

Pile Foundation Design

Camp Field,

Bartons Road,

Havant,

Hampshire,

PO9 5NA



Date: 11/08/2024

Prepared by: Sameul Akinola, Piledesigns Ltd

Checked by: Peter Illingworth, Piledesigns Ltd

Design Ref: 24755

NFS Ref: 210690

Revision: C3 – Issued for Approval

Document Control

Project:	Havant
Site Address:	Camp Field, Bartons Road, Havant, Hampshire, PO9 5NA
Document Title:	Bearing Pile Foundations
Project No.	24755-BP
Document produced for (Client):	Neil Foundations/ 210690

Issue Register

Rev	Date	Issue Status / Description	Prepared By	Checked By
C0	06/06/2023	For Comment / Approval	Peter Illingworth	David Illingworth
C1	13/07/2023	For Comment / Approval - revised for engineers comments	Peter Illingworth	David Illingworth
C2	23/04/2023	Revised calculations based on new site investigation report	Peter Illingworth	David Illingworth
C3	11/08/2023	Revised calculations based on new site investigation report and additional plots (updated to include phase 1 and 2	Samuel Akinola	Peter Illingworth

Contents

1.0	Introduction	1
2.0	Information Provided	3
2.1	Engineering Documentation	3
2.2	Specification Documentation	3
2.3	Ground Investigation	4
2.4	Design Scope & Further Information.....	4
3.0	Ground Conditions	5
3.1	Ground Investigation Assessment	5
3.2	Geotechnical Design Parameters.....	7
3.3	Ground Model	8
3.4	Design Parameters.....	9
4.0	Geotechnical Design Methodology	10
4.1	Design Actions	11
4.2	Axial Design Philosophy	12
4.3	Lateral Design Philosophy.....	12
5.0	Geotechnical Design.....	13
5.1	Axial Pile Load	13
5.2	Lateral Loading Design.....	16
6.0	Structural Analysis.....	18
6.1	Axial Structural Analysis.....	18
6.2	Primary Pile Reinforcement.....	18
6.3	Pile Reinforcement Projection.....	19
6.4	Concrete	20
7.0	Summary	21

1.0 Introduction

These calculations are for the design of the piled foundations at Camp Field, Bartons Road in Havant, Hampshire. It is understood that the proposed development comprises of the construction of new residential houses and apartments with associated private gardens which will be founded on a piled foundation. These calculations are for the plots listed in Table 1.

The site is located at Camp Field to the north of Bartons Road which can be found by approximate national grid reference 473320E, 108050N. The site is currently part of a large agricultural field covered by vegetation with large Oak tree located centrally. The site is irregular in shape covers an area of approximately 3 hectares and generally slopes downwards towards the south west corner. In the south east corner of the site is a tarmac access road, which passes through this corner of the site to the Crematorium, located off site to the north. Further to the south east on the opposite side of the tarmac road, is small corner of the site segregated from the main site. The site is set in a mixed rural and residential area with an adjoining field a Crematorium and woodland is present to the north of the site. See Figure 1 for Site Location Plan.



Figure 1 - Site Location Plan

Pile loadings have been provided on drawings from Eastwood Consulting Engineers & MJA Consulting Civil & Structural Engineers who are the structural engineers for the project. The drawings show pile locations and axial and lateral loads. These loads have been taken at cut off level.

The design has been carried out in accordance with BS EN 1997 and other relevant documents. All loads have been converted into Eurocode design actions and a pile design is based upon these actions.

Piledesigns Limited (PDL) has been appointed by Neil Foundations Limited to undertake the detailed 'element' design for the bearing pile foundations.

2.0 Information Provided

The main documents that have been consulted in preparing these calculations are summarised below. Any subsequent revisions to these documents should be forwarded for review.

2.1 Engineering Documentation

The following drawings have been produced and utilised for the project:

Table 1 – Design Documents

Reference	Phase Ref	Rev	Title
Author: Eastwood Consulting Engineers			
48224-ECE-XX-XX-DR-S-0003	Phase 1	C01	Windsor House Type Pile & Ground Beam Layout (Plot 44)
48224-ECE-XX-XX-DR-S-0005		C01	Henley House Type Pile & Ground Beam Layout (Plot 46)
48224-ECE-XX-XX-DR-S-0007		C02	Oxford House Type Pile & Ground Beam Layout (Plot 45)
Author: MJA Consulting Civil & Structural Engineers			
6628-MJA-128-PL-DR-S-1017	Phase 2	T2	Plots 128-131 Foundation Layout

2.2 Specification Documentation

The following specification(s) have been used within this design.

Table 2 – Specification Report

Reference	Rev	Title	Date
None Provided			

Reference has been made to the Institute of Civil Engineers publication, ICE Specification for Piling and Embedded Retaining Walls, SPERW, Third Edition published 2017. This is an administrative document for good working practice of piling works and the design has been carried out in general accordance with this document.

2.3 Ground Investigation

Table 3 - Ground Investigation Report

Author	Reference	Rev	Title	Date
BRD Environmental Ltd	BRD3818-OR5-B	Updated Foundation Zoning Plan and Preliminary Foundation Recommendations	Geo-Environmental Site Investigation	October 2021
	BRD3818-OR3-B	Updated following drilling of additional borehole.	Factual Borehole Investigation	October 2022

2.4 Design Scope & Further Information

The design herein is for the bearing piles to the loads provided within the documents referenced above.

- It is proposed to use 300mm diameter auger piles.
- The design has been carried out to EC7.
- Drawings denotes FOS = 3.0 but not considered for design as we are designing to EC7
- Loads have been provided by engineer as an unfactored total load therefore we have assumed an 75/25% dead / live split to calculate EC7 design actions for vertical component. The Vertical/Axial load has been taken as a compression load only, therefore there has been no allowance made for structural tension loads. This should be checked prior to construction.
- For the lateral loading component, it has been assumed to be fully variable.
- No piling commencement levels have been given; therefore, we have assumed as the FFL level as shown in the drawings. Piling levels to be confirmed by the principle contractor.
- Pile loads have been taken as acting at cut off level.
- All pile positions have been taken as tied, either by a slab, two ground beams and/or within a pile cap. Such piles have been taken as fixed, and effectively restrained in two directions by the above structure.
- Design only considers the element design of the bored augured piles/ continuous flight auger piles based on the specified loads

3.0 Ground Conditions

This section describes ground conditions, based upon the available ground information, and provides a ground model for use within the design and comments on the geotechnical parameters taken.

3.1 Ground Investigation Assessment

Information on ground conditions have been based on a geotechnical investigation report by BRD Environmental Ltd, for report references and dates refer to Table 3. This contained the following information:

Phase 1:

- Two boreholes taken to a maximum depth of 25.0mBGL (metres below ground level)
- Five window sample boreholes
- Several shallower trial pits

Borehole commencement levels were provided for only BH102 window samples only and it was 34.195mAOD, while for BH101 it has been assumed they were carried out from approximately existing ground / piling level.

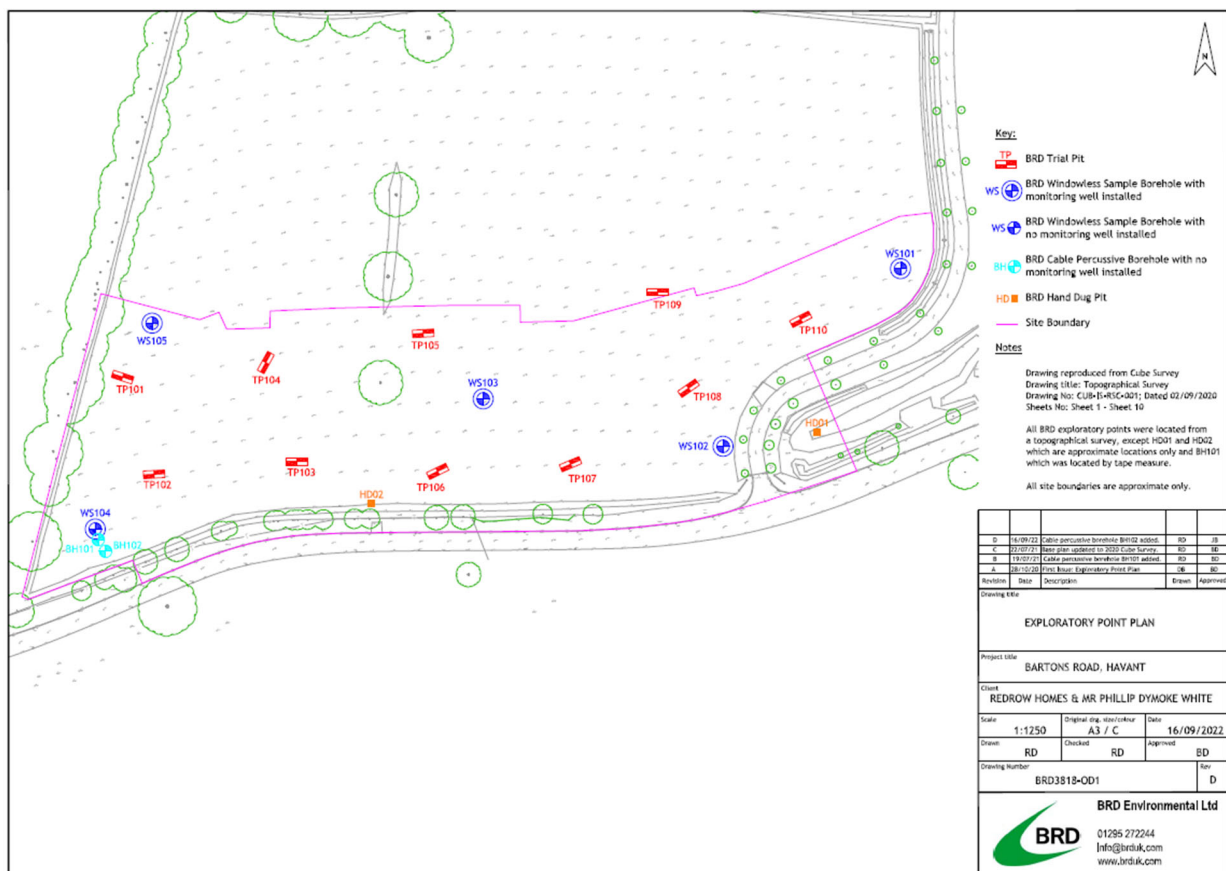


Figure 2 – Borehole Location Plan (BRD Report Phase 1)

Phase 2:

- Six window sample boreholes taken to a maximum depth of 5.45mBGL (metres below ground level)
- 9 shallow trial pits taken to a maximum depth of 3.2mBGL.

Borehole commencement levels were provided for the window samples only and they were between 30.154mAOD and 40.083mAOD

