Contract Reference:
M23746

Site Address:
St Giles Quarter,
1 Museum Street,
London
WC1A 1JR

Client:
John F Hunt

Design Element:
Tension Pile Structural Design Calculations

Issue	Date	By	Checked	Comments
1	11/12/2024	A2-Studio	Harry Shaw	First Issue

A-squared Studio

1 Museum Street

Tension Pile Design Calculations

December 2024

3696-A2S-XX-XX-CA-Y-0001-00

Project Name	1 Museum Street
Project Number	3696
Client	Martello Piling Ltd
Document Name	Tension Pile Design Calculations

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Revision	Date	Prepared by	Checked by	Description	Internal level of Check (1, 2 or 3)	BS 5975 level of Check (0, 1, 2 or 3)
00	10/12/24	Thomas Benham	Andrew Brindle	First Issue	2	1

Internal Level of Checking

Check Level 1 is a general check by another member of the A-squared design team

Check level 2 is a check of principles and arithmetic by another member of the A-squared design team

Check level 3 is a fully independent design for comparison by another independent team either within A-squared or from another organisation

BS 5975 Level of Checking

Check Level 0 is a general check by another member of the A-squared design team

Check Level 1 is a check of principles and arithmetic by another member of the A-squared design team

Check Level 2 is a fully independent design for comparison by another independent team within A-squared

Check Level 3 is a fully independent design for comparison by another team that is from another organisation

Executive Summary

A-squared Studio Engineers Ltd (A-Squared) has been commissioned by Martello Piling Ltd (Martello) to undertake the detailed structural design of movement reducing tension piles at 1 Museum Street, also known as St Giles Quarter.

The tension piles required are 15 No. 900mm dimeter rotary bored piles. 900mm is the tool diameter, any temporary casing adopted must ensure that a minimum 900mm diameter pile is present along the entire length of the pile.

The piling platform has been assumed as the structural slab level based on drawings from Heyne Tillet Steel (HTS). HTS to confirm assumptions.

Pile Cut Off Level is +16.500mOD throughout as noted on drawing SGQ-HTS-1MS-B3-DR-S-10060.

Pile loads have been provided by HTS on drawing SGQ-HTS-1MS-B3-DR-S-10060.

Pile lengths are determined by HTS. Piles are understood to movement reducing piles and as such the pile length and diameter is determined by others, not the Piling Contractor. As such no geotechnical assessment is carried out in this report.

Characteristic tension actions are understood to be due to heave and are therefore treated as persistent actions.

Characteristic compression actions are assumed to be 70:30 permanent to variable.

Pile design is in accordance with BS EN 1997-1 and the associated UK National Annex.

A detailed CDM risk assessment, only for the proposed piling works, is provided in Appendix A: . The Client & Designer for this project are subject to certain duties under the CDM Regulations.

A tension pile schedule provided in Appendix C: .

Contents

Appendices

1. Scope

A-squared Studio Engineers Ltd (A-Squared) has been commissioned by Martello Piling Ltd (Cohesion) to undertake the detailed structural design of tension piles at 1 Museum Street, also known as St Giles Quarter.

The tension piles required are 15 No. 900mm dimeter rotary bored piles. 900mm is the tool diameter, any temporary casing adopted must ensure that a minimum 900mm diameter pile is present along the entire length of the pile.

The piling platform has been assumed as the structural slab level based on drawings from Heyne Tillet Steel (HTS). HTS to confirm assumptions.

Pile Cut Off Level is +16.500mOD throughout as noted on drawing SGQ-HTS-1MS-B3-DR-S-10060.

Pile loads have been provided by HTS on drawing SGQ-HTS-1MS-B3-DR-S-10060.

Pile lengths are determined by HTS. Piles are understood to movement reducing piles and as such the pile length and diameter is determined by others, not the Piling Contractor.

Characteristic tension actions are understood to be due to heave and are therefore treated as persistent actions.

