000	1590.4	2537.6	0.0	4128.1	2948.6	1700.9	2 0.0 (C) 0.0 (C)
14.100	14.100	1590.4	2577.5	0.0	4167.9	2977.1	1718.7	2 0.0 (C) 0.0 (C)
14.200	14.200	1590.4	2617.4	0.0	4207.8	3005.6	1736.5	2 0.0 (C) 0.0 (C)
14.300	14.300	1590.4	2657.2	0.0	4247.7	3034.0	1754.3	2 0.0 (C) 0.0 (C)
14.400	14.400	1590.4	2697.1	0.0	4287.5	3062.5	1772.1	2 0.0 (C) 0.0 (C)
14.500	14.500	1590.4	2737.0	0.0	4327.4	3091.0	1789.9	2 0.0 (C) 0.0 (C)
14.600	14.600	1590.4	2776.8	0.0	4367.3	3119.5	1807.7	2 0.0 (C) 0.0 (C)
14.700	14.700	1590.4	2816.7	0.0	4407.1	3147.9	1825.5	2 0.0 (C) 0.0 (C)
14.800	14.800	1590.4	2856.6	0.0	4447.0	3176.4	1843.3	2 0.0 (C) 0.0 (C)
14.900	14.900	1590.4	2896.4	0.0	4486.9	3204.9	1861.1	2 0.0 (C) 0.0 (C)
15.000	15.000	1590.4	2936.3	0.0	4526.7	3233.4	1878.9	2 0.0 (C) 0.0 (C)
15.100	15.100	1590.4	2976.2	0.0	4566.6	3261.8	1896.7	2 0.0 (C) 0.0 (C)
15.200	15.200	1590.4	3016.0	0.0	4606.5	3290.3	1914.4	2 0.0 (C) 0.0 (C)
15.300	15.300	1590.4	3055.9	0.0	4646.3	3318.8	1932.2	2 0.0 (C) 0.0 (C)
15.400	15.400	1590.4	3095.8	0.0	4686.2	3347.3	1950.0	2 0.0 (C) 0.0 (C)
15.500	15.500	1590.4	3135.6	0.0	4726.1	3375.8	1967.8	2 0.0 (C) 0.0 (C)
15.600	15.600	1590.4	3175.5	0.0	4765.9	3404.2	1985.6	2 0.0 (C) 0.0 (C)
15.700	15.700	1590.4	3215.4	0.0	4805.8	3432.7	2003.4	2 0.0 (C) 0.0 (C)
15.800	15.800	1590.4	3255.2	0.0	4845.7	3461.2	2021.2	2 0.0 (C) 0.0 (C)
15.900	15.900	1590.4	3295.1	0.0	4885.5	3489.7	2039.0	2 0.0 (C) 0.0 (C)
16.000	16.000	1590.4	3335.0	0.0	4925.4	3518.1	2056.8	2 0.0 (C) 0.0 (C)
16.100	16.100	1590.4	3374.8	0.0	4965.3	3546.6	2074.6	2 0.0 (C) 0.0 (C)
16.200	16.200	1590.4	3414.7	0.0	5005.1	3575.1	2092.4	2 0.0 (C) 0.0 (C)
16.300	16.300	1590.4	3454.6	0.0	5045.0	3603.6	2110.2	2 0.0 (C) 0.0 (C)
16.400	16.400	1590.4	3494.4	0.0	5084.9	3632.0	2128.0	2 0.0 (C) 0.0 (C)
16.500	16.500	1590.4	3534.3	0.0	5124.7	3660.5	2145.8	2 0.0 (C) 0.0 (C)
16.600	16.600	1590.4	3574.2	0.0	5164.6	3689.0	2163.6	2 0.0 (C) 0.0 (C)
16.700	16.700	1590.4	3614.0	0.0	5204.5	3717.5	2181.4	2 0.0 (C) 0.0 (C)
16.800	16.800	1590.4	3653.9	0.0	5244.3	3745.9	2199.2	2 0.0 (C) 0.0 (C)
16.900	16.900	1590.4	3693.8	0.0	5284.2	3774.4	2217.0	2 0.0 (C) 0.0 (C)

Job No.	Sheet No.	Rev.
46887A1		
Drg. Ref.		
Made by SD	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*
							#	
17.000	17.000	1590.4	3733.6	0.0	5324.1	3802.9	2234.8	2 0.0 (C) 0.0 (C)
17.100	17.100	1590.4	3773.5	0.0	5363.9	3831.4	2252.6	2 0.0 (C) 0.0 (C)
17.200	17.200	1590.4	3813.4	0.0	5403.8	3859.9	2270.4	2 0.0 (C) 0.0 (C)
17.300	17.300	1590.4	3853.2	0.0	5443.7	3888.3	2288.2	2 0.0 (C) 0.0 (C)
17.400	17.400	1590.4	3893.1	0.0	5483.5	3916.8	2306.0	2 0.0 (C) 0.0 (C)
17.500	17.500	1590.4	3933.0	0.0	5523.4	3945.3	2323.8	2 0.0 (C) 0.0 (C)
17.600	17.600	1590.4	3972.8	0.0	5563.3	3973.8	2341.6	2 0.0 (C) 0.0 (C)
17.700	17.700	1590.4	4012.7	0.0	5603.1	4002.2	2359.4	2 0.0 (C) 0.0 (C)
17.800	17.800	1590.4	4052.6	0.0	5643.0	4030.7	2377.2	2 0.0 (C) 0.0 (C)
17.900	17.900	1590.4	4092.4	0.0	5682.9	4059.2	2395.0	2 0.0 (C) 0.0 (C)
18.000	18.000	1590.4	4132.3	0.0	5722.7	4087.7	2412.8	2 0.0 (C) 0.0 (C)
18.100	18.100	1590.4	4172.2	0.0	5762.6	4116.1	2430.6	2 0.0 (C) 0.0 (C)
18.200	18.200	1590.4	4212.0	0.0	5802.5	4144.6	2448.4	2 0.0 (C) 0.0 (C)
18.300	18.300	1590.4	4251.9	0.0	5842.3	4173.1	2466.2	2 0.0 (C) 0.0 (C)
18.400	18.400	1590.4	4291.8	0.0	5882.2	4201.6	2484.0	2 0.0 (C) 0.0 (C)
18.500	18.500	1590.4	4331.6	0.0	5922.1	4230.0	2501.8	2 0.0 (C) 0.0 (C)
18.600	18.600	1590.4	4371.5	0.0	5961.9	4258.5	2519.6	2 0.0 (C) 0.0 (C)
18.700	18.700	1590.4	4411.4	0.0	6001.8	4287.0	2537.4	2 0.0 (C) 0.0 (C)
18.800	18.800	1590.4	4451.2	0.0	6041.7	4315.5	2555.2	2 0.0 (C) 0.0 (C)
18.900	18.900	1590.4	4491.1	0.0	6081.5	4343.9	2573.0	2 0.0 (C) 0.0 (C)
19.000	19.000	1590.4	4531.0	0.0	6121.4	4372.4	2590.8	2 0.0 (C) 0.0 (C)
19.100	19.100	1590.4	4570.8	0.0	6161.3	4400.9	2608.6	2 0.0 (C) 0.0 (C)
19.200	19.200	1590.4	4610.7	0.0	6201.1	4429.4	2626.4	2 0.0 (C) 0.0 (C)
19.300	19.300	1590.4	4650.6	0.0	6241.0	4457.9	2644.2	2 0.0 (C) 0.0 (C)
19.400	19.400	1590.4	4690.4	0.0	6280.9	4486.3	2662.0	2 0.0 (C) 0.0 (C)
19.500	19.500	1590.4	4730.3	0.0	6320.7	4514.8	2679.8	2 0.0 (C) 0.0 (C)
19.600	19.600	1590.4	4770.2	0.0	6360.6	4543.3	2697.5	2 0.0 (C) 0.0 (C)
19.700	19.700	1590.4	4810.0	0.0	6400.5	4571.8	2715.3	2 0.0 (C) 0.0 (C)
19.800	19.800	1590.4	4849.9	0.0	6440.3	4600.2	2733.1	2 0.0 (C) 0.0 (C)
19.900	19.900	1590.4	4889.8	0.0	6480.2	4628.7	2750.9	2 0.0 (C) 0.0 (C)
20.000	20.000	1590.4	4929.6	0.0	6520.1	4657.2	2768.7	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	Net ultimate resistance	Design resistance	Combination with least resistance	Factored load*
					#	
		(Q _s)	DA1-C1	DA1-C2		
[m]	[m]	[kN]	[kN]	[kN]		
6.0000	6.0000	311.02	311.02	222.16	111.08	2 N.A. N.A.
6.1000	6.1000	318.79	318.79	227.71	113.85	2 N.A. N.A.
6.2000	6.2000	326.57	326.57	233.26	116.63	2 N.A. N.A.
6.3000	6.3000	334.34	334.34	238.82	119.41	2 N.A. N.A.
6.4000	6.4000	342.12	342.12	244.37	122.19	2 N.A. N.A.
6.5000	6.5000	349.89	349.89	249.92	124.96	2 N.A. N.A.
6.6000	6.6000	357.67	357.67	255.48	127.74	2 N.A. N.A.
6.7000	6.7000	365.45	365.45	261.03	130.52	2 N.A. N.A.
6.8000	6.8000	373.22	373.22	266.59	133.29	2 N.A. N.A.
6.9000	6.9000	381.00	381.00	272.14	136.07	2 N.A. N.A.
7.0000	7.0000	388.77	388.77	277.69	138.85	2 N.A. N.A.
7.1000	7.1000	396.55	396.55	283.25	141.62	2 N.A. N.A.
7.2000	7.2000	404.32	404.32	288.80	144.40	2 N.A. N.A.
7.3000	7.3000	412.10	412.10	294.36	147.18	2 N.A. N.A.
7.4000	7.4000	419.87	419.87	299.91	149.95	2 N.A. N.A.
7.5000	7.5000	427.65	427.65	305.46	152.73	2 N.A. N.A.