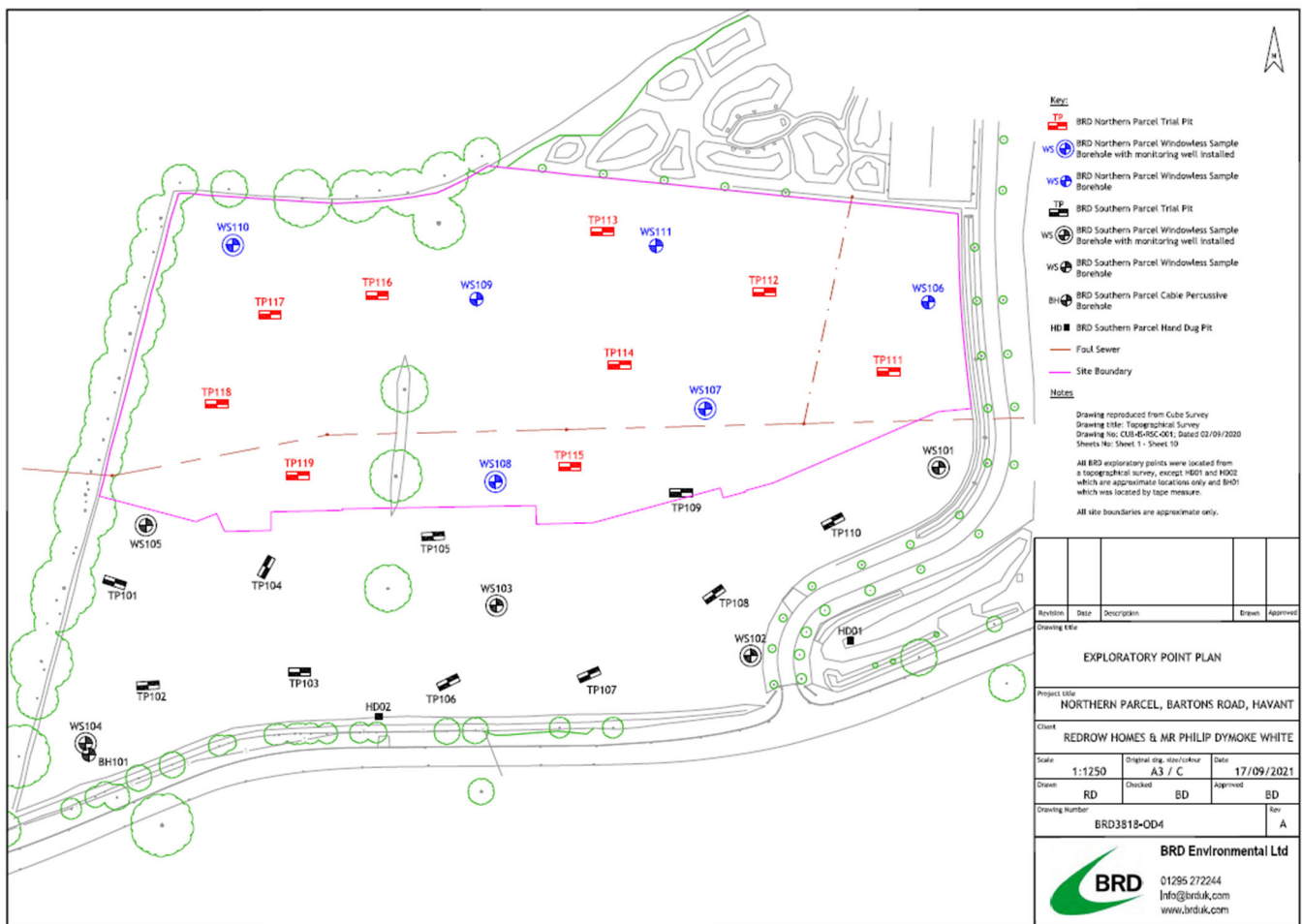


Figure 3 – Borehole Location Plan (BRD Report Phase 2)

These records show that the site is underlain by made ground overlying Head Deposits, London Clay and Lambeth Group with depth. Reference was also made to the British Geological Website's 1:50 000 Map series, which shows that the investigation is in keeping with expected geological sequence.

The soil profile and assumed parameters must be checked on site during initial piling operations.

3.2 Geotechnical Design Parameters

This section details the derivation of geotechnical properties from field and/or laboratory test data, empirical correlation, theoretical conversions and or reference to design codes. The following soil descriptions below have been taken from site investigation reports

3.2.1 Made Ground

Made Ground was encountered in all the exploratory borehole to a maximum depth of 0.7mBGL. The Made Ground generally comprises of soft to firm, dark brown, slightly sandy, silty, gravelly clay with occasional rootlets.

This should be checked on site during piling operations, if encountered significantly deeper then the designer must be notified for review.

3.2.2 Head Deposits

Beneath the made ground strata is material identified as Head Deposits and were only encountered in all exploratory boreholes to a maximum base depth of 3.05mBGL. it comprises of both cohesive and granular materials. The granular layer was described as medium dense, orange brown, slightly sandy, very clayey gravel of fine to coarse, sub-angular to subrounded flint. The cohesive layer were described as Stiff, orange brown mottled grey brown, slightly sandy, very gravelly clay. Gravel of fine to coarse, sub-angular to sub-rounded flint with occasional flint cobbles.

3.2.3 London Clay Formation

Beneath the Head Deposit strata is material identified as London Clay and were encountered in all exploratory boreholes to a maximum base depth of 12.2mBGL. The London Clay Formation was recorded as a stiff, dark grey and orange brown, very gravelly clay. Gravel of fine to coarse, sub-rounded to rounded flint.

3.2.4 Lambeth Group

Beneath the London Clay strata is material identified as Lambeth Group and were only encountered in BH101 & BH102 to a maximum base depth of 25.0mBGL (maximum depth of the investigation). It comprises of both cohesive and granular materials. The granular layer was encountered between depths of 12.20m to 16.00m BGL and described as dense, orange, beige, slightly silty fine sand. The cohesive layer was encountered between depths of 16.00m to 25.00m BGL and described as stiff to very stiff dark grey, slightly sandy, silty to very silty clay with rare fine pyrite crystals.

3.2.5 Ground Water

During the progressing of exploratory holes, the following general observations of groundwater behaviour were made;

Groundwater was encountered at a depth of 0.80mBGL in borehole BH101 within the granular Head Deposits rising to 0.60m after 20 minutes. A slight groundwater seepage was also encountered at 5.70m in borehole BH101 when a claystone was encountered within the London Clay Formation.

A slight groundwater seepage was encountered at a depth of 23.50m in borehole BH102 within the clay strata of the Lambeth Group.

For design purposes the ground water has been modelled at 1.0mBGL

3.3 Ground Model

The geotechnical design data has been analysed and is presented within the appendices. The following table presents the various profiles that have been used within the design.

The London Clay Formation was encountered in the two window samples at depths of 0.2 and 3.4mBGL, for design purposes it has been assumed from an approximate depth of 3mBGL.

Table 4.0 - Ground Profile

Depth (mBGL)			Soil
PPL	-	3.0	Made Ground and Head Deposits
3.0	-	12.2	London Clay
12.2	-	16.0	Lambeth Group - Sand
16.0	-	---	Lambeth Group - Clay

For design purposes the ground water has been modelled at 1.0mBGL.

3.4 Design Parameters

From the above the following design parameters will be adopted.

Table 5 - Design Properties

Soil	γ (kN/m ³)	SPT (N)	Cu (kN/m ²)	ϕ' (°)	E' (kN/m ²)
Made Ground and Head Deposits	18	n/a	n/a	n/a	10,000
Head Deposits	18	4-50	n/a	n/a	10,000
London Clay	20	5-50	$60+7.07z^{[1]}$	n/a	30,000
Lambeth Group - Sand	20	13-50	n/a	34	30,000
Lambeth Group - Clay	20	18-50	$110+6.11z^{[1]}$	n/a	55,000

The figures are Service Limit State (SLS) values and have not had any partial factors applied. Please note where no direct testing has been undertaken to determine the specific design value quoted in Table 5, the value has been based upon published correlations, engineering descriptions and engineering judgment.

Should ground conditions differ to that of the ground model and parameters be found during the piling works this should be relayed back to the designers.

4.0 Geotechnical Design Methodology

The design has been carried out in general in accordance with Eurocode (BS EN 1997-1:2004+A1:2013) with reference made to the UK National Annex and Execution Codes. This is an ultimate limit state design approach with partial factors applied to actions (A), materials (M) and resistances (R).

The main approach is to satisfy that the Design Effect of Actions, E_d is less than the Design Resistance, R_d . The Design Effect of Actions is a combination of actions (A) and or materials (M). Whereas the Design Resistance, R_d , is a combination of resistances (R) and or materials (M). Furthermore, elements will need to satisfy Serviceability Limit State (SLS) requirements which relates to settlements at working conditions.

Reference to typical actions (A), materials (M) & resistances (R) arrangements related to specific elements are presented below. Individual partial factors are presented in the table below, which have been taken from the UK National Annex.

Table 6 - Partial factor for GEO/STR Design Situations

Element	Design Approach 1	A1	A2	M1	M2	R1	R4
Axial Design	Combination 1	•		•		•	
	Combination 2		•	•			•
Lateral Design	Combination 1	•		•		•	
	Combination 2		•		•	•	

Table 7 - Partial factors on actions for the structural (STR) and geotechnical (GEO) limit states

Actions (A) [table NA.A1.2(B) in the NA to BS EN 1990]	Notation	A1	A2
Permanent Action (Unfavourable)	$G_{k,unfav}$	1.35	1.00
Permanent Action (Favourable)	$G_{k,fav}$	1.00	1.00
Variable Action (Unfavourable)*	$Q_{k,unfav}$	1.50	1.30
Variable Action (Favourable)	$Q_{k,fav}$	0.00	0.00
* Secondary variable actions are combined with an accompanying variable partial factor, taken from table NA.A1.1			

Table 8 - Partial factors for soil parameters for the STR and GEO limit states

Soil factors (M) [table A.NA.4 in the NA to BS EN 1997]	Notation	M1	M2
Effective angle of shearing resistance	$\tan \phi'$	1.00	1.25
Effective cohesion	c'	1.00	1.25
Undrained shear strength	C_u	1.00	1.40

Table 9 - Partial factors for design resistance for the STR and GEO limit states

Resistances (R) [table A.NA.7 and A.NA.8 in the NA to BS EN 1997]	Notation	R1	R4 <u>without</u> explicit verification of SLS	R4 <u>with</u> explicit verification of SLS
Pile Base	γ_{bRe}	1.00	2.0	1.7
Pile Shaft (compression)	γ_{sRe}	1.00	1.6	1.4
Pile Shaft (tension)	γ_{tRe}	1.00	2.0	2.0
Model Factor	Notation	R1	R4 <u>without</u> explicit verification of ULS	R4 <u>with</u> explicit verification of ULS
Model Factor	γ_{mod}	n/a	1.4	1.2

4.1 Design Actions

From section 2 the piles are to be designed for axial compressive and lateral loads. Loads have been provided by engineer as an unfactored total load taken to be the representative action, F_{rep} . We have assumed a permanent / variable split to calculate EC7 design actions for vertical component. Design actions for the SLS & ULS (STR/GEO) vertical conditions are detailed below.

- Permanent Action, G_k = $F_{rep} \times 75\%$
- Variable Action, Q_k = $F_{rep} \times 25\%$
- $F_{rep.min}$ = $G_k \times 1.0$ $F_{rep.max}$ = $[G_k \times 1.0] + [Q_{k.imp} \times 1.0]$
- DA1-1min = $G_k \times 0.9$ DA1-1max = $[G_k \times 1.35] + [Q_{k.imp.} \times 1.5]$
- DA1-2min = $G_k \times 1.0$ DA1-2max = $[G_k \times 1.0] + [Q_{k.imp} \times 1.3]$

For the lateral loading component, loads have been provided by engineer as an unfactored total load taken to be the representative action, $F_{rep.lat}$. It has been assumed to be fully variable therefore the design actions for the ULS (STR/GEO) lateral conditions are detailed below.

- Permanent Action, $G_{k,lat}$ = $F_{rep.lat} \times 0\%$
- Variable Action, $Q_{k,lat}$ = $F_{rep.lat} \times 100\%$
- $F_{rep.lat}$ = $[G_k \times 1.0] + [Q_{k.imp} \times 1.0]$
- DA1-1max.lat = $[G_k \times 1.35] + [Q_{k.imp.} \times 1.5]$
- DA1-2max.lat = $[G_k \times 1.0] + [Q_{k.imp} \times 1.3]$

4.2 Axial Design Philosophy

Pile lengths have been determined from the appropriate partial factors as detailed within Tables A.NA.3, A.NA.4 and A.NA.8. For the above combinations the factors are indicated within Table 7 with the combination summary detailed below.

- Combination 1 (DA1-1): A1 + M1 + R1
- Combination 2 (DA1-2): A2 + M1 + R4

4.3 Lateral Design Philosophy

Lateral loading has been assessed in the same manner as the vertical load to generate forces for design purposes.

- Combination 1 (DA1-1): A1 + M1 + R1
- Combination 2 (DA1-2): A2 + M2 + R1

5.0 Geotechnical Design

Design for bearing piles to BS EN 1997. The bearing piles are detailed are within the drawings by Eastwood Consulting Engineers & MJA Consulting Civil & Structural Engineers as referenced within Table 1. The design has been carried out to EC7 with loads have been provided by the engineer as unfactored total loads (Safe Working Load - SWL) and to which we have assumed an 75 / 25 % dead / live split to calculate EC7 design actions.

During the design process if it proposed to utilise 300mm diameter piles and the design herein is based upon this. For design purposes we have assumed the bearing piles will be installed from approximately existing ground / borehole level.

5.1 Axial Pile Load

The ultimate design resistance of a bearing pile is calculated from the sum of resistance gained on the pile shaft and the base, as detailed in Section 4.

For this site it is understood that neither preliminary nor working tests are proposed. Therefore, the piles have been designed to factors that do not require validation by testing. These calculations consider a model factor of 1.4 and partial factors of 1.6 and 2.0 applied to shaft and base resistances respectively.