Characteristic compression actions are assumed to be 70:30 permanent to variable.

This assessment considers the structural design of the piles only, no geotechnical design is considered in this report.

2. Relevant Documentation

The information provided comprises of, but is not limited to, the following:

2.1. Specifications

- None

2.2. Documents

- None

2.3. Drawings

- HTS - Pre-Demolition Piling Drawing – SGQ-HTS-1MS-B3-DR-S-10060

3. Pile Design Key Requirements and Assumptions

The pile design is in accordance with ICE SPERW 3rd Edition, 2017, BS EN 1992-1-1 and BS EN 1997-1. Piles are assumed to be constructed in accordance with BS EN 1536:2010.

The following assumptions are made in the design of the tension piles. These assumptions are to be validated by all parties prior to construction works:

- The piling platform has been assumed as the structural slab level based on drawings from HTS. HTS to confirm assumptions.
- All the piles are designed as rotationally restrained at the pile head, i.e., moment restraint has been applied. No eccentric moments have been allowed for. If this is not the case, then the pile designer should be notified immediately.
- Pile loads have been provided by HTS on drawing no. SGQ-HTS-1MS-B3-DR-S-10060. A load split of 70:30 permanent to variable has been assumed in compression.
- Tension loads provided by HTS on drawing no. SGQ-HTS-1MS-B3-DR-S-10060 are assumed to be due to heave and are therefore treated as persistent actions.
- Cover of 75mm to be adopted for all piles.
- Grade B500 reinforcement steel is adopted within the design of the pile cages.

4. Pile Loading

Pile loads have been provided by HTS on drawing no. SGQ-HTS-1MS-B3-DR-S-10060.

A load split of 70:30 permanent to variable has been assumed in compression.

Characteristic tension actions are assumed to be due to heave and are therefore treated as persistent actions.

No lateral loads have been provided therefore none have been designed for.

The characteristic actions for the tension piles can be summarised as follows:

- Characteristic Compression Action: 7490kN
- Characteristic Tension Action: 1460kN to 2630kN

Design actions are shown in the tension pile schedule in Appendix C: .

5. Structural Calculations

5.1. Concrete Strength

Once drilled to the required length, the piles will be filled with a minimum C28/35 at 28 days concrete (with a maximum aggregate size of 20mm).

The piles are to be broken down to cut-off-level with equipment and methods suitable so as not to damage the piles or reinforcement.

5.2. Compression Capacity

The compression capacity of the piles has been assessed using the Oasys programme AdSec to BS EN 1992-1-1. The design compression capacities are greater than the maximum combination 1 design action acting on any pile. See calculations in Appendix B.

5.3. Main Reinforcement

Pile reinforcement has been determined using the Oasys programme AdSec, to BS EN 1992-1-1. The structural design of the bearing piles is undertaken using the maximum and minimum C1 axial actions. The design calculations are included in Appendix B and can be summarised as follows:

Table 5-1 Summary of tension pile reinforcement

Cage Type	Pile Diameter (mm)	Maximum c1 Compression Action (kN)	Maximum C1 Tension Action (kN)	Main Reinforcement	Shear Reinforcement
Cage A	900		3551	7B40	B12 at 300mm c/c
Cage B	900		3429	6B40	B12 at 300mm c/c
Cage C	900		2606	7B32	B12 at 300mm c/c

All pile reinforcement shall be Grade B500. Ductility class B or C.

Reinforcement cage toe levels are provided by HTS, as -7.50mOD.

5.3.1. Anchorage

Anchorage lengths for the main reinforcement into the pile cap (in accordance with BS EN 1992-1-1 and considering SPERW tolerances for reinforcement placement) are proposed to be as follows:

- 32mm diameter bars – 1280mm
- 40mm diameter bars – 1600mm

It is not clear if the proposed slabs will have sufficient anchorage length within the proposed basement slabs. It may be that full strength couplers are required so that additional reinforcement bars can be coupled to the main cage to provide the minimum required projection length into the proposed slabs.