CENTRAL PILING LIMITED

Plymouth Grove, Manchester

Bearing piles

Capacity check

Job No.	Sheet No.	Rev.
46887A1		
Drg. Ref.		
Made by SD	Date	Checked

Depth	Pile length	Cumulative external Friction	Net ultimate resistance	Design resistance	Combination resistance	Factored load* with least resistance	#
7.6000	7.6000	435.42	435.42	311.02	155.51	2 N.A. N.A.	2
7.7000	7.7000	443.20	443.20	316.57	158.29	2 N.A. N.A.	2
7.8000	7.8000	450.98	450.98	322.13	161.06	2 N.A. N.A.	2
7.9000	7.9000	458.75	458.75	327.68	163.84	2 N.A. N.A.	2
8.0000	8.0000	466.53	466.53	333.23	166.62	2 N.A. N.A.	2
8.1000	8.1000	474.30	474.30	338.79	169.39	2 N.A. N.A.	2
8.2000	8.2000	482.08	482.08	344.34	172.17	2 N.A. N.A.	2
8.3000	8.3000	489.85	489.85	349.89	174.95	2 N.A. N.A.	2
8.4000	8.4000	497.63	497.63	355.45	177.72	2 N.A. N.A.	2
8.5000	8.5000	505.40	505.40	361.00	180.50	2 N.A. N.A.	2
8.6000	8.6000	513.18	513.18	366.56	183.28	2 N.A. N.A.	2
8.7000	8.7000	520.95	520.95	372.11	186.06	2 N.A. N.A.	2
8.8000	8.8000	528.73	528.73	377.66	188.83	2 N.A. N.A.	2
8.9000	8.9000	536.51	536.51	383.22	191.61	2 N.A. N.A.	2
9.0000	9.0000	544.28	544.28	388.77	194.39	2 N.A. N.A.	2
9.0000	9.0000	544.28	544.28	388.77	194.39	2 N.A. N.A.	2
9.1000	9.1000	584.15	584.15	417.25	208.62	2 N.A. N.A.	2
9.2000	9.2000	624.01	624.01	445.72	222.86	2 N.A. N.A.	2
9.3000	9.3000	663.88	663.88	474.20	237.10	2 N.A. N.A.	2
9.4000	9.4000	703.75	703.75	502.68	251.34	2 N.A. N.A.	2
9.5000	9.5000	743.61	743.61	531.15	265.58	2 N.A. N.A.	2
9.6000	9.6000	783.48	783.48	559.63	279.81	2 N.A. N.A.	2
9.7000	9.7000	823.35	823.35	588.11	294.05	2 N.A. N.A.	2
9.8000	9.8000	863.22	863.22	616.58	308.29	2 N.A. N.A.	2
9.9000	9.9000	903.08	903.08	645.06	322.53	2 N.A. N.A.	2
10.000	10.000	942.95	942.95	673.53	336.77	2 N.A. N.A.	2
10.100	10.100	982.82	982.82	702.01	351.01	2 N.A. N.A.	2
10.200	10.200	1022.7	1022.7	730.49	365.24	2 N.A. N.A.	2
10.300	10.300	1062.5	1062.5	758.96	379.48	2 N.A. N.A.	2
10.400	10.400	1102.4	1102.4	787.44	393.72	2 N.A. N.A.	2
10.500	10.500	1142.3	1142.3	815.92	407.96	2 N.A. N.A.	2
10.600	10.600	1182.2	1182.2	844.39	422.20	2 N.A. N.A.	2
10.700	10.700	1222.0	1222.0	872.87	436.43	2 N.A. N.A.	2
10.800	10.800	1261.9	1261.9	901.35	450.67	2 N.A. N.A.	2
10.900	10.900	1301.8	1301.8	929.82	464.91	2 N.A. N.A.	2
11.000	11.000	1341.6	1341.6	958.30	479.15	2 N.A. N.A.	2
11.100	11.100	1381.5	1381.5	986.77	493.39	2 N.A. N.A.	2
11.200	11.200	1421.4	1421.4	1015.3	507.63	2 N.A. N.A.	2
11.300	11.300	1461.2	1461.2	1043.7	521.86	2 N.A. N.A.	2
11.400	11.400	1501.1	1501.1	1072.2	536.10	2 N.A. N.A.	2
11.500	11.500	1541.0	1541.0	1100.7	550.34	2 N.A. N.A.	2
11.600	11.600	1580.8	1580.8	1129.2	564.58	2 N.A. N.A.	2
11.700	11.700	1620.7	1620.7	1157.6	578.82	2 N.A. N.A.	2
11.800	11.800	1660.6	1660.6	1186.1	593.05	2 N.A. N.A.	2
11.900	11.900	1700.4	1700.4	1214.6	607.29	2 N.A. N.A.	2
12.000	12.000	1740.3	1740.3	1243.1	621.53	2 N.A. N.A.	2
12.100	12.100	1780.2	1780.2	1271.5	635.77	2 N.A. N.A.	2
12.200	12.200	1820.0	1820.0	1300.0	650.01	2 N.A. N.A.	2
12.300	12.300	1859.9	1859.9	1328.5	664.24	2 N.A. N.A.	2
12.400	12.400	1899.8	1899.8	1357.0	678.48	2 N.A. N.A.	2
12.500	12.500	1939.6	1939.6	1385.4	692.72	2 N.A. N.A.	2
12.600	12.600	1979.5	1979.5	1413.9	706.96	2 N.A. N.A.	2
12.700	12.700	2019.4	2019.4	1442.4	721.20	2 N.A. N.A.	2
12.800	12.800	2059.2	2059.2	1470.9	735.44	2 N.A. N.A.	2
12.900	12.900	2099.1	2099.1	1499.3	749.67	2 N.A. N.A.	2
13.000	13.000	2139.0	2139.0	1527.8	763.91	2 N.A. N.A.	2
13.100	13.100	2178.8	2178.8	1556.3	778.15	2 N.A. N.A.	2
13.200	13.200	2218.7	2218.7	1584.8	792.39	2 N.A. N.A.	2
13.300	13.300	2258.6	2258.6	1613.3	806.63	2 N.A. N.A.	2
13.400	13.400	2298.4	2298.4	1641.7	820.86	2 N.A. N.A.	2
13.500	13.500	2338.3	2338.3	1670.2	835.10	2 N.A. N.A.	2
13.600	13.600	2378.2	2378.2	1698.7	849.34	2 N.A. N.A.	2
13.700	13.700	2418.0	2418.0	1727.2	863.58	2 N.A. N.A.	2
13.800	13.800	2457.9	2457.9	1755.6	877.82	2 N.A. N.A.	2
13.900	13.900	2497.8	2497.8	1784.1	892.06	2 N.A. N.A.	2
14.000	14.000	2537.6	2537.6	1812.6	906.29	2 N.A. N.A.	2
14.100	14.100	2577.5	2577.5	1841.1	920.53	2 N.A. N.A.	2
14.200	14.200	2617.4	2617.4	1869.5	934.77	2 N.A. N.A.	2
14.300	14.300	2657.2	2657.2	1898.0	949.01	2 N.A. N.A.	2
14.400	14.400	2697.1	2697.1	1926.5	963.25	2 N.A. N.A.	2
14.500	14.500	2737.0	2737.0	1955.0	977.48	2 N.A. N.A.	2
14.600	14.600	2776.8	2776.8	1983.4	991.72	2 N.A. N.A.	2
14.700	14.700	2816.7	2816.7	2011.9	1006.0	2 N.A. N.A.	2
14.800	14.800	2856.6	2856.6	2040.4	1020.2	2 N.A. N.A.	2
14.900	14.900	2896.4	2896.4	2068.9	1034.4	2 N.A. N.A.	2
15.000	15.000	2936.3	2936.3	2097.3	1048.7	2 N.A. N.A.	2
15.100	15.100	2976.2	2976.2	2125.8	1062.9	2 N.A. N.A.	2



CENTRAL PILING LIMITED

Plymouth Grove, Manchester

Bearing piles

Capacity check

Job No.	Sheet No.	Rev.
46887A1		
Drg. Ref.		
Made by SD	Date	Checked

Depth	Pile length	Cumulative external Friction	Net ultimate resistance	Design resistance	Combination resistance	Factored load* with least resistance	#
15.200	15.200	3016.0	3016.0	2154.3	1077.2	2 N.A. N.A.	2
15.300	15.300	3055.9	3055.9	2182.8	1091.4	2 N.A. N.A.	2
15.400	15.400	3095.8	3095.8	2211.3	1105.6	2 N.A. N.A.	2
15.500	15.500	3135.6	3135.6	2239.7	1119.9	2 N.A. N.A.	2
15.600	15.600	3175.5	3175.5	2268.2	1134.1	2 N.A. N.A.	2
15.700	15.700	3215.4	3215.4	2296.7	1148.3	2 N.A. N.A.	2
15.800	15.800	3255.2	3255.2	2325.2	1162.6	2 N.A. N.A.	2
15.900	15.900	3295.1	3295.1	2353.6	1176.8	2 N.A. N.A.	2
16.000	16.000	3335.0	3335.0	2382.1	1191.1	2 N.A. N.A.	2
16.100	16.100	3374.8	3374.8	2410.6	1205.3	2 N.A. N.A.	2
16.200	16.200	3414.7	3414.7	2439.1	1219.5	2 N.A. N.A.	2
16.300	16.300	3454.6	3454.6	2467.5	1233.8	2 N.A. N.A.	2
16.400	16.400	3494.4	3494.4	2496.0	1248.0	2 N.A. N.A.	2
16.500	16.500	3534.3	3534.3	2524.5	1262.2	2 N.A. N.A.	2
16.600	16.600	3574.2	3574.2	2553.0	1276.5	2 N.A. N.A.	2
16.700	16.700	3614.0	3614.0	2581.4	1290.7	2 N.A. N.A.	2
16.800	16.800	3653.9	3653.9	2609.9	1305.0	2 N.A. N.A.	2
16.900	16.900	3693.8	3693.8	2638.4	1319.2	2 N.A. N.A.	2
17.000	17.000	3733.6	3733.6	2666.9	1333.4	2 N.A. N.A.	2
17.100	17.100	3773.5	3773.5	2695.4	1347.7	2 N.A. N.A.	2
17.200	17.200	3813.4	3813.4	2723.8	1361.9	2 N.A. N.A.	2
17.300	17.300	3853.2	3853.2	2752.3	1376.2	2 N.A. N.A.	2
17.400	17.400	3893.1	3893.1	2780.8	1390.4	2 N.A. N.A.	2
17.500	17.500	3933.0	3933.0	2809.3	1404.6	2 N.A. N.A.	2
17.600	17.600	3972.8	3972.8	2837.7	1418.9	2 N.A. N.A.	2
17.700	17.700	4012.7	4012.7	2866.2	1433.1	2 N.A. N.A.	2
17.800	17.800	4052.6	4052.6	2894.7	1447.3	2 N.A. N.A.	2
17.900	17.900	4092.4	4092.4	2923.2	1461.6	2 N.A. N.A.	2
18.000	18.000	4132.3	4132.3	2951.6	1475.8	2 N.A. N.A.	2
18.100	18.100	4172.2	4172.2	2980.1	1490.1	2 N.A. N.A.	2
18.200	18.200	4212.0	4212.0	3008.6	1504.3	2 N.A. N.A.	2
18.300	18.300	4251.9	4251.9	3037.1	1518.5	2 N.A. N.A.	2
18.400	18.400	4291.8	4291.8	3065.5	1532.8	2 N.A. N.A.	2
18.500	18.500	4331.6	4331.6	3094.0	1547.0	2 N.A. N.A.	2
18.600	18.600	4371.5	4371.5	3122.5	1561.2	2 N.A. N.A.	2
18.700	18.700	4411.4	4411.4	3151.0	1575.5	2 N.A. N.A.	2
18.800	18.800	4451.2	4451.2	3179.4	1589.7	2 N.A. N.A.	2
18.900	18.900	4491.1	4491.1	3207.9	1604.0	2 N.A. N.A.	2
19.000	19.000	4531.0	4531.0	3236.4	1618.2	2 N.A. N.A.	2
19.100	19.100	4570.8	4570.8	3264.9	1632.4	2 N.A. N.A.	2
19.200	19.200	4610.7	4610.7	3293.4	1646.7	2 N.A. N.A.	2
19.300	19.300	4650.6	4650.6	3321.8	1660.9	2 N.A. N.A.	2
19.400	19.400	4690.4	4690.4	3350.3	1675.2	2 N.A. N.A.	2
19.500	19.500	4730.3	4730.3	3378.8	1689.4	2 N.A. N.A.	2
19.600	19.600	4770.2	4770.2	3407.3	1703.6	2 N.A. N.A.	2
19.700	19.700	4810.0	4810.0	3435.7	1717.9	2 N.A. N.A.	2
19.800	19.800	4849.9	4849.9	3464.2	1732.1	2 N.A. N.A.	2
19.900	19.900	4889.8	4889.8	3492.7	1746.3	2 N.A. N.A.	2
20.000	20.000	4929.6	4929.6	3521.2	1760.6	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.

Appendix 3

Settlement Calculations

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Drg. Ref.		
Made by SD	Date	Checked

Notes

L = 12.5m
SWL = 1350kN

Analysis Options

Datum type	Depth based
Effective stress profile	Calculated
Depth of rigid boundary	15.000 m
Poisson's ratio of soil	0.25000
Young's modulus of soil above toe level of pile	44000. kPa
Young's modulus of soil below toe level of pile	300000. kPa
Number of pile elements	10
Increment type:	Both loads and displacements
Number of load & displacement increments	1
Increment results would be printed once every	1 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	12.500 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	0.45000				

Undrained Materials - General Data

No.	Material description	Bulk unit weight [kN/m³]	Cu material factor	Top Cu [kPa]	Base Cu [kPa]
1	Glacial Till	20.000	NA	110.00	110.00

Undrained Materials - Skin Friction Data

No.	Material description	Skin friction computation	Alpha	qs Top [kPa]	qs Base [kPa]	Spec.	qs,lim Value [kPa]
1	Glacial Till	Alpha specified	0.50000	NA	NA	Yes	100.00

Undrained Materials - End Bearing Data

No.	Material description	End bearing computation	Nc	qb Top [kPa]	qb Base [kPa]	Spec.	qb,lim Value [kPa]
1	Glacial Till	Nc specified	9.0000	NA	NA	Yes	2500.0

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	Glacial Till	N.A.	N.A.	1.0000	1.0000	N.A.	N.A.