The ultimate design resistance of a bearing pile is calculated from the sum of resistance gained on the pile shaft and the base, as detailed below;

$$R_{d,vert} = \frac{R_{bk}}{\gamma_b \cdot \gamma_{mod}} + \frac{R_{sk}}{\gamma_s \cdot \gamma_{mod}}$$

5.1.1 Ultimate Shaft Adhesion, R_{sk}

The shaft resistance contribution from the made ground and Head Deposits has been ignored, furthermore material above pile cut off level has also been discounted. The characteristic shaft resistance for the relevant strata's has been calculated as follows;

In Cohesive Material;

$$R_{sk} = C_{u,ave} * \alpha * A_s$$

where, $C_{u,ave}$ = shear strength along the length of the pile as shown in table 4

α = adhesion factor taken as 0.5

A_s = Area of pile shaft

In Granular Material;

$$Q_s = K_s * p_d' * \tan \delta * A_s$$

where, K_s = coefficient of earth pressure at rest, taken as 0.8 for auger bored piles in granular soil

p_d' = average effective overburden stress

δ = angle of friction between concrete and soil, taken as ϕ' for auger bored piles

A_s = Area of pile shaft

5.1.2 Ultimate End Bearing, Q_b

All piles will found in the London Clay or Lambeth Group Formation therefore the base resistance for the Made Ground and Head Deposits has been ignored. The characteristic base resistance for the relevant strata's has been calculated as follows;

In Cohesive Material;

$$Q_b = C_{u.base} * N_c * A_b$$

where, $C_{u.base}$ = Shear strength at pile base as shown in table 4

N_c = Bearing capacity factor, taken as 9 for circular piles in clay

A_b = Area of pile base

In Granular Material;

Where;

$$R_{bk} = p_d' * N_q * A_b$$

p_d' = effective overburden pressure at pile toe level bearing capacity factor related to the angle of shearing resistance

N_q = Sand with ϕ' as 34° with N_q taken as 40

A_b = Area of pile base

5.1.3 Pile Heave

From the site investigation report the near surface soils are noted as having High Volume change potential. Calculate the potential uplift force from this material based upon an affective depth of 3.0m, therefore pile length due to possible desiccation ($3m - 1m = 2.0m$),

$$T_{k.heave.pile} = 35kN/m^2 * \phi\pi * 2.0m$$

$$T_{k.heave.pile} = 66kN$$

In addition to the above the additional uplift force from void former, $T_{k.heave.beam}$, assumed as 20kN is considered.

$$\begin{aligned} \text{Tk.heave.design} &= \text{Tk.heave.pile} + \text{Tk.heave.beam} \\ \text{Tk.heave.design} &= 66 + 20 = 86\text{kN} \end{aligned}$$

Review required anchorage resistance for Tk.heave.design. From calculations above for vertical pile capacity - ultimate skin friction for a 7m reinforced pile length is 140kN. Therefore, safety factor on possible heave on pile element only is $(140 / 86) > 1.5$ which is considered satisfactory.

5.1.4 Pile Length

The above calculations have been carried out using the OASYS Pile program, version 19.7 which allows the appropriate partial factors to be applied to the soil parameters. The results are given in the appendices which includes a summary table of the design resistances calculated.

5.2 Lateral Loading Design

All bearing piles are subjected to a horizontal loading. As with the vertical capacity the lateral design load cases have been carried out in general accordance with Eurocode (BS EN 1997-1:2004) with reference made to the UK National Annex. The appropriate partial factors as derived for these combinations is indicated in section 4.

Lateral loads indicated as 10kN, which was specified by the engineer. These loads have been assumed as fully variable with the 10kN load assessed on 300mm diameter piles

5.2.1 Geotechnical Lateral Analysis

Analysis of the pile under horizontal load/bending moments has been carried out using the OASYS Limited computer program ALP; version 19.3. The program models the interaction between the pile and the surrounding soil, predicts the pressures, horizontal movements, shear forces and the bending moments induced in the pile.

The pile is modelled as a series of elastic beam elements. The soil is modelled as a series of non-interactive, non-linear springs. The soil deflection has been modelled assuming an elastic-plastic behaviour. Two stiffness matrices relating nodal forces to displacements are developed - one represents the pile in bending the other represents the soil.

For the piles at this site, the pile head has been taken as fixed. The method of analysis used has allowed for a nominal rotational stiffness applied at the pile head, taken as 5,000kN.m per radian for 300mm diameter piles.

The assumed soil profile and soil parameters are detailed in the vertical pile calculations.

Coefficients for passive resistance for the various soils have been taken from the data given in the program manual which are based on Tomlinson's coefficients, 1986.

The flexural rigidity (EI) of the pile is calculated as 7952kN/m² for 300mm diameter piles.

This approach allows an assessment of the depth at which the derived moments should be dissipated and therefore allows a determination of reinforcement length.

Details of the ALP analysis carried out are given in the table below. For the analysis, both lateral actions to DA1-1 (STR) and DA1-2 (GEO) have been considered with the worst case considered for shear/moment design. The results of the ALP analysis are given in the appendices and show the maximum derived moment and indicate the depth below the cut-off level the moment can be considered as sensibly dissipated.

The 'depth to dissipate' has been taken where the calculated ALP bending moment within the pile is negligible.

Table 10 - Lateral Load Analysis

Load Case	Pile Diameter (mm)	F.rep.lat (kN)	Lateral Load DA1-1 / DA1-2 (kN)	STR Moment (kN.m)	Depth to dissipate below COL (m)
1	300	10	15	8.4	4.0
			13	7.9	4.0

6.0 Structural Analysis

Pile section design has been carried out on the basis of the reinforced concrete design code BS EN 1992-1-1:2004 (Eurocode 2) using the following parameters;

Pile Diameter, d_{nom}	=	300mm
Design Concrete strength, f_{ck}	=	28 N/mm ² { f_{cu} = 35N/mm ² (C28/35)}
Steel f_y	=	500 N/mm ² [high yield] (BS EN 1992-1-1:2004)
Design Concrete Cover	=	75mm

6.1 Axial Structural Analysis

The axial compressive stress of concrete has been checked in accordance with BS EN 1992-1-1:2004 where the value of design compressive strength, f_{cd} , of concrete is defined as:

$$f_{cd} = (\alpha_{cc} \cdot f_{ck}) / (\gamma_c \cdot k_f)$$

Where, α_{cc} = 0.6 for unreinforced section

$$\gamma_c = 1.5$$

$$k_f = 1.1$$

Considering C28/35 grade concrete, the following axial compressive resistance for a 300mm diameter pile has been calculated as 720kN. This is greater than the maximum STR on the associated pile diameters.

6.2 Primary Pile Reinforcement

The derived maximum bending moments are checked against the ultimate moments obtained using the OASYS - ADCOL program for columns to BS EN 1992-1-1:2004 Eurocode 2. This program calculates the ultimate moment capacity of the pile section with concrete and reinforcement and at specified working loads. We have not reviewed the pile section against crack width.

The results are as follows; with each case analysed for specific pile diameter, reinforcement, and axial load. Outputs for the section analysis for bending and shear are presented within the appendices.

The pile stresses detailed in table 11 have been reviewed within the ADC programme to allow for utilisation of at least unity on the equivalent derived ultimate moments of the section.

Table 11 - Adcol Analysis

Load Case	Pile Dia (mm)	STR Axial Load (kN)	STR Moment Load (kNm)	STR Shear Load (kN)	Reinforcement	Ult moment (Mu) (kN.m)	M/Mu
1.min	300	68	8.4	15	4B12/B8@150c/c	24.48	0.34
1.max		486				34.33	0.25

6.2.1 Pile Heave (Tension) Reinforcement

The heave check calculates a maximum load of 86kN, calculated area of reinforcement, Ast, required to satisfy the tension load.

$$\text{Use } A_{st} = \frac{\text{Tk.heave.design} * F_s}{0.87 * F_y}$$

where A_{st} = area of reinforcement

F_s = safety factor, taken as 1.5

0.87 = material factor on reinforcement

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

$$\text{Therefore } A_{st} = \frac{86\text{kN} * 1.5 * 1000}{0.87 * 500}$$

$$= \frac{129000}{466.5} = 277\text{mm}^2 < 4B12 (452\text{mm}^2), \text{ therefore nominal 0.5\% } A_{st} \text{ 4B12 reinforcement cage sufficient.}$$

6.3 Pile Reinforcement Projection

The radial cage has been designed to cater for all loadings at cut off level, the Basic Anchorage Length has been calculated in accordance with EC2 cl. 8

This generates a design tension anchorage, l_{bd} , of 375mm for 12mm. This is the minimum anchorage that is to be supplied for the radial cages.

6.4 Concrete

C28/35 concrete has been used in the structural analysis and is sufficient for the pile actions. From the site investigation a ACEC class of AC-4 (AC-2 for piling design) requirement is given. The site investigation indicates a DC-2 concrete for piling design. Which should be validated prior to construction.

For the design allow for, C28/35, with 75mm cover.

7.0 Summary

The design herein is for the bearing pile element only, issued for approval from the professional team and relevant third-party bodies.

If any works proceed on site prior to receiving approval from any warranty provider, approved inspector or insurance provider (e.g. NHBC, Premier Guarantee, LABC) that may impact the final design and/or details the contractor/client are proceeding at their own risk

- All piles to be constructed in accordance with the piling schedule issued separately.
- Design in accordance with Eurocode (EC7)
- Piles have been designed to the loads given in the relevant drawings
- No allowance has been made for structural tension loads
- C28/35 concrete and 75mm cover to all piles.

APPENDIX A

DESIGNERS RISK ASSESMENT

STATEMENT ON CDM REGULATIONS (2015) AND RESIDUAL RISKS

CDM Regulations (2015)

The Client and Designer for this project are subject to certain duties under the CDM (2015) Regulations. It is the duty of the Designer to ensure that the client is aware of these duties prior to commencing the design. Piledesigns Ltd are responsible for an 'elemental' part of the design only and are not the 'overall' scheme designer. This 'elemental' design has been undertaken on the premise that this duty has been carried out by the scheme designer, and that no separate approach, in respect of this elemental design, by Piledesigns Ltd is required.

Residual Risks – In accordance with the CDM Regulations (2015) any specific residual design risks and construction sequences relevant to this design are given below. As stated in the CDM Regulations (2015), whilst we have assessed the design risks for our works we have only listed the risks we consider significant to the design and which we consider are not likely to be obvious to a competent contractor or other designer. It does not constitute or remove the need for task related risk assessments for the activities carried out in the implementation of the design. Furthermore, it is the responsibility of the client and principal designer to ensure a competent principal contractor is appointed for these works.

The residual risks below should be added to any relevant construction drawing or method statements and copied to relevant designers and contractors on site.