6. Carbon Footprint

Based on the design described within this document, the volume of concrete (assuming high cement replacement) and tonnage of reinforcing steel required for the proposed piling scheme will result in approximately 60 tonnes of CO_2 emissions.

The calculated emissions are an approximation based on empirical data regarding the amount of CO_2 produced to manufacture reinforcing steel and concrete. This approximation can be used to compare the sustainability of alternative foundation solutions. It does not include CO_2 produced from the procurement of materials and their delivery to site, or from the operations of site plant. This is all dependent on the efficiency of the processes and plant used and the travel distance from where the materials or plant are to be collected and delivered to the site.

7. Design Summary

The bearing pile design requirements can be summarised as follows:

- 15 No. 900mm (tool diameter) rotary bored tension piles to reduce vertical movement of the soil body.
- The piling platform has been assumed as the structural slab level based on drawings from Heyne Tillet Steel (HTS). HTS to confirm assumptions.
- Pile lengths are determined by HTS. Piles are understood to movement reducing piles and as such the pile length and diameter is determined by others, not the Piling Contractor.
- Concrete grade C28/35 has been assumed.
- All the piles are designed as rotationally restrained at the pile head, i.e., a moment restraint has been applied. No eccentric moments have been allowed for. If this is not the case, then the pile designer should be notified immediately.
- Reinforcement varies, see the bearing pile schedule in Appendix C: .

Appendix A: CDM Risk Assessment

A-squared Studio

Designers Risk Assessment

Project Name:	1 Museum Street	**Rev.** 0	**Date:** 06/12/2024
Title	Designers Risk Assessment - Permanent Bearing Piles		
Fatal Risks:	Plant - Person Interface Overturning of Plant Lifting Operations	Third Parties / Public Existing Services Uncontrolled Excavations	
Project No:	3696		
Designer	Tom Benham		
Checker	Andrew Brindle		

RISK ASSESSMENT

LIKELIHOOD (L) \ SEVERITY (S)	S5	S4	S3	S2	S1
L5	25	20	15	10	5
L4	20	16	12	8	4
L3	15	12	9	6	3
L2	10	8	6	4	2
L1	5	4	3	2	1

RISK DESCRIPTIONS

RISK INDEX	DEFINITION
17 to 25	Complete re-design required.
10 to 16	The risk is intolerable. Further design alternatives should be assessed
4 to 9	The risk is on the border line of acceptability. Design alternatives must be assessed
3	The risk is just tolerable. Design alternatives need to be investigated.
1 to 2	The risk is tolerable. No further analysis of design alternatives is necessary.

LIKELIHOOD (L)	L5	L4	L3	L2	L1
	HIGHLY LIKELY	PROBABLE	POSSIBLE	UNLIKELY	HIGHLY UNLIKELY

SEVERITY (S)	S5	S4	S3	S2	S1
Structure	Major collapse	Partly collapse	Failure	Distress	Acceptable
Safety	Multiple fatality	Major injury / single fatality	Injury or illness	Minor injury	No injury

