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Agrément Certificate
18/5477
Product Sheet 1

TECHNO PIEUX PILING SYSTEM

TECHNO METAL POST

This Agrément Certificate Product Sheet(1) relates to the Techno Metal Post(2), a prefabricated steel foundation pile system comprising load bearing elements, shaft, shaft couplings, protective sleeve and helical blades (helices), for providing a piled foundation. The system is mainly designed for compressive loading where no rotation or lateral movement of the soil mass is expected.

(1) Hereinafter referred to as 'Certificate'.
(2) Techno Metal Post is a registered trademark.

CERTIFICATION INCLUDES:

- factors relating to compliance with Building Regulations where applicable
- factors relating to additional non-regulatory information where applicable
- independently verified technical specification
- assessment criteria and technical investigations
- design considerations
- installation guidance
- regular surveillance of production†
- formal three-yearly review.†

KEY FACTORS ASSESSED

Structural performance — the system has adequate strength and stiffness to support foundations, and can sustain and transmit foundation loads provided the appropriate assessments of specific torque requirements and on-site welding are considered (see section 6).

Durability — the system components will have a design life in accordance with section 8.

The BBA has awarded this Certificate to the company named above for the system described herein. This system has been assessed by the BBA as being fit for its intended use provided it is installed, used and maintained as set out in this Certificate

On behalf of the British Board of Agrément

Date of Second issue: 21 May 2020

Originally certificated on 26 January 2018

Hardy Giesler
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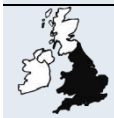
Regulations

In the opinion of the BBA, the Techno Metal Post, if installed, used and maintained in accordance with this Certificate, can satisfy or contribute to satisfying the relevant requirements of the following Building Regulations (the presence of a UK map indicates that the subject is related to the Building Regulations in the region or regions of the UK depicted):



The Building Regulations 2010 (England and Wales) (as amended)

Requirement:	**A1**	**Loading**
Requirement:	**A2**	**Ground movement**
Requirement:	**A3**	**Disproportionate collapse**
Comment:		The system can contribute to providing foundations of adequate strength. See sections 6.1 to 6.3 of this Certificate.
Regulation:	**7(1)**	**Materials and workmanship**
Comment:		The system is acceptable. See section 8.4 and the *Installation* part of this Certificate.

The Building (Scotland) Regulations 2004 (as amended)

Regulation:	**8(1)**	**Durability, workmanship and fitness of materials**
Comment:		The system can contribute to a structure satisfying this Regulation. See section 8.4 and the *Installation* part of this Certificate.
Regulation:	**9**	**Building standards applicable to construction**
Standard:	1.1(a)(b)(c)	Structure
Standard:	1.2	Disproportionate collapse
Comment:		The system can contribute to a structure satisfying these Standards, with reference to clauses 1.1.1[(1)(2)] and 1.2.1[(1)(2)]. See sections 6.1 to 6.3 of this Certificate.

(1) Technical Handbook (Domestic).
(2) Technical Handbook (Non-Domestic).

The Building Regulations (Northern Ireland) 2012 (as amended)

Regulation:	**23**	**Fitness of materials and workmanship**
Comment:		The system is acceptable. See section 8.4 and the *Installation* part of this Certificate.
Regulation:	**30**	**Stability**
Regulation:	**31**	**Disproportionate collapse**
Comment:		The system, when incorporated into a suitable structure, can contribute to satisfying these Regulations. See sections 6.1 to 6.3 of this Certificate.

Construction (Design and Management) Regulations 2015
Construction (Design and Management) Regulations (Northern Ireland) 2016

Information in this Certificate may assist the client, designer (including Principal Designer) and contractor (including Principal Contractor) to address their obligations under these Regulations.

See sections: 1 *Description* (1.3) and 3 *Delivery and site handling* (3.3) of this Certificate.