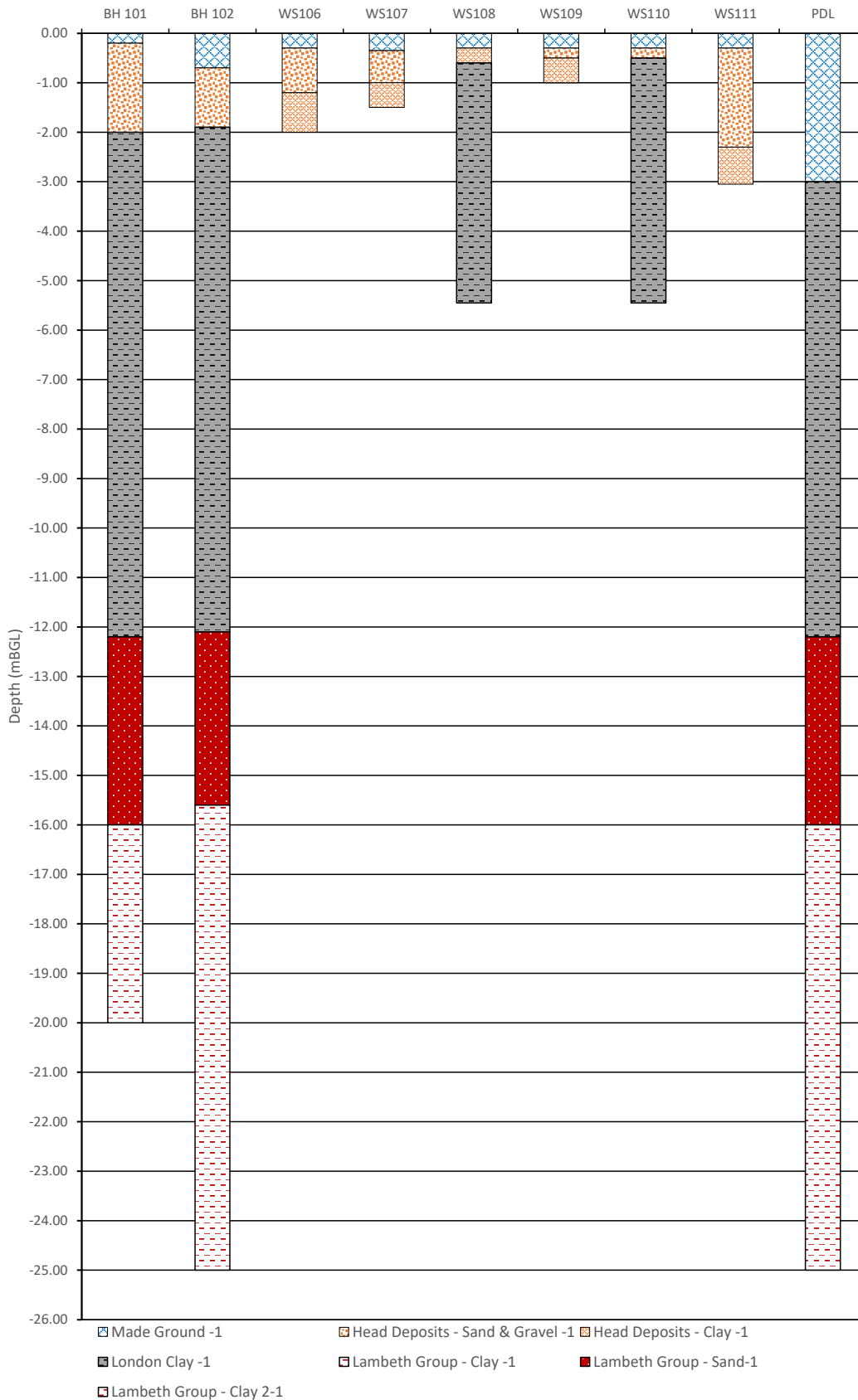
Item No	Risk	Potential Effects	Risk Management / Mitigation
1	Unforeseen ground conditions	Pile performance could be compromised.	Ground conditions encountered during pile construction should be logged and checked against the assumed design profile and any variations from that assumed in the design must be reported immediately to the designer.
2	Services	Injury to site operatives / public and damage to equipment	No works should be carried out until a permit to work has been provided to the piling contractor by the Principle Contractor. Where it is necessary to carry out works close to any services the main contractor must positively locate (visually) the service, or divert and decommission the service prior to the commencement of any piling works.
3	Working Platform	Rig instability which could make unsafe	Ensure working platform is designed, constructed and maintained in accordance with published

Item No	Risk	Potential Effects	Risk Management / Mitigation
		working conditions for site personnel	guidance or other appropriate best practice. Construct platform according to specification, inspect regularly and maintain to original specification.
4	Obstructions	Unable to achieve proposed design lengths, damage to equipment.	Ensure all known existing obstructions are removed prior to piling works.
5	Unable to install reinforcement cages in CFA piles	Pile reinforcement does not achieve the required to level.	Reinforcement stated within the design is the minimum required. Reinforcement can be increased in bar diameter and number to increase cage stiffness for pile installation. to ensure adequate rigidity for temporary lifting and also provision of lifting etc.
6	Lifting reinforcement cages	Damage cages, injury to personnel	Ensure all lifting operations are carried out to an agreed method statement / lift plan. All reinforcement cages to have designed lifting points
7	Piling adjacent to neighbouring structures.	Damage to structures	Ensure all piling activities are agreed with the required third parties and the appropriate sign off have been completed before commencement.
8	Non-conformance of concrete	Compromised pile performance	Implement an agreed testing regime of concrete cubes and relay any non-conformances for checking at earliest opportunity

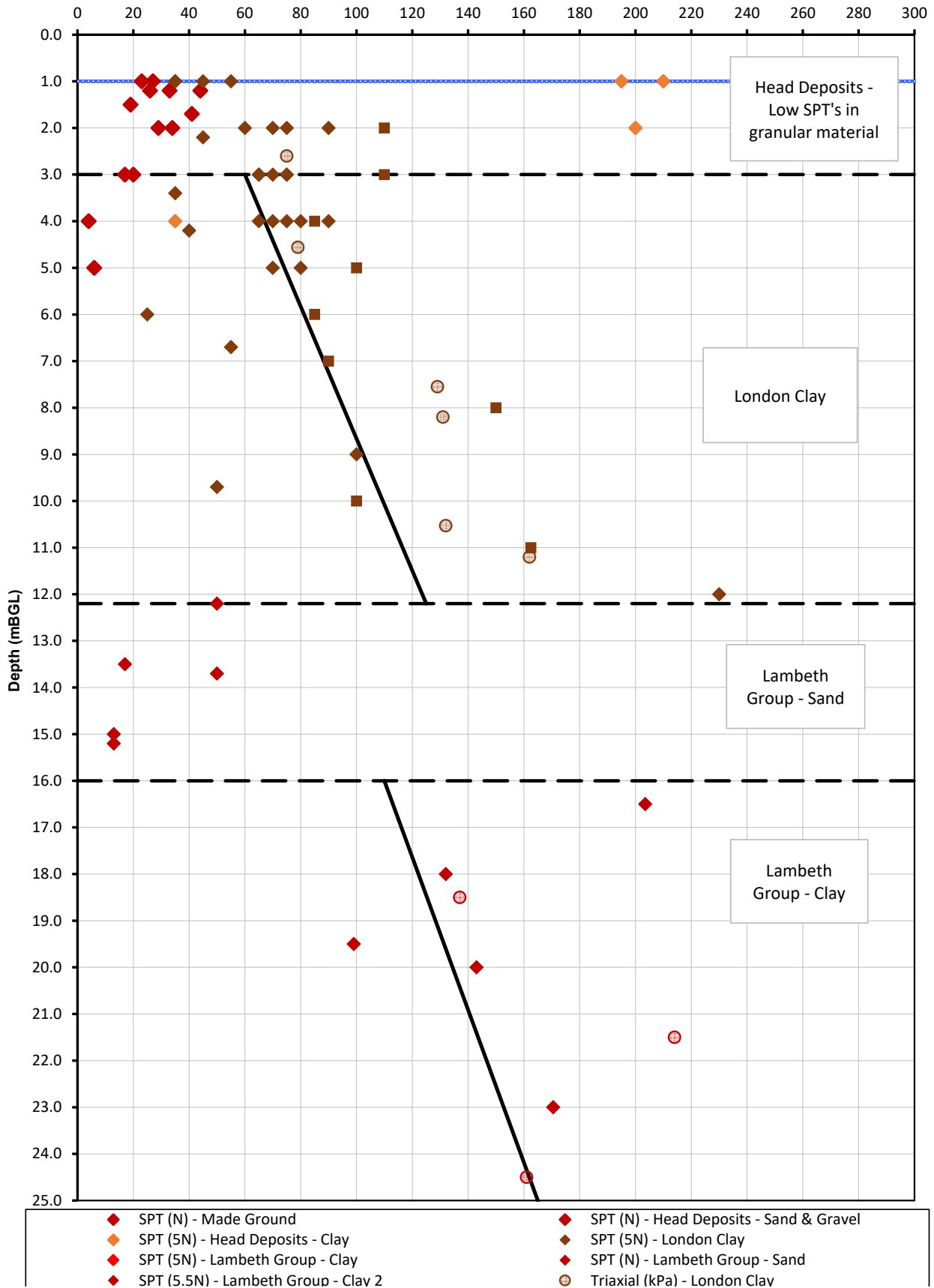
APPENDIX B

SOILS INFORMATION

Borehole Profile

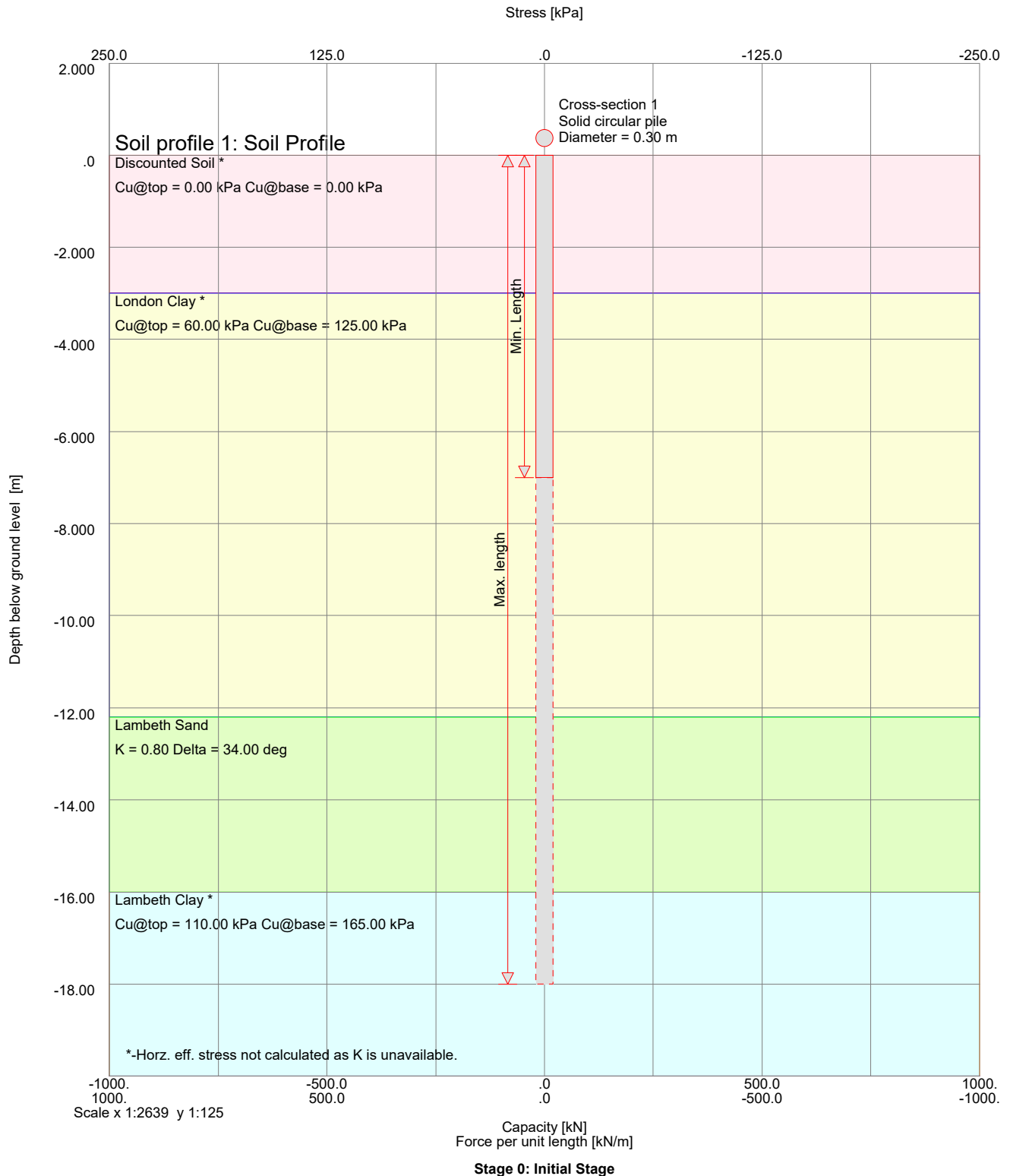


All against depth for all boreholes



APPENDIX C

OASYS PILE



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
Is BS8004 SLS check enabled?	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	7.0000 m
Maximum pile length	18.000 m
Increment size	0.50000

Cross-section	Number of cross sections	Top Diameter [m]	Second Diameter location [m]	Second Diameter [m]	Third Diameter location [m]	Third Diameter [m]
Cross-section 1	1	0.30000				

Undrained Materials - General Data

No.	Material description	Bulk unit weight [kN/m³]	Cu material factor	Top Cu [kPa]	Base Cu [kPa]
1	Discounted Soil	19.000	NA	0.0	0.0
2	London Clay	20.000	NA	60.000	125.00
3	Lambeth Clay	20.000	NA	110.00	165.00
4	Lambeth Clay 2	20.000	NA	165.00	165.00

Undrained Materials - Skin Friction Data

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

Undrained Materials - End Bearing Data

No.	Material description	End bearing computation	Nc	qb	qb, lim
				Top [kPa]	Base Spec. Value [kPa]
1	Discounted Soil	Nc specified	0.0	NA	NA No NA
2	London Clay	Nc specified	9.0000	NA	NA No NA
3	Lambeth Clay	Nc specified	9.0000	NA	NA No NA

 PILEDESIGNS GEOTECHNICAL EXPERTISE Havant - Camp Field, Bartons Road (Phase 1&2) 300mm diameter auger piles Vertical Capacity, EC7 (no testing)	Job No.		Sheet No.		Rev.	
	24755					
	Drg. Ref.					
	Made by SA		Date		Checked	

No.	Material description	End bearing computation	Nc	qb	qb, lim
				Top [kPa] NA	Base Spec. Value [kPa] NA No NA
4	Lambeth Clay 2	Nc specified	9.0000		

Undrained Materials - Material Factors (Code Based)

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

Drained Materials - General Data

No.	Material description	Bulk unit weight [kN/m³]	Tan(δ) material factor
1	Lambeth Sand	20.000	NA

Drained Materials - Friction Data

No.	Material description	Skin friction computation	Beta	Delta (δ) [deg]	Coefficient of earth pressure K	qs	qs, lim
						Top [kPa] NA	Base Spec. Value [kPa] NA No NA
1	Lambeth Sand	Earth pressure	NA	34.000	0.80000		

Drained Materials - End Bearing Data

No.	Material description	End bearing computation	Nq	Phi' [deg]	PhiD [deg]	Phicv' [deg]	Ir	qb	qb, lim	Nq-Phi curves
								Top [kPa] NA	Base Spec. Value [kPa] NA Yes 1000.0	
1	Lambeth Sand	Nq specified	40.000	NA	NA	NA	NA			

Drained Materials - Material Factors (Code Based)

No.	Material description	Qs factors		Nq factors		Qb factors	
		M1	M2	M1	M2	M1	M2
1	Lambeth Sand	N.A.	N.A.	1.0000	1.0000	N.A.	N.A.