Ref.	Stage (Construction, Operational or Maintenance)	Hazard	Possible consequences without mitigation	Risk L	Risk S	Risk	Design Action / Control Measures	Residual Risk L	Residual Risk S	Residual Risk	Residual Risk	Risk Owner	Comments / Actions
Project specific risks													
1	Construction	Incorrect cage placed in pile	Insufficient tension reinforcement and structural failure of pile	3	3	9	Piling Contractor shall ensure sufficient labelling of cages on site to avoid the wrong cage being placed into the wrong pile	1	3	3		Piling Contractor	
2	Construction	Incorrect pile diameter being installed	Insufficient compression capacity and structural failure of pile	3	3	9	Piling Contractor shall ensure a minimum 900mm diameter auger is used	1	3	3		Piling Contractor	
3	Construction	Insufficient temporary casing / bore instability during drilling	Bore instability and failure to construct pile in accordance with ICE SPERW (2017)	3	3	9	Piling Contractor to familiarise themselves with the expected ground conditions and ensrue that sufficent support is provided to the pile bore	1	3	3		Piling Contractor	
General construction risks related to the design													
1	Construction	Piling Rig used in the platform design	Piling rig overturning	3	4	12	Piling Contractor to ensure piling rig type does not change.	1	4	4	Piling contractor still changes the piling rig without informing the platform designer	Principal Contractor	If piling rig changes the designer of the piling platform must be informed
2	Construction	Strength of subgrade affecting the stability of the piling platform	Piling rig overturning	3	4	12	Subgrade to be inspected. Excavation to be deepened if design strength not encountered.	1	4	4	Subgrade not inspected properly.	Principal Contractor	Competent persons to inspect the subgrade
3	Construction	Piling rig instability	Piling rig overturning	3	4	12	Adequate piling platform to be designed, constructed, tested and maintained.	1	4	4	Design not adequate. Construction, testing, maintenance not in accordance with best practice.	Principal Contractor	Competent person to design the platform. Competent contractor to construct, test and maintain the platform.
4	Construction	Use of piling rigs, plant or equipment	Damage of constructed piles	2	1	2	Piling rig etc to be used as planned and not to undertake any uncontrolled activities.	1	1	1	Affect the integrity of the piles.	Principal Contractor	Competent contractor to be used with trained operatives.
5	Construction	Lifting of reinforcement	Injury to persons	3	4	12	Safe lifting of reinforcement cages to be detailed in lifting plans.	1	4	4	Lifting plan not followed.	Principal Contractor	Competent contractor to be used with trained operatives.
6	Construction	Services below ground level	Injury to persons or damage to plant	3	3	9	No works to commence until a permit to dig has been provided.	1	3	3	Unchartered services are encountered	Principal Contractor	Best practice to be followed.
7	Construction	Injury from projecting reinforcement	Injury to persons	3	3	9	Pile reinforcement to be terminated below piling platform level.	1	3	3	None	Principal Contractor	None
8	Construction	Ensure no uncontrolled excavations for pile cap or capping beam construction	Instability of temporary slopes	3	3	9	Contractor to ensure safe battered excavations within the piling platform material. Sides need to slope at a safe angle.	1	3	3	Excavation design not adequate.	Principal Contractor	Competent contractor to design and provide the safe excavation.
9	Construction	Breaking down piles with projecting reinforcement	Injury to persons	3	3	9	Operatives to use methods, plant or equipment that does not put them at risk of falling onto the exposed reinforcement.	1	3	3	Safe methods not followed.	Principal Contractor	Competent contractor to be used with trained operatives.
10	Construction	Manual work within excavations	Injury to persons	3	3	9	Manual work within excavations to be minimised as much as possible.	1	3	3	Safe methods not followed.	Principal Contractor	Competent contractor to be used with trained operatives.
11	Construction	Excavation access and egress	Injury to persons	3	3	9	Safe access and egress to the excavations to be detailed in a site specific plan.	1	3	3	Safe access / egress not used.	Principal Contractor	Competent contractor to be used with trained operatives.
12	Construction	Safe access to the pile for integrity testing	Injury	3	3	9	Testing to be suitably programmed by the Principal Contractor prior to placing cap reinforcement. Contractor RAMS to incorporate.	1	3	3	Safe access / egress not provided or is concurrent with steel fixing activities.	Principal Contractor	To be planned properly.

Appendix B: Pile Structural Design

1 Units

The following units are used throughout this calculation.