Drained Materials - General Data

Plymouth Grove, Manchester
Bearing piles
Settlement check

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

No.	Material description	Bulk unit weight [kN/m³]	Tan(δ) material factor
1	Made Ground	18.000	NA
2	Chester Formation	20.000	NA

Drained Materials - Friction Data

No.	Material description	Skin friction computation	Beta	Delta (δ) [deg]	Coefficient of earth pressure K	Qs Top [kPa]	Qs Base [kPa]	Qs, lim Spec. Value [kPa]
1	Made Ground	qs specified	NA	NA	NA	0.0	0.0	No NA
2	Chester Formation	qs specified	NA	NA	NA	282.00	282.00	No NA

Drained Materials - End Bearing Data

No.	Material description	End bearing computation	Nq	Phi'	PhiD	Phicv'	Ir	Qb	Qb, lim	Nq-Phi curves	
				[deg]	[deg]	[deg]		Top [kPa]	Base [kPa]	Spec. Value [kPa]	
1	Made Ground	qb specified	NA	NA	NA	NA	NA	0.0	0.0	No	NA NA
2	Chester Formation	qb specified	NA	NA	NA	NA	NA	10000.	10000.	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
2	Chester Formation	1.0000 1.0000	N.A. N.A.	1.0000 1.0000

STAGE SPECIFIC DATA

Stage 0 : Initial Stage

Groundwater

No.	Level [m]	Pressure [kPa]	Unit weight of water [kN/m³]
1	7.0000	0.0	10.000

Soil Profiles

Soil Profile 1: Soil Profile 1

No.	Depth [m]	Material description	Contributes to negative skin friction
1	0.0	Made Ground	No
2	2.0000	Glacial Till	No
3	9.0000	Chester Formation	No

Soil Profile - Groundwater Map

No.	Soil Profile	Groundwater
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No. Soil Profile Groundwater

1 Soil Profile 1 Groundwater Profile 1

Static Loads & Displacements

Depth	Applied load	Prescribed soil displacement	Load factor	
[m]	[kN]	[mm]	A1	A2
0.0	1350.0	0.0	1.0000	1.0000

Calculated Limiting shaft skin friction

Soil Profile 1: Soil Profile 1

Cross Section 1

Depth	Limiting shaft skin friction
[m]	[kPa]
0.0	0.0
2.0000	0.0
2.0000	55.000
9.0000	55.000
9.0000	282.00
12.500	282.00

SETTLEMENT RESULTS

Soil Profile 1: Soil Profile 1

Results for Length 12.500 [m] Cross-section 1 Load & Displacement increment 1

Load applied to pile = 1350.0 kN
Converged at iteration number = 19
Maximum displacement = 5.5086 mm at node 1
Displacement error = 0.0058537 mm
Skin friction error = 0.67405 kPa

Stresses and Displacements along Pile

Depth	Shaft skin friction	Pile stress	Pile displacement
[m]	[kPa]	[kPa]	[mm]
-0.62500	0.0	8488.3	5.5086
-1.8750	0.0	8488.3	4.9783
-3.1250	55.000	8182.7	4.4486
-4.3750	55.000	7571.6	3.9575
-5.6250	55.000	6960.5	3.5050
-6.8750	55.000	6349.4	3.0912
-8.1250	55.000	5738.3	2.7158
-9.3750	61.971	5088.4	2.3788
-10.625	51.294	4459.2	2.0849
-11.875	64.228	3817.4	1.8266

Base pressure = 3448.2 kPa Base displacement = 1.7136 mm

Appendix 4

Reinforcement Calculations

Input Parameters

Head fixity	Free
Soil type	Cohesive
Effective density (kN/m ³)	8
Angle of friction (φ°)	0
Cohesion (C _u) (kPa)	20
Coefficient of earth pressure, K _p	1.00
Pile diameter, d (m)	0.45
Horizontal load, H (kN)	15 (Service Horizontal Load)
Factor of safety for bending	1.5
Ultimate horizontal load, H _u (kN)	22.5 (Ultimate Horizontal Load)

Calculation Method

F (m) =	$H / (9 * C_u * B)$	(Point of Zero Shear)
M _u (kNm) =	$H_u * ((1.5 * B) + (0.5 * F))$	(Maximum Ultimate Moment)

Output

Point of zero shear, F (m)	0.28
Maximum ultimate moment, M _u (kN-m)	18

Concrete Parameters

Compression load, P (kN)	0
Concrete strength, F _{ck} (N/mm ²)	28

Reinforcement Design

M _u / (B ³ * F _{ck})	0.007
N / (B ² * F _{ck})	0.000
(A _s * F _{yk}) / (A _c * F _{ck})	0.028 (Minimum 0.02) (Steel strength F _{yk} = 500 N/mm ²)
A _c (mm ²)	159043
A _s required (mm ²)	246

Steel Requirements

No. bars	6
Steel grade	B
Bar diameter (mm)	16
Depth of cage (m)	8
A _{sc} allowed (mm ²)	1206

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/mm²)

Reinforcement Properties

Number of bars

Main bar diameter (mm)

Steel strength, F_y (N/mm²) (Main bar and helical reinforcement)

Helical bar diameter (mm)

Area Outputs

A_c (mm²) Main bar A_s (mm²)

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 (mm²)

$100A_s / b \cdot d$

Value of Design Concrete Shear Stress

V_c (N/mm²) (Table 4.17)

Shear resistance, V_{rd} (kN)

Design of Links

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

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

Shear Requirements

Steel grade
 Bar diameter (mm)
 Pitch (mm)
 A_{sv} / sv allowed (mm²/mm)
 (From table 4.20)

Notes:

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

$0.75 \cdot z$

Input Parameters

Head fixity	Free
Soil type	Cohesive
Effective density (kN/m ³)	8
Angle of friction (φ°)	0
Cohesion (C _u) (kPa)	20
Coefficient of earth pressure, K _p	1.00
Pile diameter, d (m)	0.45
Horizontal load, H (kN)	50 (Service Horizontal Load)
Factor of safety for bending	1.5
Ultimate horizontal load, H _u (kN)	75 (Ultimate Horizontal Load)

Calculation Method

F (m) =	$H / (9 * C_u * B)$	(Point of Zero Shear)
M _u (kNm) =	$H_u * ((1.5 * B) + (0.5 * F))$	(Maximum Ultimate Moment)

Output

Point of zero shear, F (m)	0.93
Maximum ultimate moment, M _u (kN-m)	85

Concrete Parameters

Compression load, P (kN)	0
Concrete strength, F _{ck} (N/mm ²)	28

Reinforcement Design

M _u / (B ³ * F _{ck})	0.033
N / (B ² * F _{ck})	0.000
(A _s * F _{yk}) / (A _c * F _{ck})	0.137 (Minimum 0.02) (Steel strength F _{yk} = 500 N/mm ²)
A _c (mm ²)	159043
A _s required (mm ²)	1222

Steel Requirements

No. bars	6
Steel grade	B
Bar diameter (mm)	20
Depth of cage (m)	8
A _{sc} allowed (mm ²)	1885

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/mm²)

Reinforcement Properties

Number of bars

Main bar diameter (mm)

Steel strength, F_y (N/mm²) (Main bar and helical reinforcement)

Helical bar diameter (mm)

Area Outputs

A_c (mm²) Main bar A_s (mm²)

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 (mm²)

$100A_s / b \cdot d$

Value of Design Concrete Shear Stress

V_c (N/mm²) (Table 4.17)

Shear resistance, V_{rd} (kN)

Design of Links

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

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

Shear Requirements

Steel grade
 Bar diameter (mm)
 Pitch (mm)
 A_{sv} / s_v allowed (mm²/mm)
 (From table 4.20)

Notes:

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

$0.75 \cdot z$

Input Parameters

Pile diameter, B (m)	0.45
	DA1-C1 DA1-C2
Factor of safety for steel area (dead load)	1.35 1.00
Factor of safety for steel area (live load)	1.50 1.30
Factor of safety for shaft resistance	2.0
Model factor	1.4
Cage steel yield strength (N/mm ²)	500
Central bar steel yield strength (N/mm ²)	
Material partial safety factor, γ_m	1.15
Tension force - DA1-C2 (kN)	115
Tension force - DA1-C1 (kN)	175

Total reinforcement requirements

A_{sc} required (mm ²)	403
USC required (kN)	322
Depth where USC exceeds (m)	8.0
USC at depth (kN)	466

Cage design

Depth of cage (m)	8.0
USC at cage toe (kN)	466
Tension serviceable by cage (kN)	166

Central bar design

Residual tension to be taken by the central bar (kN)	
A_{sc} required for central bar (mm ²)	

Steel Requirements	Central bar		Notes:
	Cage	bar	
No. bars	6	0	
Steel grade	B	0	
Bar diameter (mm)	20	0	
Depth of steel (m)	8	0	
A_{sc} allowed (mm ²)	1885	0	
USC at depth (kN)	466	466	Tension check (due to wind loads)

Input Parameters

Pile diameter, B (m)	0.45
	DA1-C1 DA1-C2
Factor of safety for steel area (dead load)	1.35 1.00
Factor of safety for steel area (live load)	1.50 1.30
Factor of safety for shaft resistance	2.0
Model factor	1.4
Cage steel yield strength (N/mm ²)	500
Central bar steel yield strength (N/mm ²)	
Material partial safety factor, γ_m	1.15
Tension force - DA1-C2 (kN)	175
Tension force - DA1-C1 (kN)	240

Total reinforcement requirements

A_{sc} required (mm ²)	552
USC required (kN)	490
Depth where USC exceeds (m)	9.0
USC at depth (kN)	544

Cage design

Depth of cage (m)	9.0
USC at cage toe (kN)	544
Tension serviceable by cage (kN)	194

Central bar design

Residual tension to be taken by the central bar (kN)	
A_{sc} required for central bar (mm ²)	

Steel Requirements	Central bar		Notes:
	Cage	bar	
No. bars	6	0	Tension check (due to wind loads) 175kN DA1-C2
Steel grade	B	0	
Bar diameter (mm)	25	0	
Depth of steel (m)	9	0	
A_{sc} allowed (mm ²)	2945	0	
USC at depth (kN)	544	544	

Input Parameters

Cohesion (C_u) (kPa)	110
Soil softening factor (α)	0.5
Pile diameter, B (m)	0.45
Ignored depth, h (m)	0.5
Depth of dessication, D (m)	3

Calculation Method

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

Output

Heave force, H_f (kN)	194
-------------------------	-----

Reinforcement Design

Factor of safety on Heave force	2.0
Steel yield strength (N/mm ²)	500
Material partial safety factor, γ_m	1.15
A_{sc} required (mm ²)	894
USC required (kN)	389
Depth where USC exceeds (m)	8.00
USC at depth (kN)	466

Steel Requirements

No. bars	6
Steel grade	B
Bar diameter (mm)	16
Depth of cage (m)	8
A_{sc} allowed (mm ²)	1206
USC at depth (kN)	466

Notes:

Heave check



CENTRAL PILING
LIMITED

Plymouth Grove
450mm diameter pile
Section capacity check

Job No.	Sheet No.	Rev.
46887A1		
Drg. Ref.		
Made by SD	Date 20-Sep-2024	Checked

Title & Specification

Job number	46887A1
Job title	Plymouth Grove
Subtitle	450mm diameter pile
Calc. heading	Section capacity check
File	S:\V6. Contracts\46876-46900\46887\Technical\Design\02 Load bearing\01 Preliminary issue - 07.11.2025\AD01_46887A1_450mm_6B16.ads
Notes	6B16 cage
Code of Practice	BS EN 1992-2:2005 [United Kingdom]
Bending Axes	Biaxial
Number of sections	1
Number of ULS cases	1
Number of SLS cases	1

Analysis Task

Section	1 : 450mm - 6B16
Analysis type	ULS strength
Analysis case(s)	1 : ULS Case 1
Number of iterations	2400
Limit iteration step	Yes
Perturbation factor	0%

Section : Definition

1 : 450mm - 6B16

Name	450mm - 6B16
Type	Concrete
Material	C28/35
Origin	Centre
Dimensions	
Diameter	450.0mm
Section Area	159000.mm ²
Reinforcement Area	1206.mm ²
Reinforcement	0.7585%

Section : Nodes

1 : 450mm - 6B16

Node	Y [mm]	Z [mm]
1	0.0	226.3
2	58.57	218.6
3	113.1	196.0
4	160.0	160.0
5	196.0	113.1
6	218.6	58.57
7	226.3	-9.892E-6
8	218.6	-58.57
9	196.0	-113.1
10	160.0	-160.0
11	113.1	-196.0
12	58.57	-218.6
13	-19.78E-6	-226.3
14	-58.57	-218.6
15	-113.1	-196.0
16	-160.0	-160.0
17	-196.0	-113.1
18	-218.6	-58.57
19	-226.3	2.699E-6
20	-218.6	58.57
21	-196.0	113.1
22	-160.0	160.0
23	-113.1	196.0
24	-58.57	218.6

Section : Cover & Links

1 : 450mm - 6B16

Cover	75.00mm
Link Size	10.00mm
Link Material	500B

Section : Bars

1 : 450mm - 6B16

Bar	Y	Z	Diameter	Area	Effective Area	Type	Material	Prestress Force	Prestress Strain	Appl. loads include/exclude prestress
	[mm]	[mm]	[mm]	[mm ²]	[mm ²]			[kN]		
1	132.0	0.0	16.00	201.1	201.1	Steel	500B			
2	66.00	114.3	16.00	201.1	201.1	Steel	500B			
3	-66.00	114.3	16.00	201.1	201.1	Steel	500B			
4	-132.0	-915.4E-9	16.00	201.1	201.1	Steel	500B			
5	-66.00	-114.3	16.00	201.1	201.1	Steel	500B			
6	66.00	-114.3	16.00	201.1	201.1	Steel	500B			

Section : Elastic Properties

1 : 450mm - 6B16

Effective properties of the section, ignoring reinforcement.