Nq-Phi curve data

Curve 1 : Nq-Phi Curve 1

Nq	Phi' [deg]
----	------------

STAGE SPECIFIC DATA

Stage 0 : Initial Stage

Groundwater

No.	Level [m]	Pressure [kPa]	Unit weight of water [kN/m³]
1	1.0000	0.0	9.8100

Soil Profiles



PILEDESIGNS

GEOTECHNICAL EXPERTISE

Job No.

Sheet No.

Rev.

24755

Drg. Ref.

Made by SA

Date

Checked

Havant - Camp Field, Bartons Road (Phase 1&2)

300mm diameter auger piles

Vertical Capacity, EC7 (no testing)

No.	Level [m]	Pressure [kPa]	Unit weight of water [kN/m³]
-----	--------------	-------------------	------------------------------------

Soil Profile 1: Soil Profile

No.	Depth [m]	Material description	Contributes to negative skin friction
1	0.0	Discounted Soil	No
2	3.0000	London Clay	No
3	12.200	Lambeth Sand	No
4	16.000	Lambeth Clay	No
5	25.000	Lambeth Clay 2	No

Soil Profile - Groundwater Map

No.	Soil Profile	Groundwater
1	Soil Profile	Groundwater Profile 1

Stage specific warnings

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

CAPACITY RESULTS

Partial Resistance Factors Used:

DA1 C1

Shaft resistance factor for set R1 (Compression):

1.00

Base resistance factor for set R1:

1.00

Shaft resistance factor for set R1 (Tension):

1.00

DA1 C2

Shaft resistance factor for set R4 (Compression):

1.60

Base resistance factor for set R4:

2.00

Shaft resistance factor for set R4 (Tension):

2.00

Model factor:

1.40

Stress Profiles

Soil Profile 1: Soil Profile

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	19.000	0.0	N.A.	0.0	0.0	0.0	NA	0.0
1.0000	19.000	0.0	N.A.	19.000	0.0	19.000	NA	0.0
3.0000	19.000	0.0	N.A.	57.000	19.620	37.380	NA	0.0
3.0000	20.000	60.000	N.A.	57.000	19.620	37.380	NA	0.0
7.0000	20.000	88.261	N.A.	137.00	58.860	78.140	NA	148.26
7.5000	20.000	91.793	N.A.	147.00	63.765	83.235	NA	170.77
8.0000	20.000	95.326	N.A.	157.00	68.670	88.330	NA	194.16
8.5000	20.000	98.859	N.A.	167.00	73.575	93.425	NA	218.43
9.0000	20.000	102.39	N.A.	177.00	78.480	98.520	NA	243.59
9.5000	20.000	105.92	N.A.	187.00	83.385	103.61	NA	269.63
10.000	20.000	109.46	N.A.	197.00	88.290	108.71	NA	296.55
10.500	20.000	112.99	N.A.	207.00	93.195	113.81	NA	324.35
11.000	20.000	116.52	N.A.	217.00	98.100	118.90	NA	353.04
11.500	20.000	120.05	N.A.	227.00	103.00	124.00	NA	382.62
12.000	20.000	123.59	N.A.	237.00	107.91	129.09	NA	413.07
12.200	20.000	125.00	N.A.	241.00	109.87	131.13	NA	425.50
12.200	20.000	0.0	40.000	241.00	109.87	131.13	104.90	425.50

Program Pile Version 19.7 Copyright © 2000-2018

Printed 11-Aug-2024

Page 3

Time 23:09

PILEDESIGNS GEOTECHNICAL EXPERTISE Havant - Camp Field, Bartons Road (Phase 1&2) 300mm diameter auger piles Vertical Capacity, EC7 (no testing)						Job No.	Sheet No.	Rev.
						24755		
						Drg. Ref.		
						Made by SA	Date	Checked

Depth	Density	Undrained Cohesion	Nq	Total vertical stress	Porewater pressure	Effective vertical stress	Effective horizontal stress*	Cumulative skin friction per unit
12.500	20.000	0.0	40.000	247.00	112.82	134.18	107.35	446.97
13.000	20.000	0.0	40.000	257.00	117.72	139.28	111.42	483.87
13.500	20.000	0.0	40.000	267.00	122.63	144.38	115.50	522.13
14.000	20.000	0.0	40.000	277.00	127.53	149.47	119.58	561.77
14.500	20.000	0.0	40.000	287.00	132.43	154.57	123.65	602.79
15.000	20.000	0.0	40.000	297.00	137.34	159.66	127.73	645.18
15.500	20.000	0.0	40.000	307.00	142.24	164.76	131.80	688.94
16.000	20.000	0.0	40.000	317.00	147.15	169.85	135.88	734.08
16.000	20.000	110.00	N.A.	317.00	147.15	169.85	NA	734.08
16.500	20.000	113.06	N.A.	327.00	152.05	174.95	NA	761.96
17.000	20.000	116.11	N.A.	337.00	156.96	180.04	NA	790.61
17.500	20.000	119.17	N.A.	347.00	161.87	185.13	NA	820.02
18.000	20.000	122.22	N.A.	357.00	166.77	190.23	NA	850.19

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

Cross-section 1 results:

Uniform pile with top shaft diameter = 0.30 m

Results - Compression

Soil Profile 1: Soil Profile

Depth	Pile length	Ultimate base capacity (Q _b)	Cumulative external Friction (Q _s)	Negative skin friction (Q _{nsf})	Net ultimate resistance
[m]	[m]	[kN]	[kN]	[kN]	[kN]
7.0000	7.0000	56.149	139.73	0.0	195.88
7.5000	7.5000	58.396	160.94	0.0	219.34
8.0000	8.0000	60.644	182.99	0.0	243.63
8.5000	8.5000	62.891	205.87	0.0	268.76
9.0000	9.0000	65.139	229.58	0.0	294.71
9.5000	9.5000	67.386	254.12	0.0	321.50
10.000	10.000	69.633	279.49	0.0	349.12
10.500	10.500	71.881	305.70	0.0	377.58
11.000	11.000	74.128	332.74	0.0	406.86
11.500	11.500	76.375	360.61	0.0	436.98
12.000	12.000	78.623	389.31	0.0	467.93
12.500	12.500	70.686	421.26	0.0	491.95
13.000	13.000	70.686	456.03	0.0	526.72
13.500	13.500	70.686	492.10	0.0	562.78
14.000	14.000	70.686	529.46	0.0	600.14
14.500	14.500	70.686	568.11	0.0	638.80
15.000	15.000	70.686	608.06	0.0	678.75
15.500	15.500	70.686	649.31	0.0	720.00
16.000	16.000	70.686	691.85	0.0	762.54
16.000	16.000	69.979	691.85	0.0	761.83
16.500	16.500	71.923	718.13	0.0	790.05
17.000	17.000	73.867	745.13	0.0	819.00
17.500	17.500	75.811	772.85	0.0	848.66
18.000	18.000	77.754	801.28	0.0	879.04

Depth	Pile length	Design resistance	Combination with least resistance	Factored load*
			#	
		DA1-C1	DA1-C2	
[m]	[m]	[kN]	[kN]	
7.0000	7.0000	139.92	82.434	2 0.0(C) 0.0(C)
7.5000	7.5000	156.67	92.706	2 0.0(C) 0.0(C)
8.0000	8.0000	174.02	103.35	2 0.0(C) 0.0(C)
8.5000	8.5000	191.97	114.37	2 0.0(C) 0.0(C)
9.0000	9.0000	210.51	125.75	2 0.0(C) 0.0(C)
9.5000	9.5000	229.64	137.51	2 0.0(C) 0.0(C)
10.000	10.000	249.37	149.64	2 0.0(C) 0.0(C)
10.500	10.500	269.70	162.14	2 0.0(C) 0.0(C)
11.000	11.000	290.62	175.02	2 0.0(C) 0.0(C)
11.500	11.500	312.13	188.26	2 0.0(C) 0.0(C)
12.000	12.000	334.24	201.88	2 0.0(C) 0.0(C)
12.500	12.500	351.39	213.31	2 0.0(C) 0.0(C)
13.000	13.000	376.23	228.83	2 0.0(C) 0.0(C)

Program Pile Version 19.7 Copyright © 2000-2018

Printed 11-Aug-2024

Page 4
Time 23:09

Havant - Camp Field, Bartons Road (Phase 1&2)
 300mm diameter auger piles
 Vertical Capacity, EC7 (no testing)

Job No.	Sheet No.	Rev.
24755		
Drg. Ref.		
Made by SA	Date	Checked

Depth	Pile length	Design resistance	Combination with least resistance	Factored load*
			#	
13.500	13.500	401.99	244.93	2 0.0(C) 0.0(C)
14.000	14.000	428.67	261.61	2 0.0(C) 0.0(C)
14.500	14.500	456.28	278.87	2 0.0(C) 0.0(C)
15.000	15.000	484.82	296.70	2 0.0(C) 0.0(C)
15.500	15.500	514.28	315.12	2 0.0(C) 0.0(C)
16.000	16.000	544.67	334.11	2 0.0(C) 0.0(C)
16.000	16.000	544.17	333.86	2 0.0(C) 0.0(C)
16.500	16.500	564.32	346.28	2 0.0(C) 0.0(C)
17.000	17.000	585.00	359.03	2 0.0(C) 0.0(C)
17.500	17.500	606.18	372.10	2 0.0(C) 0.0(C)
18.000	18.000	627.89	385.49	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 - Material Factor Set - 1