Force	kN	*Area*	mm^2
Length	m	*Second moment of area*	mm^4
Section dimensions	mm	*Section modulus*	mm^3
Stress	N/mm²	*Area per unit length*	mm^2/m
Strain	‰	*Angle*	°
Moment	kNm	*Axial stiffness*	kN
Curvature	‰/m	*Bending stiffness*	kNm^2
Density	t/m^3		

2 Design code

The following design code is used: Eurocode 2 (part 1), National Annex: UK

3 Materials

The following materials are used in these calculations.

3.1 Concrete

- C28/35

Strength, f_{ck}:	28 N/mm²
Elastic modulus, E:	32308 N/mm²
Density, ρ:	2.4 t/m^3

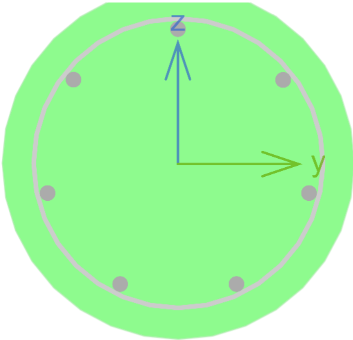
3.2 Reinforcement

- 500B

Strength, f_{yk}:	500 N/mm²
Elastic modulus, E:	200e3 N/mm²
Density, ρ:	7.85 t/m^3

4 Sections

4.1 Section 1 (Cage Type A)



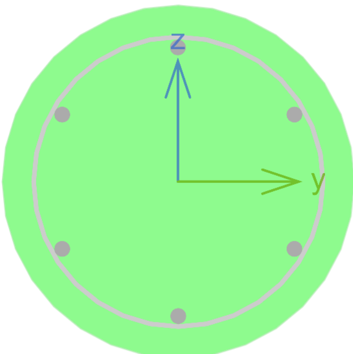
Definition		*Reinforcement*	
Material	Concrete	*Type*	*Description*
Grade	C28/35	*LINK*	B12
Profile	STD C 900	*PERIMETER*	7B40
Cover	75mm		

4.1.1 Analysis

4.1.1.1 ULS Results Summary

Case	F_x *(kN)*	M_{yy} *(kNm)*	M_{zz} *(kNm)*	*Utilisation*	*Status*
1	3551	0	0	87%	✓
2	-10449	0	0	78%	✓

4.2 Section 2 (Cage Type B)



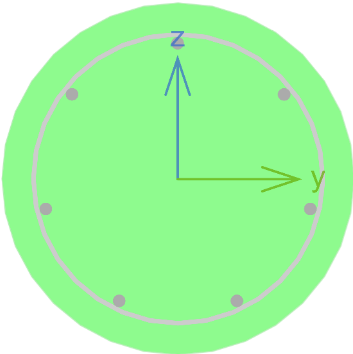
Definition		*Reinforcement*	
Material	Concrete	*Type*	*Description*
Grade	C28/35	*LINK*	B12
Profile	STD C 900	*PERIMETER*	6B40
Cover	75mm		

4.2.1 Analysis

4.2.1.1 ULS Results Summary

Case	*F_x (kN)*	*M_{yy} (kNm)*	*M_{zz} (kNm)*	*Utilisation*	*Status*
1	3429	0	0	98%	✓
2	-10449	0	0	81%	✓

4.3 Section 3 (Cage Type C)



Definition		*Reinforcement*	
Material	Concrete	*Type*	*Description*
Grade	C28/35	*LINK*	B12
Profile	STD C 900	*PERIMETER*	7B32
Cover	75mm		

4.3.1 Analysis

4.3.1.1 ULS Results Summary

Case	*F_x (kN)*	*M_{yy} (kNm)*	*M_{zz} (kNm)*	*Utilisation*	*Status*
1	2606	0	0	99%	✓
2	-10449	0	0	86%	✓