Geometric Centroid	y	0.0mm
	z	0.0mm
Area		159000.mm ²
Second Moments of Area	I _{yy}	2.013E+9mm ⁴
	I _{zz}	2.013E+9mm ⁴
	I _{yz}	0.0mm ⁴
Principal Second Moments of Area	I _{uu}	2.013E+9mm ⁴
	I _{zz}	2.013E+9mm ⁴
Shear Area Factor	Angle	0.0°
	k _y	0.8571
	k _z	0.8571
Torsion Constant		4.026E+9mm ⁴
Section Modulus	Z _y	8.946E+6mm ³



CENTRAL PILING
LIMITED

Plymouth Grove
450mm diameter pile
Section capacity check

Job No.	Sheet No.	Rev.
46887A1		
Drg. Ref.		
Made by SD	Date 20-Sep-2024	Checked

Bar	Y	Z	Diameter	Area	Effective Area	Type	Material	Prestress Force	Prestress Strain	Appl. loads include/exclude prestress
	[mm]	[mm]	[mm]	[mm ²]	[mm ²]			[kN]		
			Z _z		8.946E+6mm ³					
Plastic Modulus			Z _{py}		15.19E+6mm ³					
			Z _{pz}		15.19E+6mm ³					
Radius of Gyration			R _y		112.5mm					
			R _z		112.5mm					

Properties of gross section, including reinforcement.

Geometric Centroid	y	-88.03E-9mm
	z	0.0mm
EA		5.341E+6kN
EI	EI _{yy}	66800.kNm ²
	EI _{zz}	66800.kNm ²
	EI _{yz}	0.0kNm ²
Principal EI	EI _{uu}	66800.kNm ²
	EI _{zz}	66800.kNm ²
	Angle	0.0°

Material : Concrete

1 : C28/35

Name	C28/35
Cylinder	f _{ck} 28.00N/mm ²
Strength	
Tensile	f _{ctm} 2.766N/mm ²
Strength	
Weight	Normal Weight
Density	ρ 2.400t/m ³
Elastic	E 32310.N/mm ²
Modulus	
Poisson's	ν 0.2000
Ratio	
Coeff. Thermal Expansion	α 10.00E-6/°C
Partial	γ _c 1.500
Safety	
Factor	
Maximum	0.003500
Strain	
Plateau	0.002000
Strain	
ULS	Parabola
Compression	rectangle
Curve	
ULS	No-tension
Tension	
Curve	
SLS	FIB Model
Compression	Code
Curve	
SLS	Interpolated
Tension	
Curve	
Design	α _{cc} 0.8500
strength	
factor	
Aggregate	0.0mm
Size	

Material : Rebar

1 : 500B

Type	Steel rebar
Strength	f _{yk} 500.0N/mm ²
Elastic Modulus	E 200000.N/mm ²
Hardening Modulus	E _h 0.0N/mm ²
Density	ρ 7.850t/m ³
Poisson's Ratio	ν 0.3000
Coeff. Thermal Expansion	α 12.00E-6/°C
Ductility	Normal Modified
Partial Safety Factor	γ _s 1.150
	γ _{se} 1.000
Maximum Strain	ε _{uk} 0.05000 Modified
Maximum Strain	ε _{ud} 0.04500 Modified
Stress/Strain Curve	Elastic-plastic

Section 1 Details

0.76% reinforcement in section 1 (450mm - 6B16). Check this against code requirements.

ULS Cases Analysed

Name	Section	Loading	Prestress Factor
ULS Case 1	1 : 450mm - 6B16	L1	1.000

Strength Analysis - Loads

Case	N	M _{yy}	M _{zz}	M	θ
	[kN]	[kNm]	[kNm]	[kNm]	[°]
1	0.0	0.0	0.0	0.0	0.0

Strength Analysis - Summary

Governing conditions are defined as:
A - reinforcing steel tension strain limit
B - concrete compression strain limit
C - concrete pure compression strain limit
Eurocode 2 Section 6.1
Effective centroid is reported relative to the reference point.



CENTRAL PILING
LIMITED

Plymouth Grove
450mm diameter pile
Section capacity check

Job No.	Sheet No.	Rev.
46887A1		
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Made by SD	Date 20-Sep-2024	Checked

Case	Eff. Centroid (y)	Eff. Centroid (z)	N [kN]	M [kNm]	M _u [kNm]	M/M _u	Governing Condition	Neutral Axis Angle [°]	Neutral Axis Depth [mm]
1	-88.03E-9	0.0	0.0	0.0	79.88	0.0	B: Node 1	0.0	110.8

Strength Analysis - Details

Case	Moment Angle [°]	Description	N [kN]	M [kNm]	Warning
	137.8	Max. compressive strain	2987.	6.127E-6	
	0.0	Max. tensile strain	-524.5	80.02E-9	
1	0.0	Axial strength at M	3028.	0.2299	
		Initial yield	0.003250	62.89	
		Balanced yield	797.1	141.2	
		Bending strength at N=0	0.0	79.88	

Strain Planes at ULS Strength

Related to Reference Point

Case	Strain Plane	ε _{ax} [-]	κ _{yy} [/m]	κ _{zz} [/m]
1	Reinforcement	-0.003647	0.03158	-3.183E-9
	User Creep/Shrinkage	0.0	0.0	0.0
	Total (Concrete)	-0.003647	0.03158	-3.183E-9

Section Material Stresses/Strains at ULS Strength

Case Point	Coordinates		Strain	Stress	Notes
	y [mm]	z [mm]	[-]	[N/mm²]	
1	1	0.0	0.003500	15.87	
1	2	58.57	0.003256	15.87	
1	3	113.1	0.002542	15.87	
1	4	160.0	0.001407	14.47	
1	5	196.0	-73.64E-6	0.0	
1	6	218.6	-0.001797	0.0	
1	7	226.3	-0.003647	0.0	
1	8	218.6	-0.005497	0.0	
1	9	196.0	-0.007221	0.0	
1	10	160.0	-0.008701	0.0	
1	11	113.1	-0.009837	0.0	
1	12	58.57	-0.01055	0.0	
1	13	-19.78E-6	-0.01079	0.0	
1	14	-58.57	-0.01055	0.0	
1	15	-113.1	-0.009837	0.0	
1	16	-160.0	-0.008701	0.0	
1	17	-196.0	-0.007221	0.0	
1	18	-218.6	-0.005497	0.0	
1	19	-226.3	-0.003647	0.0	
1	20	-218.6	-0.001797	0.0	
1	21	-196.0	-73.64E-6	0.0	
1	22	-160.0	0.001407	14.47	
1	23	-113.1	0.002542	15.87	
1	24	-58.57	0.003256	15.87	

Reinforcement Stresses/Strains at ULS Strength

Case Bar	Coordinates		Strain	Stress	Notes
	y [mm]	z [mm]	[-]	[N/mm²]	
1	1	132.0	-0.003647	-434.8	500B
1	2	66.00	-36.71E-6	-7.341	500B
1	3	-66.00	-36.71E-6	-7.341	500B
1	4	-132.0	-0.003647	-434.8	500B
1	5	-66.00	-0.007258	-434.8	500B
1	6	66.00	-0.007258	-434.8	500B

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Force/Moment Interaction

EC2-2 (GB) : 450mm - 6B16

Moment angle: 0.00

Force/Moment Interaction

□ No tension point

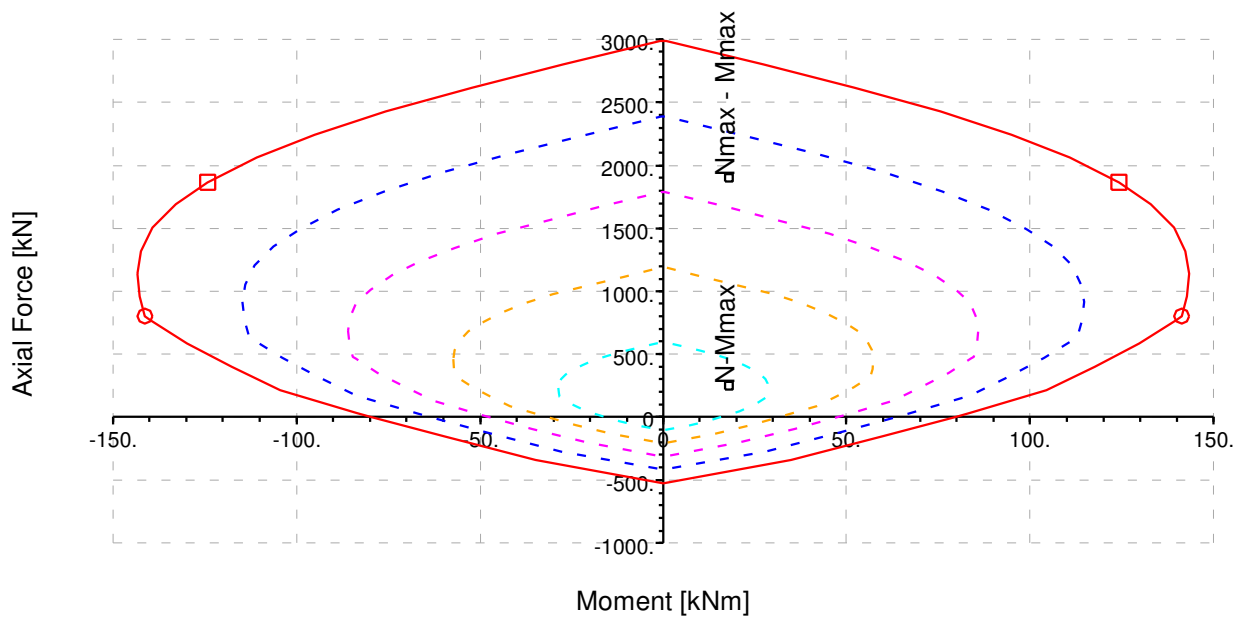
○ Balanced yield point

--- 80%

--- 60%

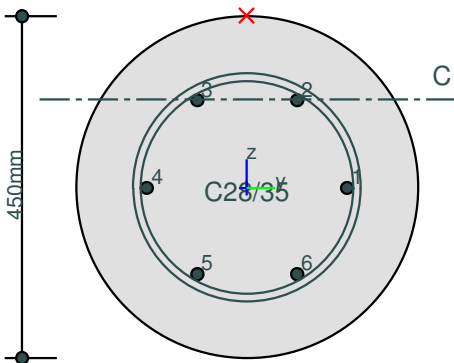
--- 40%

--- 20%



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- Key**
- 0.76% reinforcement
 - Analysis Case 1
 - + Reference Point
 - - Neutral Axis
 - C Compression Side
 - × Governing Node or Bar



Section 1 - ULS Strength Results



CENTRAL PILING
LIMITED

Plymouth Grove
450mm diameter pile
Section capacity check

Job No.	Sheet No.	Rev.
46887A1		
Drg. Ref.		
Made by SD	Date 13-Nov-2025	Checked

Title & Specification

Job number	46887A1
Job title	Plymouth Grove
Subtitle	450mm diameter pile
Calc. heading	Section capacity check
File	S:\V6. Contracts\46876-46900\46887\Technical\Design\02 Load bearing\01 Preliminary issue - 07.11.2025\AD02_46887A1_450mm_6B20.ads
Notes	6B20 cage
Code of Practice	BS EN 1992-2:2005 [United Kingdom]
Bending Axes	Biaxial
Number of sections	1
Number of ULS cases	1
Number of SLS cases	1

Analysis Task

Section	1 : 450mm - 6B20
Analysis type	ULS strength
Analysis case(s)	1 : ULS Case 1
Number of iterations	2400
Limit iteration step	Yes
Perturbation factor	0%

Section : Definition

1 : 450mm - 6B20	
Name	450mm - 6B20
Type	Concrete
Material	C28/35
Origin	Centre
Dimensions	
Diameter	450.0mm
Section Area	159000.mm ²
Reinforcement Area	1885.mm ²
Reinforcement	1.185%