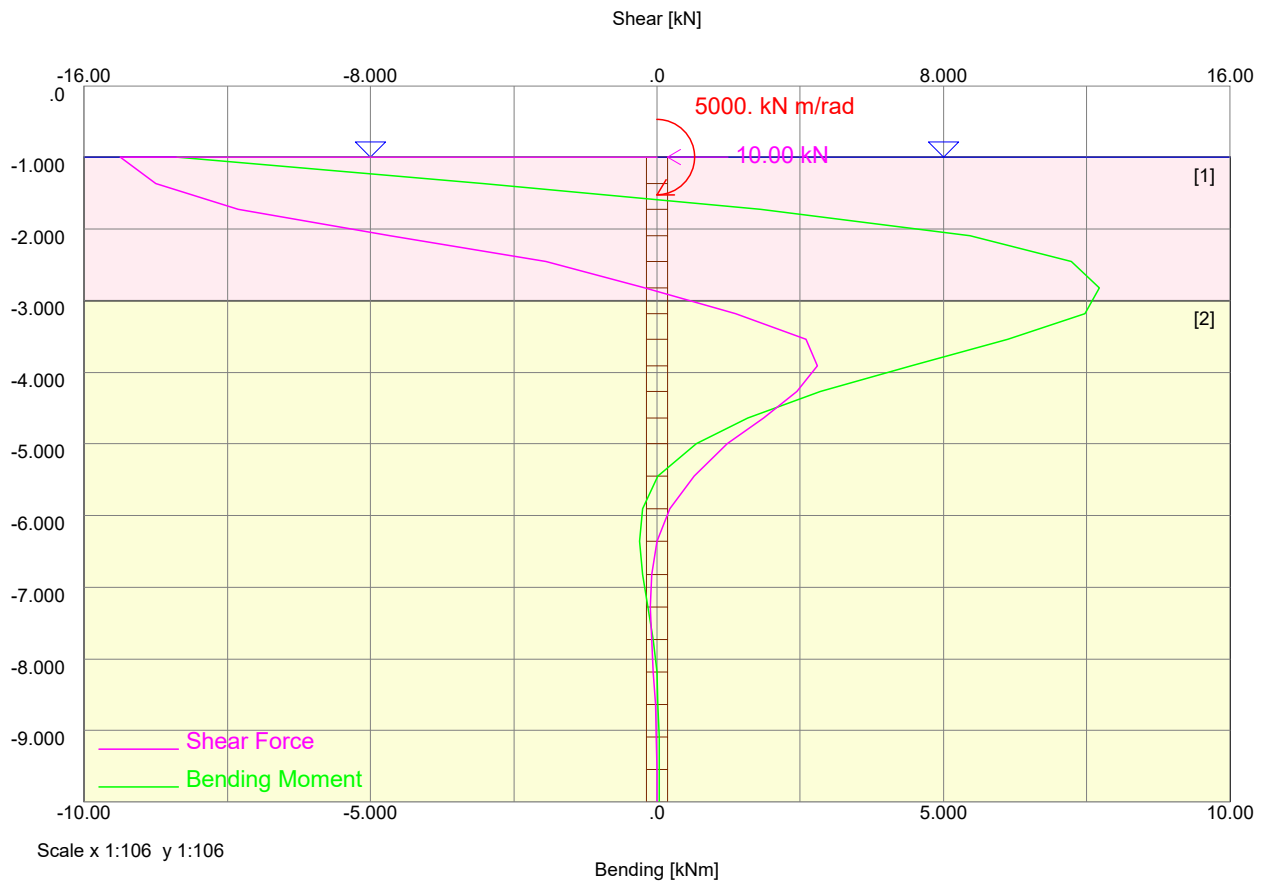
There are no pile toe levels in any drained material(with Berezantzev/Bolton option) in the given soil profile.

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

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

APPENDIX D

OASYS ALP



Output for load increment 1

Havant - Camp Field, Bartons Road
300mm diameter auger piles
10kN Lateral F.rep

Job No.	Sheet No.	Rev.
24755		
Drg. Ref.		
Made by SA	Date	Checked

Notes

Bearing Pile

General Data

Number of increments = 1
Increment applied loads only

Convergence Control

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

Soil Data

Elastic-plastic soils
Factor on soil E value: 0.8000

No.	Level	E	Unit wt.	Phi	Factored Kq	Factored Kc	c(top) [kN/m ²]	dc/dz [kN/m ² /m]
	[m]	[kN/m ²]	[kN/m ³]	[deg]				
1	-1.000000	10000.	18.000	25.000	-	-	0.0	0.0
2	-3.000000	30000.	20.000	24.000	-	-	0.0	0.0

Calculated K_q and K_c Values

Node	Z/D	K _q	K _c
1	0.0	3.2869	5.6339
2	1.2121	4.2684	14.040
3	2.4242	4.9959	18.870
4	3.6364	5.5568	22.006
5	4.8485	6.0025	24.205
6	6.0606	6.3650	25.834
7	7.2727	6.1056	25.191
8	8.4848	6.3285	26.074
9	9.6970	6.5183	26.790
10	10.909	6.6818	27.382
11	12.121	6.8242	27.880
12	13.333	6.9493	28.304
13	14.848	7.0859	28.754
14	16.364	7.2044	29.134
15	17.879	7.3083	29.459
16	19.394	7.4001	29.741
17	20.909	7.4818	29.986
18	22.424	7.5550	30.203
19	23.939	7.6209	30.395
20	25.455	7.6806	30.567
21	26.970	7.7349	30.722
22	28.485	7.7845	30.862
23	30.000	7.8300	30.989

Sections

Name	Input Type	Description	Material	Class	Effective Width [m]	EI [kNm ²]
Section 1	Explicit	Description, Material and Class not applicable			0.30000	7952.0

Pile Properties

Level [m]	Section
-1.0000	Section 1

Pile base at -10.000000 m

Applied Loads and Displacements

No.	Level	Force	Moment	Displacement
-----	-------	-------	--------	--------------

Havant - Camp Field, Bartons Road
 300mm diameter auger piles
 10kN Lateral F.rep

Job No.	Sheet No.	Rev.
24755		
Drg. Ref.		
Made by SA	Date	Checked

[m] [kN] [kNm] [mm]
 1 -1.0000 10.000 0.0 0.0

Restraints

No.	Node	Lateral Stiffness [kN/m]	Rotational Stiffness [kNm/rad]
1	1	0.0	5000.0

Geometry and Initial state

Node	Level [m]	Soil	EI [kNm ²]	Effective Width [m]	Water Pressure [kN/m ²]	Soil Disp [mm]
1	-1.0000	1	7952.0	0.30000	0.0	0.0
2	-1.3636	1	7952.0	0.30000	3.5673	0.0
3	-1.7273	1	7952.0	0.30000	7.1345	0.0
4	-2.0909	1	7952.0	0.30000	10.702	0.0
5	-2.4545	1	7952.0	0.30000	14.269	0.0
6	-2.8182	1	7952.0	0.30000	17.836	0.0
7	-3.1818	2	7952.0	0.30000	21.404	0.0
8	-3.5455	2	7952.0	0.30000	24.971	0.0
9	-3.9091	2	7952.0	0.30000	28.538	0.0
10	-4.2727	2	7952.0	0.30000	32.105	0.0
11	-4.6364	2	7952.0	0.30000	35.673	0.0
12	-5.0000	2	7952.0	0.30000	39.240	0.0
13	-5.4545	2	7952.0	0.30000	43.699	0.0
14	-5.9091	2	7952.0	0.30000	48.158	0.0
15	-6.3636	2	7952.0	0.30000	52.617	0.0
16	-6.8182	2	7952.0	0.30000	57.076	0.0
17	-7.2727	2	7952.0	0.30000	61.535	0.0
18	-7.7273	2	7952.0	0.30000	65.995	0.0
19	-8.1818	2	7952.0	0.30000	70.454	0.0
20	-8.6364	2	7952.0	0.30000	74.913	0.0
21	-9.0909	2	7952.0	0.30000	79.372	0.0
22	-9.5455	2	7952.0	0.30000	83.831	0.0
23	-10.000	2	7952.0	0.30000	88.290	0.0

Output for load increment 1

Iteration	Max Inc Disp [mm]	at node	Disp error [mm]	Pressure error [kN/m ²]
16	3.87	1	0.0010	0.03

Node	Level [m]	Defl [mm]	Rotation [rad]	Soil Pressure [kN/m ²]	Bending [kNm]	Shear [kN]	
1	-1.0000	-3.8691	-0.0016766	1	-5.3786	0.0	P
1	-1.0000				-8.3830	-15.000	
2	-1.3636	-3.2046	-0.0019377	1	-12.712	-3.0352	P
3	-1.7273	-2.4881	-0.0019658	1	-29.758	1.8084	P
4	-2.0909	-1.7985	-0.0017995	1	-47.960	5.4715	
5	-2.4545	-1.1945	-0.0015092	1	-31.852	7.2321	
6	-2.8182	-0.70710	-0.0011675	1	-18.856	7.7291	
7	-3.1818	-0.34606	-820.18E-6	2	-27.685	7.4782	
8	-3.5455	-0.10616	-509.58E-6	2	-8.4927	6.1289	
9	-3.9091	0.032964	-268.47E-6	2	2.6371	4.4428	
10	-4.2727	0.098158	-102.16E-6	2	7.8526	2.8613	
11	-4.6364	0.11518	-1.1558E-6	2	9.2144	1.5912	
12	-5.0000	0.10504	50.040E-6	2	8.4029	0.68675	
13	-5.4545	0.076512	69.135E-6	2	6.1210	0.024903	
14	-5.9091	0.046298	61.094E-6	2	3.7038	-0.25755	
15	-6.3636	0.022447	43.321E-6	2	1.7958	-0.31042	
16	-6.8182	0.0069134	25.559E-6	2	0.55307	-0.25199	
17	-7.2727	-0.0014206	11.969E-6	2	-0.11365	-0.15928	
18	-7.7273	-0.0047179	3.3302E-6	2	-0.37743	-0.073606	
19	-8.1818	-0.0050664	-1.2283E-6	2	-0.40531	-0.011331	
20	-8.6364	-0.0040095	-3.0928E-6	2	-0.32076	0.025822	
21	-9.0909	-0.0024680	-3.5496E-6	2	-0.19744	0.043093	
22	-9.5455	-856.79E-6	-3.5166E-6	2	-0.068543	0.048126	
23	-10.000	726.09E-6	-3.4652E-6	2	0.058087	0.048911	

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

Havant - Camp Field, Bartons Road
 300mm diameter auger piles
 10kN Lateral F.rep

Job No.	Sheet No.	Rev.
24755		
Drg. Ref.		
Made by SA	Date	Checked

Node	Level [m]	Defl [mm]	Rotation [rad]	Soil Pressure [kN/m ²]	Bending [kNm]	Shear [kN]
------	--------------	--------------	-------------------	---------------------------------------	------------------	---------------

EXTREME values so far:-

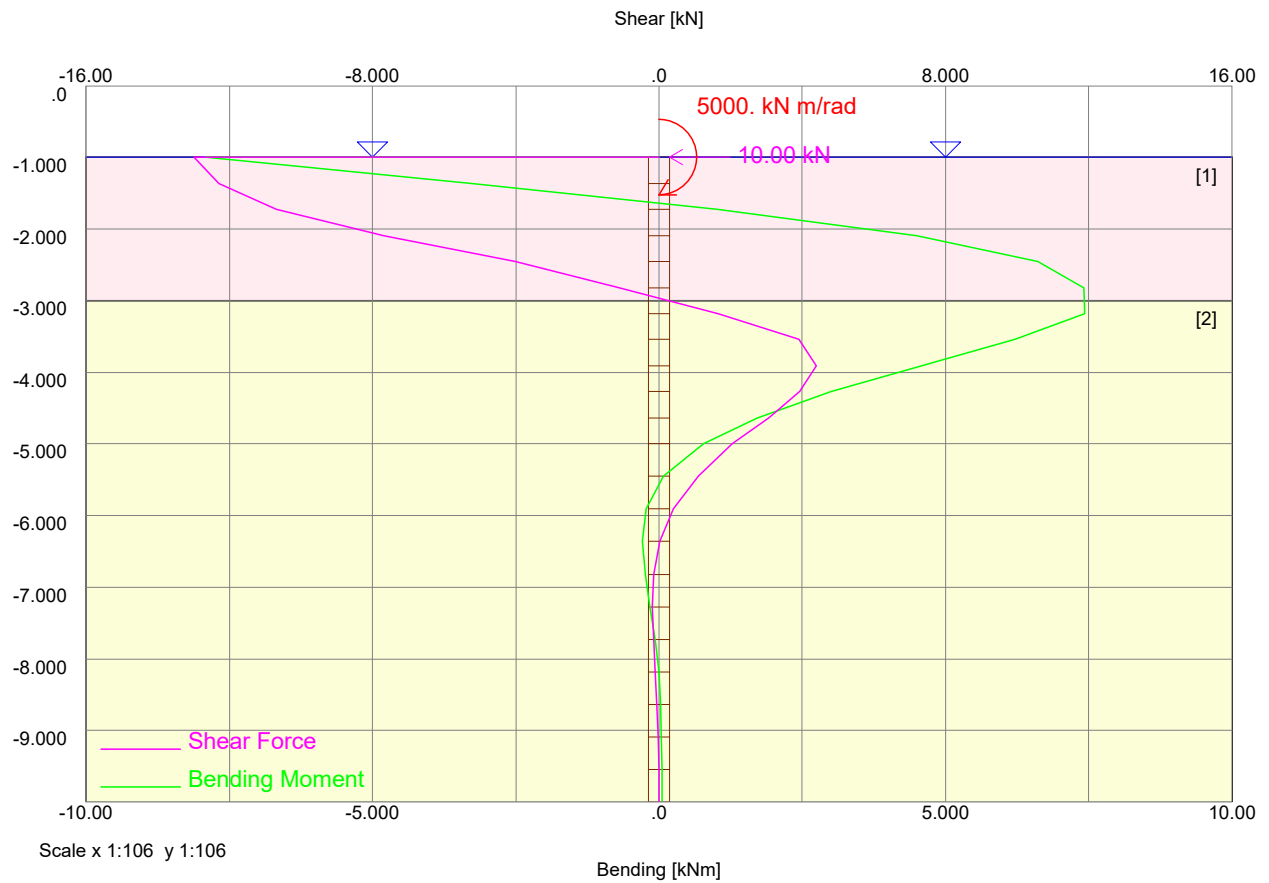
Deflections		Rotations		Moments		Shears	
Min	Max	Min	Max	Min	Max	Min	Max
[mm]	[mm]	[rad]	[rad]	[kNm]	[kNm]	[kN]	[kN]
-3.8691	0.11518	-0.0019658	69.135E-6	-8.3830	7.7291	-15.000	4.4930