Additional Information

NHBC Standards 2020

In the opinion of the BBA, the Techno Metal Post (with mechanical connections only) if installed, used and maintained in accordance with this certificate, can satisfy or contribute to satisfying the relevant requirements in relation to NHBC Standards, Chapters 4.1 *Land quality-managing ground conditions* and 4.4 *Raft, pile, pier and beam foundations.*

CE marking

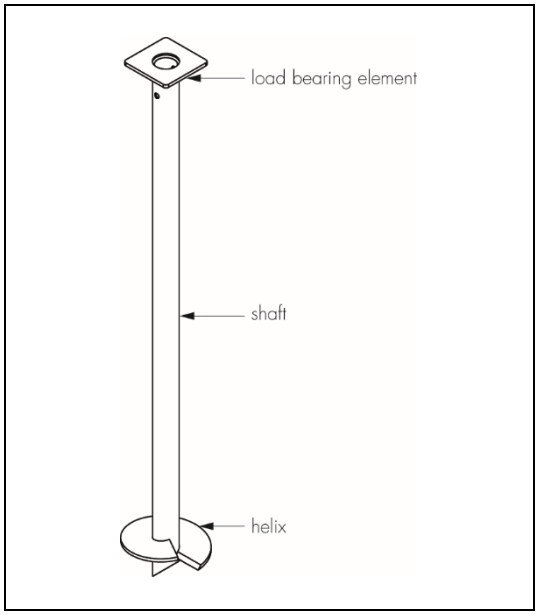
The Certificate holder has taken the responsibility of CE marking the system in accordance with harmonised European Standards BS EN 1090-1 : 2009 and BS EN 1090-2 : 2008.

Technical Specification

1 Description

1.1 The Techno Metal Post is a prefabricated foundation system designed and made of steel, in accordance with BS EN 1993-5 : 2007, and screwed into the ground to support and transmit foundation loads (see Figure 1). The piles are installed by screwing, under the combined action of rotational forces and vertical loads using specified machinery (see section 1.3 of this Certificate).