Section : Nodes

1 : 450mm - 6B20

Node	Y [mm]	Z [mm]
1	0.0	226.3
2	58.57	218.6
3	113.1	196.0
4	160.0	160.0
5	196.0	113.1
6	218.6	58.57
7	226.3	-9.892E-6
8	218.6	-58.57
9	196.0	-113.1
10	160.0	-160.0
11	113.1	-196.0
12	58.57	-218.6
13	-19.78E-6	-226.3
14	-58.57	-218.6
15	-113.1	-196.0
16	-160.0	-160.0
17	-196.0	-113.1
18	-218.6	-58.57
19	-226.3	2.699E-6
20	-218.6	58.57
21	-196.0	113.1
22	-160.0	160.0
23	-113.1	196.0
24	-58.57	218.6

Section : Cover & Links

1 : 450mm - 6B20

Cover	75.00mm
Link Size	10.00mm
Link Material	500B

Section : Bars

1 : 450mm - 6B20

Bar	Y	Z	Diameter	Area	Effective Area	Type	Material	Prestress Force	Prestress Strain	Appl. loads include/exclude prestress
	[mm]	[mm]	[mm]	[mm ²]	[mm ²]			[kN]		
1	130.0	0.0	20.00	314.2	314.2	314.2 Steel	500B			
2	65.00	112.6	20.00	314.2	314.2	314.2 Steel	500B			
3	-65.00	112.6	20.00	314.2	314.2	314.2 Steel	500B			
4	-130.0	5.392E-6	20.00	314.2	314.2	314.2 Steel	500B			
5	-65.00	-112.6	20.00	314.2	314.2	314.2 Steel	500B			
6	65.00	-112.6	20.00	314.2	314.2	314.2 Steel	500B			

Section : Elastic Properties

1 : 450mm - 6B20

Effective properties of the section, ignoring reinforcement.

Geometric Centroid	y	0.0mm
	z	0.0mm
Area		159000.mm ²
Second Moments of Area	I _{yy}	2.013E+9mm ⁴
	I _{zz}	2.013E+9mm ⁴
	I _{yz}	0.0mm ⁴
Principal Second Moments of Area	I _{uu}	2.013E+9mm ⁴
	I _{zz}	2.013E+9mm ⁴
Shear Area Factor	Angle	0.0°
	k _y	0.8571
	k _z	0.8571
Torsion Constant		4.026E+9mm ⁴
Section Modulus	Z _y	8.946E+6mm ³



CENTRAL PILING
LIMITED

Plymouth Grove
450mm diameter pile
Section capacity check

Job No.	Sheet No.	Rev.
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Bar	Y	Z	Diameter	Area	Effective Area	Type	Material	Prestress Force	Prestress Strain	Appl. loads include/exclude prestress
	[mm]	[mm]	[mm]	[mm ²]	[mm ²]			[kN]		
			Z _z		8.946E+6mm ³					
Plastic Modulus			Z _{py}		15.19E+6mm ³					
			Z _{pz}		15.19E+6mm ³					
Radius of Gyration			R _y		112.5mm					
			R _z		112.5mm					

Properties of gross section, including reinforcement.

Geometric Centroid	y	-86.19E-9mm
	z	0.0mm
EA		5.455E+6kN
EI	EI _{yy}	67700.kNm ²
	EI _{zz}	67700.kNm ²
	EI _{yz}	-29.38E-6kNm ²
Principal EI	EI _{uu}	67700.kNm ²
	EI _{zz}	67700.kNm ²
	Angle	-0.1052°

Material : Concrete

1 : C28/35

Name	C28/35
Cylinder	f _{ck} 28.00N/mm ²
Strength	
Tensile	f _{ctm} 2.766N/mm ²
Strength	
Weight	Normal Weight
Density	ρ 2.400t/m ³
Elastic	E 32310.N/mm ²
Modulus	
Poisson's	ν 0.2000
Ratio	
Coeff. Thermal Expansion	α 10.00E-6/°C
Partial	γ _c 1.500
Safety	
Factor	
Maximum	0.003500
Strain	
Plateau	0.002000
Strain	
ULS Compression	Parabola rectangle
Curve	
ULS Tension	No-tension
Curve	
SLS Compression	FIB Model Code
Curve	
SLS Tension	Interpolated
Curve	
Design	α _{cc} 0.8500
strength	
factor	
Aggregate	0.0mm
Size	

Material : Rebar

1 : 500B

Type	Steel rebar
Strength	f _{yk} 500.0N/mm ²
Elastic Modulus	E 200000.N/mm ²
Hardening Modulus	E _h 0.0N/mm ²
Density	ρ 7.850t/m ³
Poisson's Ratio	ν 0.3000
Coeff. Thermal Expansion	α 12.00E-6/°C
Ductility	Normal Modified
Partial Safety Factor	γ _s 1.150
	γ _{se} 1.000
Maximum Strain	ε _{uk} 0.05000 Modified
Maximum Strain	ε _{ud} 0.04500 Modified
Stress/Strain Curve	Elastic-plastic

Section 1 Details

1.19% reinforcement in section 1 (450mm - 6B20). Check this against code requirements.

ULS Cases Analysed

Name	Section	Loading	Prestress Factor
ULS Case 1	1 : 450mm - 6B20	L1	1.000

Strength Analysis - Loads

Case	N	M _{yy}	M _{zz}	M	θ
	[kN]	[kNm]	[kNm]	[kNm]	[°]
1	0.0	0.0	0.0	0.0	0.0

Strength Analysis - Summary

Governing conditions are defined as:
A - reinforcing steel tension strain limit
B - concrete compression strain limit
C - concrete pure compression strain limit
Eurocode 2 Section 6.1
Effective centroid is reported relative to the reference point.



CENTRAL PILING
LIMITED

Plymouth Grove
450mm diameter pile
Section capacity check

Job No.	Sheet No.	Rev.
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Case	Eff. Centroid (y)	Eff. Centroid (z)	N [kN]	M [kNm]	M _u [kNm]	M/M _u	Governing Condition	Neutral Axis Angle [°]	Neutral Axis Depth [mm]
1	-86.19E-9	0.0	0.0	0.0	114.0	0.0	B: Node 1	0.0	136.7

Strength Analysis - Details

Case	Moment Angle [°]	Description	N [kN]	M [kNm]	Warning
	116.2	Max. compressive strain	3248.	4.583E-6	
	180.0	Max. tensile strain	-819.5	2.772E-6	
1	0.0	Axial strength at M	3312.	0.2218	
		Initial yield	-0.005060	91.47	
		Balanced yield	743.9	158.8	
		Bending strength at N=0	0.0	114.0	

Strain Planes at ULS Strength

Related to Reference Point

Case	Strain Plane	ε _{ax} [-]	κ _{yy} [1/m]	κ _{zz} [1/m]
1	Reinforcement	-0.002293	0.02560	-1.010E-9
	User Creep/Shrinkage	0.0	0.0	0.0
	Total (Concrete)	-0.002293	0.02560	-1.010E-9

Section Material Stresses/Strains at ULS Strength

Case	Point	Coordinates y [mm]z [mm]		Strain [-]	Stress [N/mm²]	Notes
1	1	0.0	226.3	0.003500	15.87	
1	2	58.57	218.6	0.003303	15.87	
1	3	113.1	196.0	0.002724	15.87	
1	4	160.0	160.0	0.001803	15.71	
1	5	196.0	113.1	603.7E-6	8.133	
1	6	218.6	58.57	-793.3E-6	0.0	
1	7	226.3	-9.892E-6	-0.002293	0.0	
1	8	218.6	-58.57	-0.003792	0.0	
1	9	196.0	-113.1	-0.005189	0.0	
1	10	160.0	-160.0	-0.006388	0.0	
1	11	113.1	-196.0	-0.007309	0.0	
1	12	58.57	-218.6	-0.007888	0.0	
1	13	-19.78E-6	-226.3	-0.008085	0.0	
1	14	-58.57	-218.6	-0.007888	0.0	
1	15	-113.1	-196.0	-0.007309	0.0	
1	16	-160.0	-160.0	-0.006388	0.0	
1	17	-196.0	-113.1	-0.005189	0.0	
1	18	-218.6	-58.57	-0.003792	0.0	
1	19	-226.3	2.699E-6	-0.002293	0.0	
1	20	-218.6	58.57	-793.3E-6	0.0	
1	21	-196.0	113.1	603.7E-6	8.133	
1	22	-160.0	160.0	0.001803	15.71	
1	23	-113.1	196.0	0.002724	15.87	
1	24	-58.57	218.6	0.003303	15.87	

Reinforcement Stresses/Strains at ULS Strength

Case	Bar	Coordinates y [mm]z [mm]		Strain [-]	Stress [N/mm²]	Notes
1	1	130.0	0.0	-0.002293	-434.8	500B
1	2	65.00	112.6	589.3E-6	117.9	500B
1	3	-65.00	112.6	589.3E-6	117.9	500B
1	4	-130.0	5.392E-6	-0.002293	-434.8	500B
1	5	-65.00	-112.6	-0.005174	-434.8	500B
1	6	65.00	-112.6	-0.005174	-434.8	500B

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Force/Moment Interaction

EC2-2 (GB) : 450mm - 6B20

Moment angle: 0.00

Force/Moment Interaction

□ No tension point

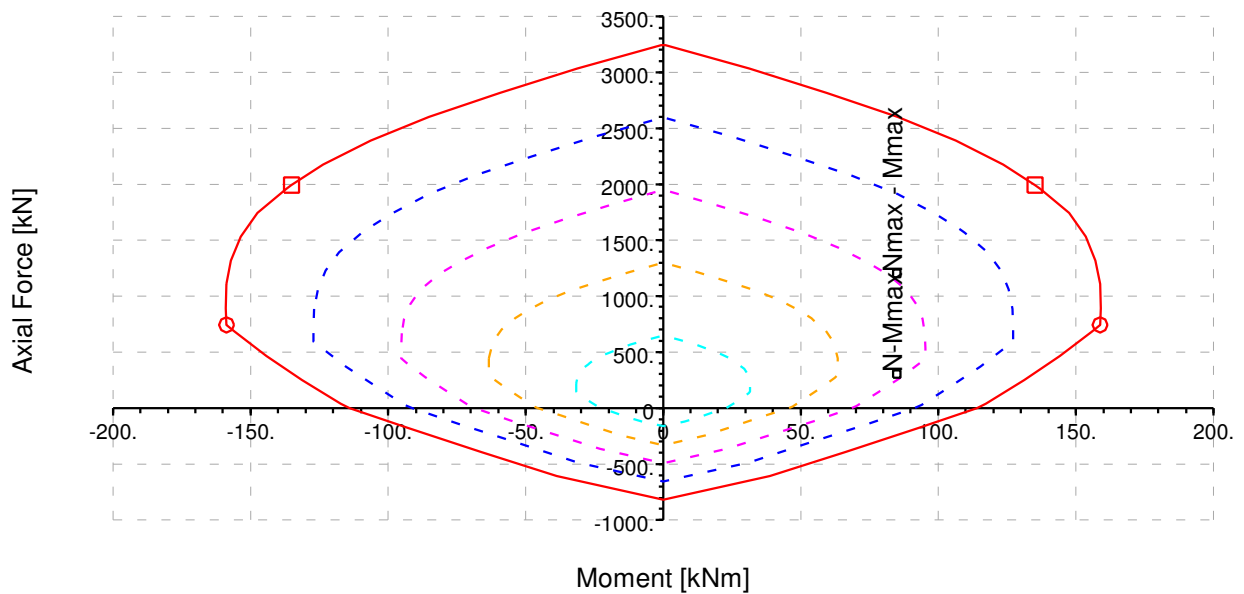
○ Balanced yield point

--- 80%

--- 60%

--- 40%

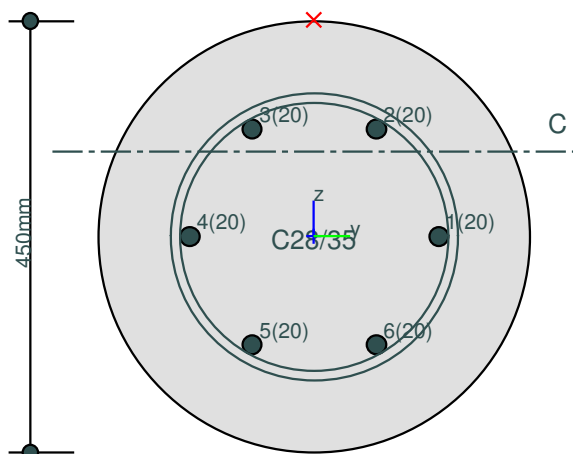
--- 20%



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Key

- 1.19% reinforcement
- Analysis Case 1
- + Reference Point
- Neutral Axis
- C Compression Side
- × Governing Node or Bar