RESTRAINT FORCES

No. Node Lateral Moment
 force

		[kN]	[kNm]
1	1	0.0	8.3830

Job No.	Sheet No.	Rev.
24755		
Drg. Ref.		
Made by	Date	Checked
SA		



Output for load increment 1

Havant - Camp Field, Bartons Road
300mm diameter auger piles
10kN Lateral F.rep

Job No.	Sheet No.	Rev.
24755		
Drg. Ref.		
Made by	Date	Checked
SA		

Notes

Bearing Pile

General Data

Number of increments = 1
Increment applied loads only

Convergence Control

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

Soil Data

Elastic-plastic soils
Factor on soil E value: 0.8000

No.	Level	E	Unit	Phi	Factored K _q	Factored K _c	c(top)	dc/dz
	[m]	[kN/m ²]	wt.	[deg]			[kN/m ²]	[kN/m ² /m]
1	-1.000000	10000.	18.000	25.000	-	-	0.0	0.0
2	-3.000000	30000.	20.000	24.000	-	-	0.0	0.0

Calculated K_q and K_c Values

Node	Z/D	K _q	K _c
1	0.0	2.3566	4.7453
2	1.2121	3.0108	11.223
3	2.4242	3.4726	14.601
4	3.6364	3.8159	16.675
5	4.8485	4.0811	18.077
6	6.0606	4.2922	19.089
7	7.2727	4.1343	18.823
8	8.4848	4.2629	19.371
9	9.6970	4.3711	19.811
10	10.909	4.4636	20.171
11	12.121	4.5434	20.472
12	13.333	4.6131	20.727
13	14.848	4.6886	20.996
14	16.364	4.7538	21.222
15	17.879	4.8105	21.414
16	19.394	4.8604	21.580
17	20.909	4.9046	21.724
18	22.424	4.9441	21.851
19	23.939	4.9795	21.963
20	25.455	5.0115	22.063
21	26.970	5.0405	22.153
22	28.485	5.0669	22.234
23	30.000	5.0911	22.308

Sections

Name	Input Type	Description	Material	Class	Effective Width	EI
					[m]	[kNm ²]
Section 1	Explicit	Description, Material and Class not applicable			0.30000	7952.0

Pile Properties

Level	Section
[m]	
-1.0000	Section 1

Pile base at -10.000000 m

Applied Loads and Displacements

No.	Level	Force	Moment	Displacement
-----	-------	-------	--------	--------------

Havant - Camp Field, Bartons Road
 300mm diameter auger piles
 10kN Lateral F.rep

Job No.	Sheet No.	Rev.
24755		
Drg. Ref.		
Made by SA	Date	Checked

[m] [kN] [kNm] [mm]
 1 -1.0000 10.000 0.0 0.0

Restraints

No.	Node	Lateral Stiffness [kN/m]	Rotational Stiffness [kNm/rad]
1	1	0.0	5000.0

Geometry and Initial state

Node	Level [m]	Soil	EI [kNm ²]	Effective Width [m]	Water Pressure [kN/m ²]	Soil Disp [mm]
1	-1.0000	1	7952.0	0.30000	0.0	0.0
2	-1.3636	1	7952.0	0.30000	3.5673	0.0
3	-1.7273	1	7952.0	0.30000	7.1345	0.0
4	-2.0909	1	7952.0	0.30000	10.702	0.0
5	-2.4545	1	7952.0	0.30000	14.269	0.0
6	-2.8182	1	7952.0	0.30000	17.836	0.0
7	-3.1818	2	7952.0	0.30000	21.404	0.0
8	-3.5455	2	7952.0	0.30000	24.971	0.0
9	-3.9091	2	7952.0	0.30000	28.538	0.0
10	-4.2727	2	7952.0	0.30000	32.105	0.0
11	-4.6364	2	7952.0	0.30000	35.673	0.0
12	-5.0000	2	7952.0	0.30000	39.240	0.0
13	-5.4545	2	7952.0	0.30000	43.699	0.0
14	-5.9091	2	7952.0	0.30000	48.158	0.0
15	-6.3636	2	7952.0	0.30000	52.617	0.0
16	-6.8182	2	7952.0	0.30000	57.076	0.0
17	-7.2727	2	7952.0	0.30000	61.535	0.0
18	-7.7273	2	7952.0	0.30000	65.995	0.0
19	-8.1818	2	7952.0	0.30000	70.454	0.0
20	-8.6364	2	7952.0	0.30000	74.913	0.0
21	-9.0909	2	7952.0	0.30000	79.372	0.0
22	-9.5455	2	7952.0	0.30000	83.831	0.0
23	-10.000	2	7952.0	0.30000	88.290	0.0

Output for load increment 1

Iteration	Max Inc Disp [mm]	at node	Disp error [mm]	Pressure error [kN/m ²]
20	3.82	1	0.0017	0.06
22	3.83	1	0.0009	0.02

Node	Level [m]	Defl [mm]	Rotation [rad]	Soil Pressure [kN/m ²]	Bending [kNm]	Shear [kN]	
1	-1.0000	-3.8281	-0.0015841	1	-3.8563	0.0	P
1	-1.0000				-7.9203	-13.000	
2	-1.3636	-3.1991	-0.0018399	1	-8.9668	-12.301	P
3	-1.7273	-2.5148	-0.0018913	1	-20.684	-10.683	P
4	-2.0909	-1.8452	-0.0017651	1	-34.093	-7.6954	P
5	-2.4545	-1.2466	-0.0015110	1	-33.242	-4.0226	
6	-2.8182	-0.75436	-0.0011901	1	-20.116	-1.1121	
7	-3.1818	-0.38325	-850.93E-6	2	-30.660	1.6575	
8	-3.5455	-0.13215	-539.39E-6	2	-10.572	3.9065	
9	-3.9091	0.016919	-292.93E-6	2	1.3535	4.4093	
10	-4.2727	0.089791	-119.91E-6	2	7.1833	3.9437	
11	-4.6364	0.11209	-12.581E-6	2	8.9669	3.0628	
12	-5.0000	0.10513	43.696E-6	2	8.4103	2.0576	
13	-5.4545	0.078423	67.101E-6	2	6.2738	1.1137	
14	-5.9091	0.048539	61.385E-6	2	3.8832	0.42122	
15	-6.3636	0.024305	44.539E-6	2	1.9444	0.023890	
16	-6.8182	0.0081714	26.888E-6	2	0.65371	-0.15325	
17	-7.2727	-714.13E-6	13.034E-6	2	-0.057131	-0.19393	
18	-7.7273	-0.0044134	4.0348E-6	2	-0.35307	-0.16596	
19	-8.1818	-0.0050075	-837.32E-9	2	-0.40060	-0.11457	
20	-8.6364	-0.0040753	-2.9171E-6	2	-0.32602	-0.065032	
21	-9.0909	-0.0025836	-3.4918E-6	2	-0.20669	-0.028710	
22	-9.5455	-985.97E-6	-3.5052E-6	2	-0.078878	-0.0092401	
23	-10.000	594.52E-6	-3.4630E-6	2	0.047562	-0.0071049	

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

Havant - Camp Field, Bartons Road
300mm diameter auger piles
10kN Lateral F.rep

Job No.	Sheet No.	Rev.
24755		
Drg. Ref.		
Made by SA	Date	Checked

Node	Level [m]	Defl [mm]	Rotation [rad]	Soil Pressure [kN/m ²]	Bending [kNm]	Shear [kN]
------	--------------	--------------	-------------------	---------------------------------------	------------------	---------------

EXTREME values so far:-

Deflections		Rotations		Moments		Shears	
Min	Max	Min	Max	Min	Max	Min	Max
[mm]	[mm]	[rad]	[rad]	[kNm]	[kNm]	[kN]	[kN]
-3.8281	0.11209	-0.0018913	67.101E-6	-7.9203	7.4311	-13.000	4.4093

RESTRAINT FORCES

No.	Node	Lateral force	Moment
-----	------	---------------	--------

		[kN]	[kNm]
1	1	0.0	7.9203

APPENDIX E

OASYS ADC

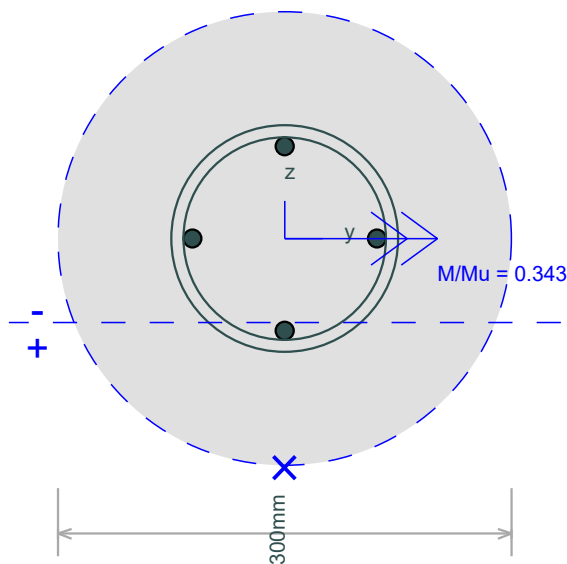
Job No.	Sheet No.	Rev.
24755		
Drg. Ref.		
Made by SA	Date 08-Aug-2024	Checked

Reinforcement Details

Bar Arrangement	1 ring(s)/4 bars per ring
Diameter of main bars	12mm
Area of reinforcement	452.389mm ²
Nominal Cover (outer)	75mm

Design Results

Analysis Case Name	1.min
Axial Design Force	68kN
Axial Capacity	1194.02kN
Design Moment 'M'	8.4kNm
Ultimate Moment 'Mu'	24.4783kNm
Neutral Axis	— — —
Comp./Tens. Side	+/-
Governing Node/Bar	X


Section 1
 Analysis Case 1

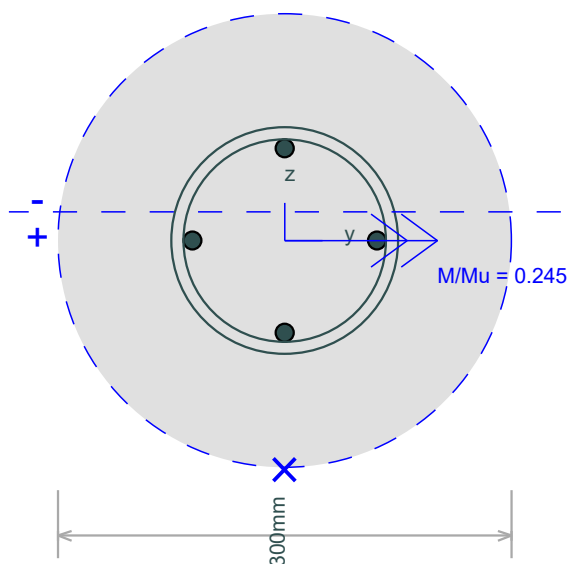
Job No.	Sheet No.	Rev.
24755		
Drg. Ref.		
Made by SA	Date 08-Aug-2024	Checked

Reinforcement Details

Bar Arrangement	1 ring(s)/4 bars per ring
Diameter of main bars	12mm
Area of reinforcement	452.389mm ²
Nominal Cover (outer)	75mm

Design Results

Analysis Case Name	1.max
Axial Design Force	486kN
Axial Capacity	1194.02kN
Design Moment 'M'	8.4kNm
Ultimate Moment 'Mu'	34.3328kNm
Neutral Axis	— — —
Comp./Tens. Side	+/-
Governing Node/Bar	X



Section 1

Analysis Case 2

Havant - Camp Field, Bartons Road
300mm diameter auger piles
Pile Reinforcement Design