Figure 1 Elements of the Techno Metal Post

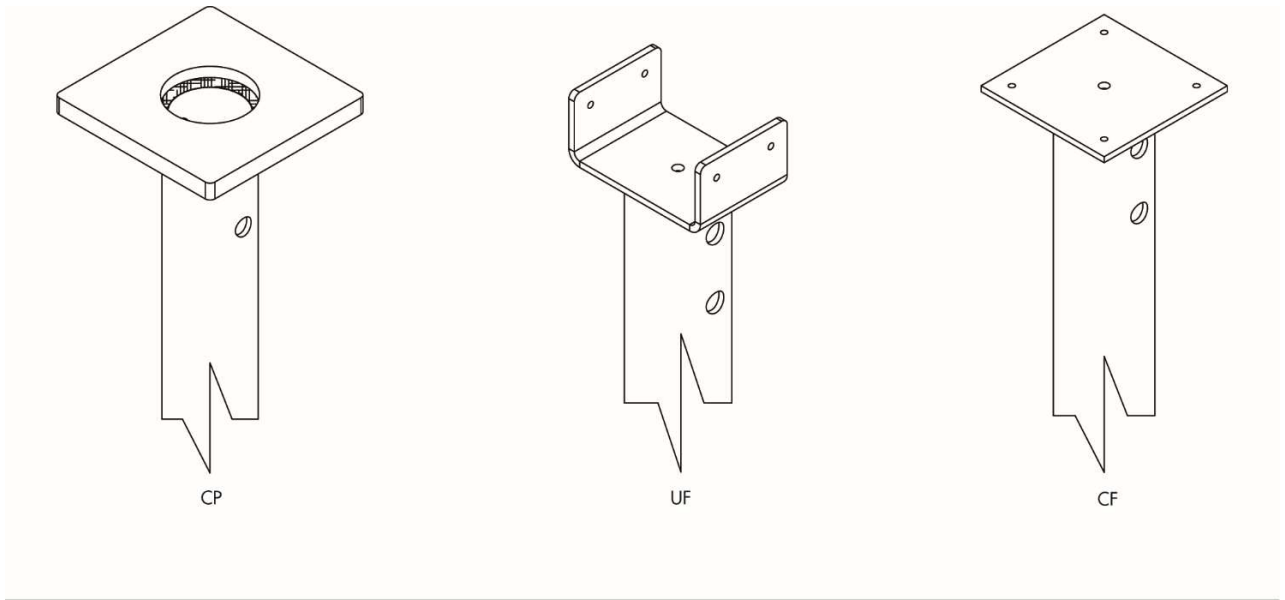


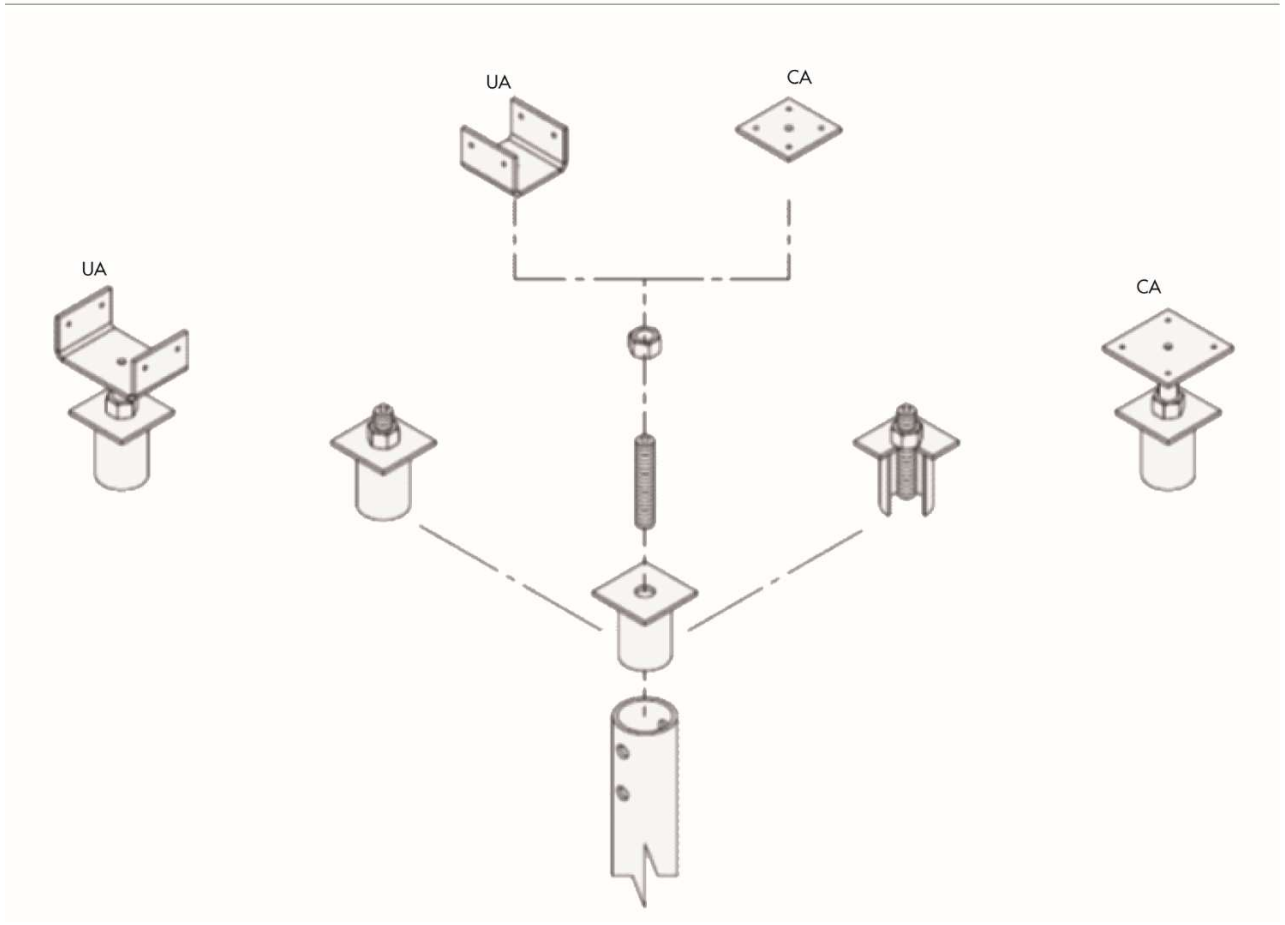
1.2 The system comprises:

- **Load bearing elements**

- made of structural steel grade S275 in accordance with BS EN 10025-3 : 2019, for connecting the structure to the supporting shaft
- different load bearing elements, either adjustable or of fixed height, are used with different shaft types.
- for shaft types P1 and P2 only (see Table 1 of this Certificate), fixed load bearing elements CP, UF or CF, or adjustable load bearing elements CA or UA, can be used (connected to the shaft and the structure by welding on site)
- for the other shaft types, bespoke load bearing elements can be used (connected to the shaft and structure by welding or bolting on site). These must be designed by an appropriately qualified design engineer in accordance with BS EN 1993-1-1 : 2005 and BS EN 1993-1-8 : 2005 and their UK National Annexes.