Appendix C: Tension Pile Schedule

Project Name	3696		
Project No.	St Giles Quarter, 1 Museum Street		
Doc No	3696-A2S-XX-XX-SC-Y-0001	Rev	01
Made by	Andrew Brindle	Date	09/12/2024
Checked by	Jon Martin	Date	09/12/2024
Scheme/Structure	Piled Foundations		
Status	For Construction		
Description of changes			

PROJECT NOTES:

1 PPL has been assumed as SSL on the HTS drawings - this is TBC
2 Loads are taken from HTS drawing SGC-HTS-1MS-B3-DR-S-10060 Rev. T1
3 No pile load testing is considered
4 Pile lengths are determined by HTS. Piles are understood to be settlement reducing piles and as such the pile length and diameter is determined by others, not the Piling Contractor
5 Assumed concrete C28/35
6 All piles are assumed to be installed in line with BS EN1536 or BS EN 14199
7 Characteristic tension actions are assumed to be due to heave and are therefore treated as persistant actions
8 Characteristic compression actions are assumed to be 70:30 permanent to variable
9 **Piles P4 and P9 to P15 to be constructed with full strength couplers and allowance made for buildup of anchorage length / pile to finished level. Shear links may also be requried, depending on final as built detail**

					Vertical Actions				Effect of Actions (E_d)							
									Characteristic	Frequent	Quasi Permanent					
Pile ID	Tool Diameter	Cage Type	COL	PPL	$G_{k\ sup}$	Q_k (Comp)	Q_k (Heave)	Allow for Eccentric Moments	SLS Vertical Action	SLS Vertical Action	SLS Vertical Action	Min Vertical Action	Compression DA1 C1	Compression DA1 C2	Tension UPL DA1 C1	Tension UPL DA1 C2
	mm		mOD	mOD	kN	kN	kN	y or n	kN	kN	kN	kN	kN	kN	kN	kN
P01	900	C	16.500	18.640	5243	2247	1930	N	7490	7490	7490	5243	10449	8164	2606	1930
P02	900	C	16.500	18.640	5243	2247	1910	N	7490	7490	7490	5243	10449	8164	2579	1910
P03	900	B	16.500	18.640	5243	2247	2260	N	7490	7490	7490	5243	10449	8164	3051	2260
P04	900	B	16.500	17.850	5243	2247	2290	N	7490	7490	7490	5243	10449	8164	3092	2290
P05	900	C	16.500	17.850	5243	2247	1880	N	7490	7490	7490	5243	10449	8164	2538	1880
P06	900	C	16.500	17.850	5243	2247	1770	N	7490	7490	7490	5243	10449	8164	2390	1770
P07	900	C	16.500	17.850	5243	2247	1620	N	7490	7490	7490	5243	10449	8164	2187	1620
P08	900	C	16.500	17.850	5243	2247	1460	N	7490	7490	7490	5243	10449	8164	1971	1460
P09	900	C	16.500	16.640	5243	2247	1850	N	7490	7490	7490	5243	10449	8164	2498	1850
P10	900	B	16.500	16.640	5243	2247	1950	N	7490	7490	7490	5243	10449	8164	2633	1950
P11	900	B	16.500	16.640	5243	2247	2230	N	7490	7490	7490	5243	10449	8164	3011	2230
P12	900	B	16.500	16.640	5243	2247	2540	N	7490	7490	7490	5243	10449	8164	3429	2540
P13	900	A	16.500	16.640	5243	2247	2630	N	7490	7490	7490	5243	10449	8164	3551	2630
P14	900	B	16.500	16.640	5243	2247	2390	N	7490	7490	7490	5243	10449	8164	3227	2390
P15	900	B	16.500	16.640	5243	2247	2390	N	7490	7490	7490	5243	10449	8164	3227	2390