Section 1 - ULS Strength Results



CENTRAL PILING
LIMITED

Plymouth Grove
450mm diameter pile
Section capacity check

Job No.	Sheet No.	Rev.
46887A1		
Drg. Ref.		
Made by SD	Date 28-Nov-2025	Checked

Title & Specification

Job number	46887A1
Job title	Plymouth Grove
Subtitle	450mm diameter pile
Calc. heading	Section capacity check
File	S:\V6. Contracts\46876-46900\46887\Technical\Design\02 Load bearing\02 Preliminary issue - 27.11.2025\AD03_46887A1_450mm_6B25.ads
Notes	6B25 cage
Code of Practice	BS EN 1992-2:2005 [United Kingdom]
Bending Axes	Biaxial
Number of sections	1
Number of ULS cases	1
Number of SLS cases	1

Analysis Task

Section	1 : 450mm - 6B25
Analysis type	ULS strength
Analysis case(s)	1 : ULS Case 1
Number of iterations	2400
Limit iteration step	Yes
Perturbation factor	0%

Section : Definition

1 : 450mm - 6B25

Name	450mm - 6B25
Type	Concrete
Material	C28/35
Origin	Centre
Dimensions	
Diameter	450.0mm
Section Area	159000.mm ²
Reinforcement Area	2945.mm ²
Reinforcement	1.852%

Section : Nodes

1 : 450mm - 6B25

Node	Y [mm]	Z [mm]
1	0.0	226.3
2	58.57	218.6
3	113.1	196.0
4	160.0	160.0
5	196.0	113.1
6	218.6	58.57
7	226.3	-9.892E-6
8	218.6	-58.57
9	196.0	-113.1
10	160.0	-160.0
11	113.1	-196.0
12	58.57	-218.6
13	-19.78E-6	-226.3
14	-58.57	-218.6
15	-113.1	-196.0
16	-160.0	-160.0
17	-196.0	-113.1
18	-218.6	-58.57
19	-226.3	2.699E-6
20	-218.6	58.57
21	-196.0	113.1
22	-160.0	160.0
23	-113.1	196.0
24	-58.57	218.6

Section : Cover & Links

1 : 450mm - 6B25

Cover	75.00mm
Link Size	10.00mm
Link Material	500B

Section : Bars

1 : 450mm - 6B25

Bar	Y	Z	Diameter	Area	Effective Area	Type	Material	Prestress Force	Prestress Strain	Appl. loads include/exclude prestress
	[mm]	[mm]	[mm]	[mm ²]	[mm ²]			[kN]		
1	127.5	0.0	25.00	490.9	490.9	Steel	500B			
2	63.75	110.4	25.00	490.9	490.9	Steel	500B			
3	-63.75	110.4	25.00	490.9	490.9	Steel	500B			
4	-127.5	-1.159E-6	25.00	490.9	490.9	Steel	500B			
5	-63.75	-110.4	25.00	490.9	490.9	Steel	500B			
6	63.75	-110.4	25.00	490.9	490.9	Steel	500B			

Section : Elastic Properties

1 : 450mm - 6B25

Effective properties of the section, ignoring reinforcement.

Geometric Centroid	y	0.0mm
	z	0.0mm
Area		159000.mm ²
Second Moments of Area	I _{yy}	2.013E+9mm ⁴
	I _{zz}	2.013E+9mm ⁴
	I _{yz}	0.0mm ⁴
Principal Second Moments of Area	I _{uu}	2.013E+9mm ⁴
	I _{zz}	2.013E+9mm ⁴
Shear Area Factor	Angle	0.0°
	k _y	0.8571
	k _z	0.8571
Torsion Constant		4.026E+9mm ⁴
Section Modulus	Z _y	8.946E+6mm ³



CENTRAL PILING
LIMITED

Plymouth Grove
450mm diameter pile
Section capacity check

Job No.	Sheet No.	Rev.
46887A1		
Drg. Ref.		
Made by SD	Date 28-Nov-2025	Checked

Bar	Y	Z	Diameter	Area	Effective Area	Type	Material	Prestress Force	Prestress Strain	Appl. loads include/exclude prestress
	[mm]	[mm]	[mm]	[mm ²]	[mm ²]			[kN]		
			Z _z		8.946E+6mm ³					
Plastic Modulus			Z _{py}		15.19E+6mm ³					
			Z _{pz}		15.19E+6mm ³					
Radius of Gyration			R _y		112.5mm					
			R _z		112.5mm					

Properties of gross section, including reinforcement.

Geometric Centroid	y	0.0mm
	z	0.0mm
EA		5.632E+6kN
EI	EI _{yy}	69050.kNm ²
	EI _{zz}	69050.kNm ²
	EI _{yz}	0.0kNm ²
Principal EI	EI _{uu}	69050.kNm ²
	EI _{zz}	69050.kNm ²
	Angle	0.0°

Material : Concrete

1 : C28/35

Name	C28/35
Cylinder	f _{ck} 28.00N/mm ²
Strength	
Tensile	f _{ctm} 2.766N/mm ²
Strength	
Weight	Normal Weight
Density	ρ 2.400t/m ³
Elastic	E 32310.N/mm ²
Modulus	
Poisson's	ν 0.2000
Ratio	
Coeff. Thermal Expansion	α 10.00E-6/°C
Partial	γ _c 1.500
Safety	
Factor	
Maximum	0.003500
Strain	
Plateau	0.002000
Strain	
ULS	Parabola
Compression	rectangle
Curve	
ULS	No-tension
Tension	
Curve	
SLS	FIB Model
Compression	Code
Curve	
SLS	Interpolated
Tension	
Curve	
Design	α _{cc} 0.8500
strength	
factor	
Aggregate	0.0mm
Size	

Material : Rebar

1 : 500B

Type	Steel rebar
Strength	f _{yk} 500.0N/mm ²
Elastic Modulus	E 200000.N/mm ²
Hardening Modulus	E _h 0.0N/mm ²
Density	ρ 7.850t/m ³
Poisson's Ratio	ν 0.3000
Coeff. Thermal Expansion	α 12.00E-6/°C
Ductility	Normal
Partial Safety Factor	γ _s 1.150
	γ _{se} 1.000
Maximum Strain	ε _{uk} 0.05000
Maximum Strain	ε _{ud} 0.04500
Stress/Strain Curve	Elastic-plastic

Section 1 Details

1.85% reinforcement in section 1 (450mm - 6B25). Check this against code requirements.

ULS Cases Analysed

Name	Section	Loading	Prestress Factor
ULS Case 1	1 : 450mm - 6B25	L1	1.000

Strength Analysis - Loads

Case	N	M _{yy}	M _{zz}	M	θ
	[kN]	[kNm]	[kNm]	[kNm]	[°]
1	0.0	0.0	0.0	0.0	0.0

Strength Analysis - Summary

Governing conditions are defined as:
A - reinforcing steel tension strain limit
B - concrete compression strain limit
C - concrete pure compression strain limit
Eurocode 2 Section 6.1
Effective centroid is reported relative to the reference point.



CENTRAL PILING
LIMITED

Plymouth Grove
450mm diameter pile
Section capacity check

Job No.	Sheet No.	Rev.
46887A1		
Drg. Ref.		
Made by SD	Date 28-Nov-2025	Checked

Case	Eff. Centroid (y)	Eff. Centroid (z)	N [kN]	M [kNm]	M _u [kNm]	M/M _u	Governing Condition	Neutral Axis Angle [°]	Neutral Axis Depth [mm]
1	0.0	0.0	0.0	0.0	150.8	0.0	B: Node 1	0.0	155.7

Strength Analysis - Details

Case	Moment Angle [°]	Description	N [kN]	M [kNm]	Warning
	138.7	Max. compressive strain	3655.	6.237E-6	
	842.5E-9	Max. tensile strain	-1281.	247.4E-9	
1	0.0	Axial strength at M	3756.	0.2282	
		Initial yield	-0.01352	131.4	
		Balanced yield	655.6	185.3	
		Bending strength at N=0	0.0	150.8	

Strain Planes at ULS Strength

Related to Reference Point

Case	Strain Plane	ε _{ax} [-]	κ _{yy} [1/m]	κ _{zz} [1/m]
1	Reinforcement	-0.001587	0.02248	169.9E-12
	User Creep/Shrinkage	0.0	0.0	0.0
	Total (Concrete)	-0.001587	0.02248	169.9E-12

Section Material Stresses/Strains at ULS Strength

Case	Point	Coordinates y [mm]z [mm]		Strain [-]	Stress [N/mm²]	Notes
1	1	0.0	226.3	0.003500	15.87	
1	2	58.57	218.6	0.003327	15.87	
1	3	113.1	196.0	0.002818	15.87	
1	4	160.0	160.0	0.002010	15.87	
1	5	196.0	113.1	956.3E-6	11.55	
1	6	218.6	58.57	-270.6E-6	0.0	
1	7	226.3	-9.892E-6	-0.001587	0.0	
1	8	218.6	-58.57	-0.002904	0.0	
1	9	196.0	-113.1	-0.004131	0.0	
1	10	160.0	-160.0	-0.005185	0.0	
1	11	113.1	-196.0	-0.005993	0.0	
1	12	58.57	-218.6	-0.006501	0.0	
1	13	-19.78E-6	-226.3	-0.006675	0.0	
1	14	-58.57	-218.6	-0.006501	0.0	
1	15	-113.1	-196.0	-0.005993	0.0	
1	16	-160.0	-160.0	-0.005185	0.0	
1	17	-196.0	-113.1	-0.004131	0.0	
1	18	-218.6	-58.57	-0.002904	0.0	
1	19	-226.3	2.699E-6	-0.001587	0.0	
1	20	-218.6	58.57	-270.6E-6	0.0	
1	21	-196.0	113.1	956.3E-6	11.55	
1	22	-160.0	160.0	0.002010	15.87	
1	23	-113.1	196.0	0.002818	15.87	
1	24	-58.57	218.6	0.003327	15.87	

Reinforcement Stresses/Strains at ULS Strength

Case	Bar	Coordinates y [mm]z [mm]		Strain [-]	Stress [N/mm²]	Notes
1	1	127.5	0.0	-0.001587	-317.5 500B	
1	2	63.75	110.4	895.0E-6	179.0 500B	
1	3	-63.75	110.4	895.0E-6	179.0 500B	
1	4	-127.5	-1.159E-6	-0.001587	-317.5 500B	
1	5	-63.75	-110.4	-0.004070	-434.8 500B	
1	6	63.75	-110.4	-0.004070	-434.8 500B	