Job No.	Sheet No.	Rev.
24755		
Drg. Ref.		
Made by SA	Date 08-Aug-2024	Checked

Havant - Camp Field, Bartons Road

300mm diameter auger piles
Pile Reinforcement Design

Notes:

Cover: 75mm
Concrete: C28/35

History

Date	Time	Name	Note
11-Aug-2024	23:11	pilllingw	

Input Data

General Specification

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

Pile section

Effective length of pile	10.00
Diameter of pile	300.0
Pile with casing	Yes
Design diameter(EC2 clause 2.3.4.2(2))	300.0

User Defined Concrete Properties

Prop.	Name	fck	Max. Agg. Size	Tensile Strength	Static E	Gamma c	Maximum Strain
		[N/mm ²]	[mm]	[N/mm ²]	[N/mm ²]		
1	CIS C28/35	28.00	20.00	1.710	31480.	1.650	0.003500
2	CIS C32/40	32.00	20.00	2.016	33350.	1.650	0.003500
3	CIS C25/30	25.00	20.00	1.710	31480.	1.650	0.003500
4	CIS C30/37	30.00	20.00	1.931	32840.	1.650	0.003500

Concrete Material Specification

Prop.	Name	fck	Max. Agg. Size	Tensile Strength	Static E	Gamma c
Maximum Strain						
		[N/mm ²]	[mm]	[N/mm ²]	[N/mm ²]	
Column	CIS C28/35	28.00	20.00	1.710	31480.	1.650
0.003500						

Reinforcement Specification

Prop.	Name	fy	Bond Coeff.	Bond Coeff.	Young's	Gamma s
-------	------	----	-------------	-------------	---------	---------

Maximum			Tension	Compr.	Modulus	Strain
		[N/mm ²]			[N/mm ²]	
Main	500B	500.0	0.5000	0.6300	200000.	1.150
0.05000						
Links	500B	500.0	0.5000	0.6300	200000.	1.150
0.05000						

Loads

Load Case	Axial Design Force 'N'	Moments			
		Top		Bottom	
		Myy [kNm]	Mzz [kNm]	Myy [kNm]	Mzz [kNm]
1	68.00	8.400	0.0	0.0	0.0
2	486.0	8.400	0.0	0.0	0.0

Analysis Cases

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

Covers

Min. Nominal Cover (outer) 75.00 mm

Available Bar Sizes

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

Bar Limits

	Minimum	Maximum
	[mm]	[mm]
Main	12.00	12.00
Links	8.000	8.000

Checks and Limits

Max. Area of Reinf.	EN 1992-1-1:2004 Eurocode 2 (GB)
Min. Area of Reinf.	EN 1992-1-1:2004 Eurocode 2 (GB)
Min. Bar Size	EN 1992-1-1:2004 Eurocode 2 (GB)
Min. No of Bars	EN 1992-1-1:2004 Eurocode 2 (GB)
Max. bar spacing (tension)	None
Max. bar spacing (compression)	None
Min. Bar Spacing	None
Link size	None
Maximum Link Spacing	EN 1992-1-1:2004 Eurocode 2 (GB)
Top and bottom of column connected to beams or slabs	No
Cover check: bar size	None
Cover check: aggregate size	None
Deviation (ΔC _{dev})	10.00 mm

Job No.	Sheet No.	Rev.
24755		
Drg. Ref.		
Made by SA	Date 08-Aug-2024	Checked

Minimum
[mm]

Maximum
[mm]

Bar Arrangements

Nr of Rings
1

Nr of Bars per Ring
4

Ring Diameter
Cover and min. pitch

Eurocode 2 Nationally Determined Parameters

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

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

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

Clause	Parameter	Value
3.1.6	α_{cc}	0.8500

Design Results

Pile Design Moment Derivation (for bending about z axis)

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

Analysis Case

All

Capacity

All

Sec.	Analysis	Axial	Init.	Init.	l_0	λ	A	B	C	n	λ_{lim}	K_r	K_ϕ	d
1/r	e_2	e_0	e_i	Braced	2nd	Imp.	Design							
	Case	Design	Top	Bottom	(E5.14)	(E5.14)	(E5.13)	(E5.13)	(E5.13)	(E5.13)	(E5.13)	(E5.34)	(E5.34)	
	(E5.35)	(E5.33)	(E5.33)	(C6.1(4))	(E5.2)	Order	Moment	Moment						
		Force	Moment	Moment										
Moment														
		'N'												
		[kN]	[kNm]	[kNm]	[m]									
		[mm]	[mm]	[mm]										
1		68.00	8.400	0.0	0.0	133.3	0.7937	1.163	1.700	0.06102	127.1	0.0	0.0	
0.0	0.0	0.0	0.0	0.0	Yes	(0.0)	(0.0)	*8.400						
1		486.0	8.400	0.0	0.0	133.3	0.7937	1.163	1.700	0.4361	47.53	0.0	0.0	
0.0	0.0	0.0	0.0	0.0	Yes	(0.0)	(0.0)	*8.400						

Notes:

() Moments shown thus have been excluded from the final design moment (ref Eurocode Cl 5.8.2(6) or Eurocode 2 Cl 5.8.9(2)).

* Design moments shown thus result from maximum end moment plus imperfection moment - if imperfection moment is to be applied about this axis.

Pile Design Moment Derivation (for bending about z axis)

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

Analysis Case

All

Capacity

All

Havant - Camp Field, Bartons Road
 300mm diameter auger piles
 Pile Reinforcement Design

Job No.	Sheet No.	Rev.
24755		
Drg. Ref.		
Made by SA	Date 08-Aug-2024	Checked

Sec.	Analysis	Axial	Init.	Init.	l_0	λ	A	B	C	n	λ_{lim}	K_r	K_ϕ	d
1/r	e_2	e_0	e_i	Braced	2nd	Imp.	Design							
	Case	Design	Top	Bottom	(E5.14)	(E5.14)	(E5.13)	(E5.13)	(E5.13)	(E5.13)	(E5.13)	(E5.34)	(E5.34)	
	(E5.35)	(E5.33)	(E5.33)	(C6.1(4))	(E5.2)	Order	Moment	Moment						
		Force	Moment	Moment										
		'N'												
		[kN]	[kNm]	[kNm]	[m]	[m]					[m]			
		[mm]	[mm]	[mm]	[mm]	[mm]	[kNm]	[kNm]	[kNm]					
1		68.00	0.0	0.0	0.0	133.3	0.7937	1.163	0.7000	0.06102	52.32	0.0	0.0	
0.0	0.0	0.0	0.0	0.0	Yes	0.0	0.0	0.0						
1		486.0	0.0	0.0	0.0	133.3	0.7937	1.163	0.7000	0.4361	19.57	0.0	0.0	
0.0	0.0	0.0	0.0	0.0	Yes	0.0	0.0	0.0						

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

Pile Summary Results

Derivation of pile design moments output for the following selection:

Analysis Case All
 Capacity All
 Sorted By Section

Sec.	Analysis Case	Bar Arrangement	No.of	Bar	Area of Reinf.	Link	Maximum	Nominal
Axial	N_{max}	N/N_{max}	Resultant	Moment	M_u	M/M_u		
Design	Design	Angle	Bars	Size	Size	Spacing	Cover	
Force	Moment					of	(outer)	
'N'	'M'					Links		
[kN]	[kN]	[kNm]	[°]	[kNm]	[mm]	[mm ²]	[%]	[mm]
1	1 1.min	1 ring(s)/4 bars per ring	4	12.00	452.4	0.6400	8.000	240.0
68.00	1194. 0.05695	8.400 0.0 24.48 0.3432 %						
1	2 1.max	1 ring(s)/4 bars per ring	4	12.00	452.4	0.6400	8.000	240.0
486.0	1194. 0.4070	8.400 0.0 34.33 0.2447 %						

Notes:
 % Sections with adequate axial and bending capacity for all analysis cases, with lowest area of longitudinal reinforcement are marked thus.

APPENDIX F

HELICAL CHECK

Project	Havant - Camp Field, Bartons Road	Project No.	24755	Date	08/08/2024
Tilte	300mm diameter auger piles	By	SA	Check By	PJI
					Page 1

Shear to EN 1992-1-1:2004 (EC2) Circular Sections (Cast In-situ) using helical reinforcement

Pile section					
pile dia d_{nom}	=	300	mm		
design pile diameter	=	300	mm		
A_c	=	70686	mm ²		
cover c_{nom}	=	75	mm	[4.4.1.3(4)]	$k_2 = 75$ mm [NA.1 4.4.1.3 (4)]
main bar dia	=	12	mm		
no. main bars	=	4	no.		
helical dia.	=	8	mm		
d	=	185	mm		
f_{ck}	=	28	MPa	$\gamma_c = 1.5$ (This is adjusted by $K_f=1.1$ [2.4.2.5 (2)] to give 1.65)	
f_{yk}	=	500	MPa	$\gamma_c = 1.65$	$\alpha_{cc} = 1$ [NA.1 3.1.6 (1)]
Ult V_{Ed}	=	15	kN	$\gamma_s = 1.15$	
Ult V_{Ed}	=	15	kN	SF factor	1
factored action: N_{Ed}	=	72	kN		

Check requirement for shear reinforcement [6.2.2]

$V_{Rd,c}$	=	$[C_{Rd,c}k(100\rho_1f_{ck})^{1/3}+k_1\sigma_{cp}]b_wd$	$CR_{d,c} = 0.18 / \gamma_c$	0.11
with minimum	=	$(v_{min}+k_1\sigma_{cp})b_wd$	$k = 1+(200/d)^{1/2}$	2.00 ≤ 2.0
v_{min}	=	$0.035k^{3/2}f_{ck}^{1/2}$	$\rho_1 = A_{sl}/b_wd$	0 ≤ 0.02
		0.5238	$\sigma_{cp} = N_{ed}/A_c$	1.02 $< 0.2f_{cd}$
$V_{Rd,c}$	=	36 kN	$k_1 = 0.15$	[NA.1 6.2.2(1)]
Is $V_{Rd,c} > V_{Ed}$	=>	YES	Action: No shear links needed - provide nominal links as req'd	

Turo, J, *et al*. Shear truss analogy for concrete members of solid and hollow circular cross section. **Eng. Struc.** (2008)

Project	Havant - Camp Field, Bartons Road	Project No.	24755	Date	08/08/2024
Tilte	300mm diameter auger piles	By	SA	Check By	PJI
					Page 2

Shear to EN 1992-1-1:2004 (EC2) Circular Sections (Cast In-situ) using helical reinforcement

<u>Pile section</u>					
pile dia d_{nom}	=	300	mm		
design pile diameter	=	300	mm		
A_c	=	70686	mm ²		
cover c_{nom}	=	75	mm	[4.4.1.3(4)]	$k_2 = 75$ mm [NA.1 4.4.1.3 (4)]
main bar dia	=	12	mm		
no. main bars	=	4	no.		
helical dia.	=	8	mm		
d	=	185	mm		
f_{ck}	=	28	MPa	$\gamma_c = 1.5$ (This is adjusted by $K_f=1.1$ [2.4.2.5 (2)] to give 1.65)	
f_{yk}	=	500	MPa	$\gamma_c = 1.65$	$\alpha_{cc} = 1$ [NA.1 3.1.6 (1)]
Ult V_{Ed}	=	15	kN	$\gamma_s = 1.15$	
Ult V_{Ed}	=	15	kN	SF factor	1
factored action: N_{Ed}	=	483	kN		

Check requirement for shear reinforcement [6.2.2]

$V_{Rd,c}$	=	$[C_{Rd,c}k(100\rho_1f_{ck})^{1/3}+k_1\sigma_{cp}]b_wd$	$CR_{d,c}$	=	$0.18 / \gamma_c$	0.11
with minimum	=	$(v_{min}+k_1\sigma_{cp})b_wd$	k	=	$1+(200/d)^{1/2}$	2.00 ≤ 2.0
v_{min}	=	$0.035k^{3/2}f_{ck}^{1/2}$	ρ_1	=	A_{sl}/b_wd	0 ≤ 0.02
		0.5238	σ_{cp}	=	N_{ed}/A_c	3.39 $< 0.2f_{cd}$
$V_{Rd,c}$	=	56 kN	k_1	=	0.15	[NA.1 6.2.2(1)]

Is $V_{Rd,c} > V_{Ed}$ $\Rightarrow$ **YES** Action: **No shear links needed - provide nominal links as req'd**
 Turo, J, *et al*. Shear truss analogy for concrete members of solid and hollow circular cross section. **Eng. Struc.** (2008)

END OF CALCULATIONS