	Pile		Design	Bored	Trimmed			Top of	Min	Main reinforcement cage				Shear		Type
Pile ID	Type CFA / Rotary	CAGE LENGTH	toe Level	Length	Length	PPL-COL	Design Proj	Steel	Design Anchorage	Nr Bars	Diam	Total Cage Length		Diameter	Pitch	Helical / Circular
		below COL	mOD	m	m	m	m	mOD	mm		mm	m		mm	mm	Links
P01	Rotary	24.0	-7.5	26.1	24.0	2.140	1.280	17.780	1280	7	32	25.280	-7.500	12	300	Helical
P02	Rotary	24.0	-7.5	26.1	24.0	2.140	1.280	17.780	1280	7	32	25.280	-7.500	12	300	Helical
P03	Rotary	24.0	-7.5	26.1	24.0	2.140	1.600	18.100	1600	6	40	25.600	-7.500	12	300	Helical
P04	Rotary	24.0	-7.5	25.4	24.0	1.350	1.600	18.100	1600	6	40	25.600	-7.500	12	300	Helical
P05	Rotary	24.0	-7.5	25.4	24.0	1.350	1.280	17.780	1280	7	32	25.280	-7.500	12	300	Helical
P06	Rotary	24.0	-7.5	25.4	24.0	1.350	1.280	17.780	1280	7	32	25.280	-7.500	12	300	Helical
P07	Rotary	24.0	-7.5	25.4	24.0	1.350	1.280	17.780	1280	7	32	25.280	-7.500	12	300	Helical
P08	Rotary	24.0	-7.5	25.4	24.0	1.350	1.280	17.780	1280	7	32	25.280	-7.500	12	300	Helical
P09	Rotary	24.0	-7.5	24.1	24.0	0.140	1.280	17.780	1280	7	32	25.280	-7.500	12	300	Helical
P10	Rotary	24.0	-7.5	24.1	24.0	0.140	1.600	18.100	1600	6	40	25.600	-7.500	12	300	Helical
P11	Rotary	24.0	-7.5	24.1	24.0	0.140	1.600	18.100	1600	6	40	25.600	-7.500	12	300	Helical
P12	Rotary	24.0	-7.5	24.1	24.0	0.140	1.600	18.100	1600	6	40	25.600	-7.500	12	300	Helical
P13	Rotary	24.0	-7.5	24.1	24.0	0.140	1.600	18.100	1600	7	40	25.600	-7.500	12	300	Helical
P14	Rotary	24.0	-7.5	24.1	24.0	0.140	1.600	18.100	1600	6	40	25.600	-7.500	12	300	Helical
P15	Rotary	24.0	-7.5	24.1	24.0	0.140	1.600	18.100	1600	6	40	25.600	-7.500	12	300	Helical

Appendix D: References

- Bond A & Harris A (2008) – Decoding Eurocode 7 – Taylor and Francis, London.
- BS EN 1990 (2002) + A1 (2005) – Eurocode: Basis of structural design, BSI, London.
- NA to BS EN 1990 (2002) + A1 (2005) – UK National Annex to Eurocode: Basis of structural design, BSI, London.
- BS EN 1992-1-1 (2004) – Eurocode 2: Design of Concrete Structures – Part 1-1: General rules and rules for Buildings, BSI, London.
- NA to BS EN 1992-1-1 (2004) - UK National Annex to Eurocode 2: Design of Concrete Structures – Part 1-1: General rules and rules for Buildings, BSI, London.
- BS EN 1997-1 (2004) – Eurocode 7: Geotechnical Design – Part 1 General Rules – BSI, London.
- NA to BS EN 1997 -1 (2004) – UK National Annex to Eurocode 7: Geotechnical Design – Part 1 General Rules – BSI, London.
- ICE Specification for Piling and Embedded Retaining Walls – 3rd Edition (2017), Thomas Telford.
- Tomlinson MJ (2001) – Foundation Design and Construction - 7th Edition, Prentice Hall.
- TRL Report 144 (1995): Design of reinforcement in piles.
- A new method for single pile settlement prediction and analysis, Fleming, W.G.K., Geotechnique 42, No 3, 411-425, 1992.

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