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Force/Moment Interaction

EC2-2 (GB) : 450mm - 6B25

Moment angle: 0.00

Force/Moment Interaction

□ No tension point

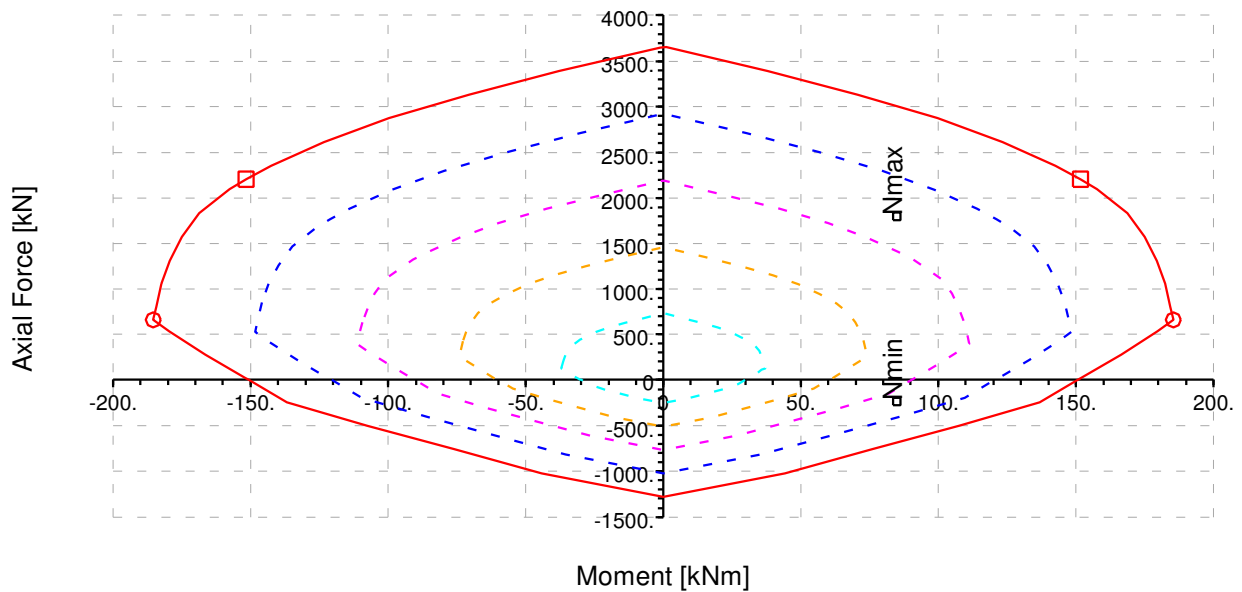
○ Balanced yield point

--- 80%

--- 60%

--- 40%

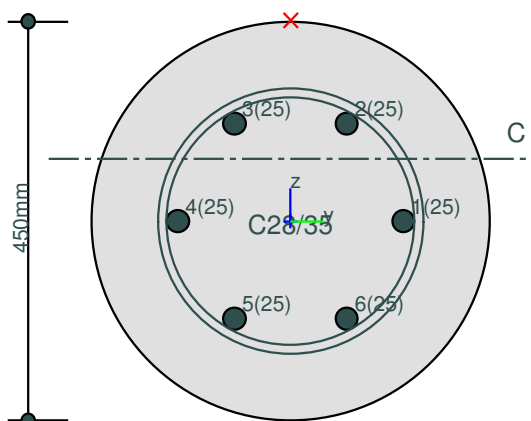
--- 20%



Job No.	Sheet No.	Rev.
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Drg. Ref.		
Made by	Date	Checked
SD	28-Nov-2025	

Key

- 1.85% reinforcement
- Analysis Case 1
- + Reference Point
- Neutral Axis
- C Compression Side
- × Governing Node or Bar



Section 1 - ULS Strength Results

Appendix 5
Pile Schedule

Pile Ref	Diameter (mm)	Permanent Load Q ₁ (kN)	Permanent Load Min Q _{1min} (kN)	Variable Load Q ₂ (kN)	Wind Load +W ₁ (kN)	Wind Load -W ₁ (kN)	Total Vertical DA1-C2 (kN)	Total Vertical DA1-C1 (kN)	Horizontal (kN)	Tension DA1-C2 (kN)	Tension DA1-C1 (kN)	Mat Level (m)	Cut-off Level (m)	Rebar Protuding (m)	Pile Depth (m)	Concrete	ULS Load (DA1-C2) (kN)	ULS Geo Capacity (kN)	Utilisation ratio (%)	No. Bars	Grade	Depth (m)	Helical Grade	Helical Pitch (mm)
P01	450	990		145			1200	1600	15				38.625		11.5	C28/35-DC2	1200	3131	38%	6	B16	8	B10	200
P02	450	990		145			1200	1600	15				38.625		11.5	C28/35-DC2	1200	3131	38%	6	B16	8	B10	200
P03	450	1065		185			1350	1750	15				38.625		12.5	C28/35-DC2	1350	3530	38%	6	B16	8	B10	200
P04	450	1065		185			1350	1750	15				38.625		12.5	C28/35-DC2	1350	3530	38%	6	B16	8	B10	200
P05	450	1080		210			1400	1800	15				38.625		12.5	C28/35-DC2	1400	3530	40%	6	B16	8	B10	200
P06	450	1080		210			1400	1800	15				38.625		12.5	C28/35-DC2	1400	3530	40%	6	B16	8	B10	200
P07	450	1010		170			1250	1650	15				38.625		12.0	C28/35-DC2	1250	3330	38%	6	B16	8	B10	200
P08	450	1010		170			1250	1650	15				38.625		12.0	C28/35-DC2	1250	3330	38%	6	B16	8	B10	200
P09	450	1080		170			1350	1750	15				38.625		12.5	C28/35-DC2	1350	3530	38%	6	B16	8	B10	200
P10	450	1080		170			1350	1750	15				38.625		12.5	C28/35-DC2	1350	3530	38%	6	B16	8	B10	200
P11	450	970		170			1200	1600	15				38.625		11.5	C28/35-DC2	1200	3131	38%	6	B16	8	B10	200
P12	450	970		170			1200	1600	15				38.625		11.5	C28/35-DC2	1200	3131	38%	6	B16	8	B10	200
P13	450	620		90			750	1000	15				38.000		10.6	C28/35-DC2	750	2772	27%	6	B16	8	B10	200
P14	450	620		90			750	1000	15				38.000		10.6	C28/35-DC2	750	2772	27%	6	B16	8	B10	200
P15	450	840		190			1100	1450	15				38.000		11.0	C28/35-DC2	1100	2932	38%	6	B16	8	B10	200
P16	450	840		190			1100	1450	15				38.000		11.0	C28/35-DC2	1100	2932	38%	6	B16	8	B10	200
P17	450	760		240			1100	1400	15				38.625		11.0	C28/35-DC2	1100	2932	38%	6	B16	8	B10	200
P18	450	760		240			1100	1400	15				38.625		11.0	C28/35-DC2	1100	2932	38%	6	B16	8	B10	200
P19	450	430		60			550	700	15				38.625		10.6	C28/35-DC2	550	2772	20%	6	B16	8	B10	200
P20	450	430		60			550	700	15				38.625		10.6	C28/35-DC2	550	2772	20%	6	B16	8	B10	200
P21	450	700		75			800	1100	15				38.625		10.6	C28/35-DC2	800	2772	29%	6	B16	8	B10	200
P22	450	700		75			800	1100	15				38.625		10.6	C28/35-DC2	800	2772	29%	6	B16	8	B10	200
P23	450	725		150			950	1250	15				38.625		10.6	C28/35-DC2	950	2772	34%	6	B16	8	B10	200
P24	450	725		150			950	1250	15				38.625		10.6	C28/35-DC2	950	2772	34%	6	B16	8	B10	200
P25	450	725		150			950	1250	15				38.625		10.6	C28/35-DC2	950	2772	34%	6	B16	8	B10	200
P26	450	700		100			850	1100	15				38.625		10.6	C28/35-DC2	850	2772	31%	6	B16	8	B10	200
P27	450	700		100			850	1100	15				38.625		10.6	C28/35-DC2	850	2772	31%	6	B16	8	B10	200
P28	450	900		200			1200	1550	15				38.625		11.5	C28/35-DC2	1200	3131	38%	6	B16	8	B10	200
P29	450	900		200			1200	1550	15				38.625		11.5	C28/35-DC2	1200	3131	38%	6	B16	8	B10	200
P30	450	900		200			1200	1550	15				38.625		11.5	C28/35-DC2	1200	3131	38%	6	B16	8	B10	200
P31	450	980		250			1300	1700	15				38.625		12.0	C28/35-DC2	1300	3330	39%	6	B16	8	B10	200
P32	450	950		250			1300	1700	15				38.625		12.0	C28/35-DC2	1300	3330	39%	6	B16	8	B10	200
P33	450	950		250			1300	1700	15				38.625		12.0	C28/35-DC2	1300	3330	39%	6	B16	8	B10	200
P34	450	800		190			1050	1400	15				38.625		11.0	C28/35-DC2	1050	2932	38%	6	B16	8	B10	200
P35	450	800		190			1050	1400	15				38.625		11.0	C28/35-DC2	1050	2932	38%	6	B16	8	B10	200
P36	450	800		190			1050	1400	15				38.625		11.0	C28/35-DC2	1050	2932	38%	6	B16	8	B10	200
P37	450	975		240			1300	1700	15				38.625		12.0	C28/35-DC2	1300	3330	39%	6	B16	8	B10	200
P38	450	975		240			1300	1700	15				38.625		12.0	C28/35-DC2	1300	3330	39%	6	B16	8	B10	200
P39	450	975		240			1300	1700	15				38.625		12.0	C28/35-DC2	1300	3330	39%	6	B16	8	B10	200
P40	450	830		180			1100	1400	15				38.000		11.0	C28/35-DC2	1100	2932	38%	6	B16	8	B10	200
P41	450	830		180			1100	1400	15				38.000		11.0	C28/35-DC2	1100	2932	38%	6	B16	8	B10	200
P42	450	830		180			1100	1400	15				38.000		11.0	C28/35-DC2	1100	2932	38%	6	B16	8	B10	200
P43	450	375		225			700	850	15				38.525		10.6	C28/35-DC2	700	2772	25%	6	B16	8	B10	200
P44	450	1020		280			1400	1800	15				38.625		12.5	C28/35-DC2	1400	3530	40%	6	B16	8	B10	200
P45	450	1020		280			1400	1800	15				38.625		12.5	C28/35-DC2	1400	3530	40%	6	B16	8	B10	200
P46	450	1020		280			1400	1800	15				38.625		12.5	C28/35-DC2	1400	3530	40%	6	B16	8	B10	200
P47	450	850		200			1150	1450	15				38.625		11.0	C28/35-DC2	1150	2932	39%	6	B16	8	B10	200
P48	450	850		200			1150	1450	15				38.625		11.0	C28/35-DC2	1150	2932	39%	6	B16	8	B10	200
P49	450	850		200			1150	1450	15				38.625		11.0	C28/35-DC2	1150	2932	39%	6	B16	8	B10	200
P50	450	900		290			1300	1650	15				38.625		12.0	C28/35-DC2	1300	3330	39%	6	B16	8	B10	200
P51	450	900		290			1300	1650	15				38.625		12.0	C28/35-DC2	1300	3330	39%	6	B16	8	B10	200
P52	450	900		290			1300	1650	15				38.625		12.0	C28/35-DC2	1300	3330	39%	6	B16	8	B10	200
P53	450	500	250	100	100	100	750	950	50				38.625		10.6	C28/35-DC2	750	2772	27%	6	B20	8	B10	200
P54	450	500	250	100	75	50	650	850	50				38.625		10.6	C28/35-DC2	650	2772	23%	6	B20	8	B10	200
P55	450	475	200	75	75	50	650	850	50				38.625		10.6	C28/35-DC2	650	2772	23%	6	B20	8	B10	200
P56	450	425	175	50	100	75	650	800	50				38.625		10.6	C28/35-DC2	650	2772	23%	6	B20	8	B10	200
P57	450	475	275	100	100	100	700	900	50				38.625		10.6	C28/35-DC2	700	2772	25%	6	B20	8	B10	200
P58	450	450	250	75	50	50	600	800	50				38.625		10.6	C28/35-DC2	600	2772	22%	6	B20	8	B10	200
P59	450	425	225	75	50	50	600	750	50				38.625		10.6	C28/35-DC2	600	2772	22%	6	B20	8	B10	200
P60	450	400	200	50	100	75	600	750	50				38.625		10.6	C28/35-DC2	600	2772	22%	6	B20	8	B10	200
P61	450	450	300	100	100	100	700	900	50				38.625		10.6	C28/35-DC2	700	2772	25%	6	B20	8	B10	200
P62	450	400	250	75	50	50	550	700	50				38.625		10.6	C28/35-DC2	550	2772	20%	6	B20	8	B10	200
P63	450	375	225	50	50	50	500	650	50				38.625		10.6	C28/35-DC2	500	2772	18%	6	B20	8	B10	200
P64	450	350	200	50	75	75	500	650	50				38.625		10.6	C28/35-DC2	500	2772	18%	6	B20	8	B10	200
P65	450	425	300	100	75	100	650	800	50				38.625		10.6	C28/35-DC2	650	2772	23%	6	B20	8	B10	200
P66	450	375	275	75	50	50	500	700	50				38.625		10.6	C28/35-DC2	500	2772						

Pile Ref	Diameter (mm)	Permanent Load Q ₁ (kN)	Permanent Load Min Q _{1min} (kN)	Variable Load Q ₂ (kN)	Wind Load +W ₁ (kN)	Wind Load -W ₁ (kN)	Total Vertical DA1-C2 (kN)	Total Vertical DA1-C1 (kN)	Horizontal (kN)	Tension DA1-C2 (kN)	Tension DA1-C1 (kN)	Mat Level (m)	Cut-off Level (m)	Rebar Protruding (m)	Pile Depth (m)	Concrete	ULS Load (DA1-C2) kN	ULS Geo Capacity (kN)	Utilisation ratio (%)	No. Bars	Grade	Depth (m)	Helical Grade	Helical Pitch (mm)
P118	450	500	375	100	75	125	700	900	50				38.200		10.6	C28/35- DC2	700	2772	25%	6	B20	8	B10	200
P119	450	475	350	100	75	100	700	900	50				38.200		10.6	C28/35- DC2	700	2772	25%	6	B20	8	B10	200
P120	450	450	325	75	75	75	650	800	50				38.200		10.6	C28/35- DC2	650	2772	23%	6	B20	8	B10	200
P121	450	425	325	75	50	75	600	750	50				38.200		10.6	C28/35- DC2	600	2772	22%	6	B20	8	B10	200
P122	450	400	300	75	50	75	550	700	50				38.200		10.6	C28/35- DC2	550	2772	20%	6	B20	8	B10	200
P123	450	400	300	75	75	75	600	750	50				38.200		10.6	C28/35- DC2	600	2772	22%	6	B20	8	B10	200
P124	450	375	275	75	125	100	650	800	50				38.200		10.6	C28/35- DC2	650	2772	23%	6	B20	8	B10	200
P125	450	550	400	125	150	250	900	1100	50				38.200		10.6	C28/35- DC2	900	2772	32%	6	B20	8	B10	200
P126	450	525	375	100	150	225	850	1050	50				38.200		10.6	C28/35- DC2	850	2772	31%	6	B20	8	B10	200
P127	450	500	350	100	150	225	800	1050	50				38.200		10.6	C28/35- DC2	800	2772	29%	6	B20	8	B10	200
P128	450	475	325	75	150	200	750	950	50				38.200		10.6	C28/35- DC2	750	2772	27%	6	B20	8	B10	200
P129	450	450	325	75	150	200	750	950	50				38.200		10.6	C28/35- DC2	750	2772	27%	6	B20	8	B10	200
P130	450	425	300	75	150	200	700	900	50				38.200		10.6	C28/35- DC2	700	2772	25%	6	B20	8	B10	200
P131	450	400	300	75	150	200	700	850	50				38.200		10.6	C28/35- DC2	700	2772	25%	6	B20	8	B10	200
P132	450	375	3275	50	150	200	650	800	50				38.200		10.6	C28/35- DC2	650	2772	23%	6	B20	8	B10	200
P133	450	575	375	125	225	325	1000	1250	50	50	115		38.200		10.6	C28/35- DC2	1000	2772	38%	6	B20	8	B10	200
P134	450	550	350	100	225	325	950	1200	50	75	140		38.200		10.6	C28/35- DC2	950	2772	34%	6	B20	8	B10	200
P135	450	525	350	100	225	325	950	1200	50	75	140		38.200		10.6	C28/35- DC2	950	2772	34%	6	B20	8	B10	200
P136	450	500	325	75	225	325	900	1100	50	100	165		38.200		10.6	C28/35- DC2	900	2772	32%	6	B20	8	B10	200
P137	450	475	325	75	225	325	850	1100	50	100	165		38.200		10.6	C28/35- DC2	850	2772	31%	6	B20	8	B10	200
P138	450	450	300	75	225	325	850	1050	50	125	190		38.200		10.6	C28/35- DC2	850	2772	31%	6	B20	8	B10	200
P139	450	425	275	50	225	325	800	1000	50	150	215		38.200		10.6	C28/35- DC2	800	2772	29%	6	B25	9	B10	200
P140	450	400	250	50	225	325	750	950	50	175	240		38.200		10.6	C28/35- DC2	750	2772	27%	6	B25	9	B10	200
P141	450	950		170			1200	1550	15				38.625		11.5	C28/35- DC2	1200	3131	38%	6	B16	8	B10	200
P142	450	950		170			1200	1550	15				38.625		11.5	C28/35- DC2	1200	3131	38%	6	B16	8	B10	200
P143	450	530		80			650	850	15				38.625		10.6	C28/35- DC2	650	2772	23%	6	B16	8	B10	200
P144	450	530		80			650	850	15				38.625		10.6	C28/35- DC2	650	2772	23%	6	B16	8	B10	200
P145	450	710		130			900	1200	15				38.625		10.6	C28/35- DC2	900	2772	32%	6	B16	8	B10	200
P146	450	710		130			900	1200	15				38.625		10.6	C28/35- DC2	900	2772	32%	6	B16	8	B10	200
P147	450	870		160			1100	1450	15				38.625		11.0	C28/35- DC2	1100	2932	38%	6	B16	8	B10	200
P148	450	870		160			1100	1450	15				38.625		11.0	C28/35- DC2	1100	2932	38%	6	B16	8	B10	200
P149	450	1068		184			1350	1750	15				38.625		12.5	C28/35- DC2	1350	3530	38%	6	B16	8	B10	200
P150	450	840		180			1100	1450	15				38.625		11.0	C28/35- DC2	1100	2932	38%	6	B16	8	B10	200
P151	450	840		180			1100	1450	15				38.625		11.0	C28/35- DC2	1100	2932	38%	6	B16	8	B10	200
P152	450	840		180			1100	1450	15				38.625		11.0	C28/35- DC2	1100	2932	38%	6	B16	8	B10	200
P153	450	840		180			1100	1450	15				38.625		11.0	C28/35- DC2	1100	2932	38%	6	B16	8	B10	200
P154	450	720		170			950	1250	15				38.625		10.6	C28/35- DC2	950	2772	34%	6	B16	8	B10	200
P155	450	720		170			950	1250	15				38.625		10.6	C28/35- DC2	950	2772	34%	6	B16	8	B10	200
P156	450	720		170			950	1250	15				38.625		10.6	C28/35- DC2	950	2772	34%	6	B16	8	B10	200
P157	450	790		130			1000	1300	15				38.625		10.6	C28/35- DC2	1000	2772	36%	6	B16	8	B10	200
P158	450	790		130			1000	1300	15				38.625		10.6	C28/35- DC2	1000	2772	36%	6	B16	8	B10	200
P159	450	760		170			1000	1300	15				38.625		10.6	C28/35- DC2	1000	2772	36%	6	B16	8	B10	200
P160	450	760		170			1000	1300	15				38.625		10.6	C28/35- DC2	1000	2772	36%	6	B16	8	B10	200
P161	450	760		170			1000	1300	15				38.625		10.6	C28/35- DC2	1000	2772	36%	6	B16	8	B10	200
P162	450	1110		180			1350	1800	15				38.625		12.5	C28/35- DC2	1350	3530	38%	6	B16	8	B10	200
P163	450	1110		180			1350	1800	15				38.625		12.5	C28/35- DC2	1350	3530	38%	6	B16	8	B10	200
P164	450	660		90			800	1050	15				38.625		10.6	C28/35- DC2	800	2772	29%	6	B16	8	B10	200
P165	450	660		90			800	1050	15				38.625		10.6	C28/35- DC2	800	2772	29%	6	B16	8	B10	200
P166	450	450	300	100	225	175	850	1050	50				38.460		10.6	C28/35- DC2	850	2772	31%	6	B20	8	B10	200
P167	450	450	300	100	225	150	850	1050	50				38.460		10.6	C28/35- DC2	850	2772	31%	6	B20	8	B10	200
P168	450	400	275	75	225	150	800	1000	50				38.460		10.6	C28/35- DC2	800	2772	29%	6	B20	8	B10	200
P169	450	375	250	75	225	150	750	950	50				38.460		10.6	C28/35- DC2	750	2772	27%	6	B20	8	B10	200
P170	450	350	250	75	225	150	750	900	50				38.460		10.6	C28/35- DC2	750	2772	27%	6	B20	8	B10	200
P171	450	325	225	50	225	150	700	850	50	20	50		38.460		10.6	C28/35- DC2	700	2772	25%	6	B20	8	B10	200
P172	450	275	175	50	200	150	600	750	50				38.460		10.6	C28/35- DC2	600	2772	22%	6	B20	8	B10	200
P173	450	475	350	100	175	150	800	1050	50				38.460		10.6	C28/35- DC2	800	2772	29%	6	B20	8	B10	200
P174	450	475	325	100	125	125	750	950	50				38.460		10.6	C28/35- DC2	750	2772	27%	6	B20	8	B10	200
P175	450	425	325	75	100	100	650	850	50				38.460		10.6	C28/35- DC2	650	2772	23%	6	B20	8	B10	200
P176	450	400	300	75	75	50	600	750	50				38.460		10.6	C28/35- DC2	600	2772	22%	6	B20	8	B10	200
P177	450	350	275	75	100	75	550	750	50				38.460		10.6	C28/35- DC2	550	2772	20%	6	B20	8	B10	200
P178	450	325	250	50	75	50	500	650	50				38.460		10.6	C28/35- DC2	500	2772	18%	6	B20	8	B10	200
P179	450	300	225	50	75	75	450	600	50				38.460		10.6	C28/35- DC2	450	2772	16%	6	B20	8	B10	200
P180	450	275	200	50	100	100	500	600	50				38.460		10.6	C28/35- DC2	500	2772	18%	6	B20	8	B10	200
P181	450	500	375	100	125	125	800	1000	50				38.460		10.6	C28/35- DC2	800							

Appendix 6

Pile Summary

Compression DA1-C2 (kN)	Horizontal (kN)	Tension load DA1-C2 (kN)	Diameter (mm)	PileDepth (m)	Count of Piles
400	50		450	10.6	1
450	50		450	10.6	4
500	50		450	10.6	14
550	50		450	10.6	9
550	15		450	10.6	2
600	50		450	10.6	11
600	50	20	450	10.6	1
650	50		450	10.6	13
650	50	10	450	10.6	1
650	50	35	450	10.6	1
650	15		450	10.6	2
700	50		450	10.6	10
700	15		450	10.6	1
750	50		450	10.6	8
750	50	175	450	10.6	1
750	15		450	10.6	2
800	50		450	10.6	8
800	50	150	450	10.6	1
800	15		450	10.6	4
850	50		450	10.6	7
850	50	125	450	10.6	1
850	50	100	450	10.6	1
850	15		450	10.6	2
900	50		450	10.6	5
900	50	100	450	10.6	1
900	15		450	10.6	2
950	50		450	10.6	1
950	50	75	450	10.6	2
950	15		450	10.6	6
1000	50	50	450	10.6	1
1000	15		450	10.6	6
1050	50		450	11.0	2
1050	15		450	11.0	3
1100	15		450	11.0	13
1150	50		450	11.0	3
1150	15		450	11.0	3
1200	50		450	11.5	2
1200	15		450	11.5	15
1250	15		450	12.0	4
1300	15		450	12.0	12
1350	15		450	12.5	8
1400	15		450	12.5	5
Grand Total					199

Appendix 7

Design Risk Assessment

Central Piling Ltd		Risk Assessment				Assessment No: 46887A1	
Activity: Design		Date Assessed: 13/11/2025				Review Date: 13/11/2025	
Assessed by: S. Draghici							
Hazard	Hazard effect	Severity	x	Probability	=	Initial Degree of Risk and Assessment	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	5 Low
Inadequately designed / constructed / maintained working platforms.	Rig overturning, unsafe working conditions for operatives.	5		3	=	15 High	5 Low
CFA auger changes.	Personal injury.	4		2	=	8 Medium	4 Low
Racking of reinforcement cages while lifting.	Injury to operatives from falling steel bars.	4		2	=	8 Medium	4 Low
Underground services.	Personal injury. Loss of amenity.	5		4	=	20 High	5 Low
Immediate environmental impact.	Unacceptable levels and/or vibration, hearing damage to operatives.	3		3	=	9 Medium	3 Negligible
Pile trimming to cut-off level and exposing of reinforcement.	Vibration white finger injuries.	3		2	=	6 Low	3 Negligible
Exposed end of reinforcement after pile trimming.	Personal injury.	4		2	=	8 Medium	4 Low
Inadequate access to piles for integrity testing.	Personal injury.	4		1	=	4 Low	4 Low
Congested reinforcement in pile caps around head of pile during integrity tests.	Inability to test piles.	3		2	=	6 Low	3 Negligible
Flighting of soils during pile installation.	Damage to/instability of adjacent buildings.	4		2	=	8 Medium	4 Low
Calculation or scheduling error	Damage/instability of adjacent structures	4		2	=	8 Medium	6 Low
		Maximum Initial Degree of Risk				20	
		Initial Risk Assessment				High	
		Maximum Residual Degree of Risk					6
		Residual Risk Assessment					Low

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 ^f	DC-4 + APM3 ^f
AC-5m	DC-4m + APM3 ^f	DC-4m + APM3 ^f
AC-5z	DC-4z + APM3 ^f	DC-4z + APM3 ^f

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	Mg	SO4	Mg	SO4	pH	pH	pH (4)	pH (4)	
	g/l	g/l	g/l	g/l	%					
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 (SO4) 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.