Figure 2 Load bearing element types





- **Shaft**

- a hollow tube, made of steel grade S355NH in accordance with EN 10219-1 : 2006
- diameter and thickness of the shafts vary (see Table 1, below), depending on the loads to be supported
- there are holes in the top of each shaft for attachment to the installation rig.

Table 1 Shaft cross-section dimensions(1)

Shaft type	Outside diameter (mm)	Inside diameter (mm)	Wall thickness (mm)
P1	48.26	40.89	3.68
P2	60.33	52.50	3.91
P3	88.90	77.93	5.49
P3-HD(2)	88.90	73.66	7.62
P4	101.60	90.12	5.74
P4-HD(2)	101.60	85.70	7.95
P5	141.29	128.18	6.55
P6	168.28	154.05	7.11

(1) The standard lengths of the shafts are 1500, 2130 and 3200 mm.
(2) Heavy duty.

- **Shaft couplings**

Shaft coupling is needed when the level of bearing layer of the ground requires extensions to be added. The shaft can be extended by using welded connectors (exterior couplings [UE], interior couplings [UI] or expanded shaft welded couplings [ESWC]) or mechanical bolted connections, either down to the desired level in the bearing layer of the ground, or for extended lengths above the ground.

Welded connectors: exterior (UE) and interior (UI) couplings

- the couplings, 76 or 89 mm in length and made from steel grade S355NH, are welded to the top end of the shaft at the factory. Additional shafts are welded to the shaft coupling on site
- during installation on site, each shaft is positioned on top of the shaft already installed, with the help of the coupling to make location easier
- with exterior couplings, each shaft is embedded inside the coupling and welded at the top. With interior couplers, a central collar on the coupling helps to locate and weld it in the installed shaft (see Figures 3a and 3b)
- interior couplings, either with a square tube (UI-1) or circular tube (UI-2), can only be used for shaft types P1 and P2
- the welds have a 6 mm throat dimension and can transfer torsional, compressive, tensile and bending actions between the shafts, in accordance with BS EN 1090-1 : 2009.

Figure 3a Shaft coupling: UE

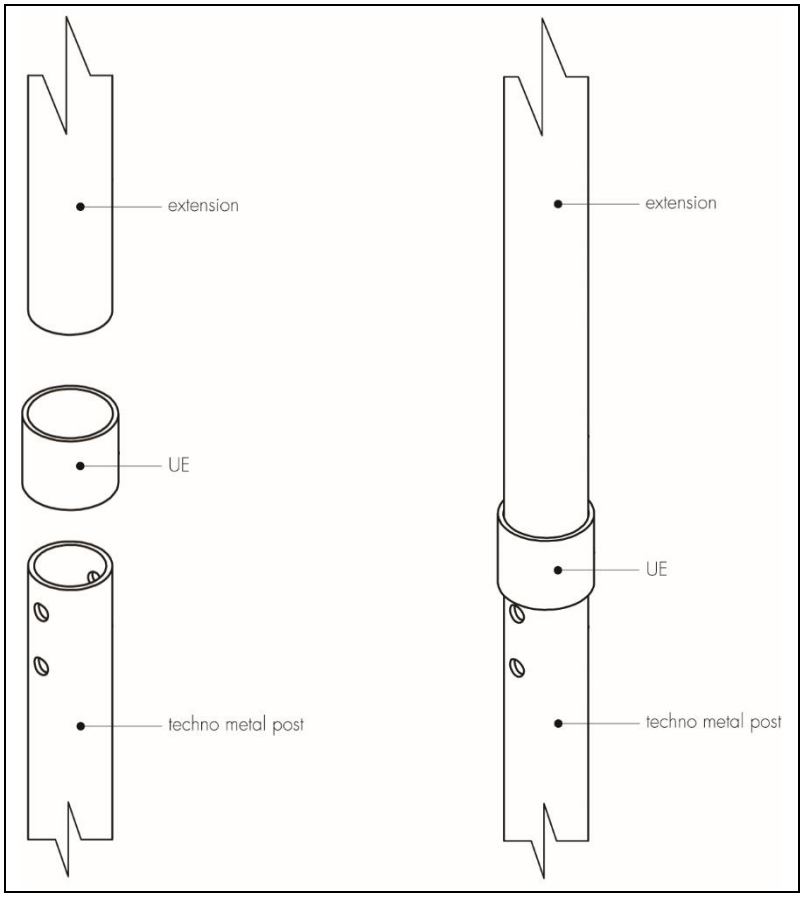
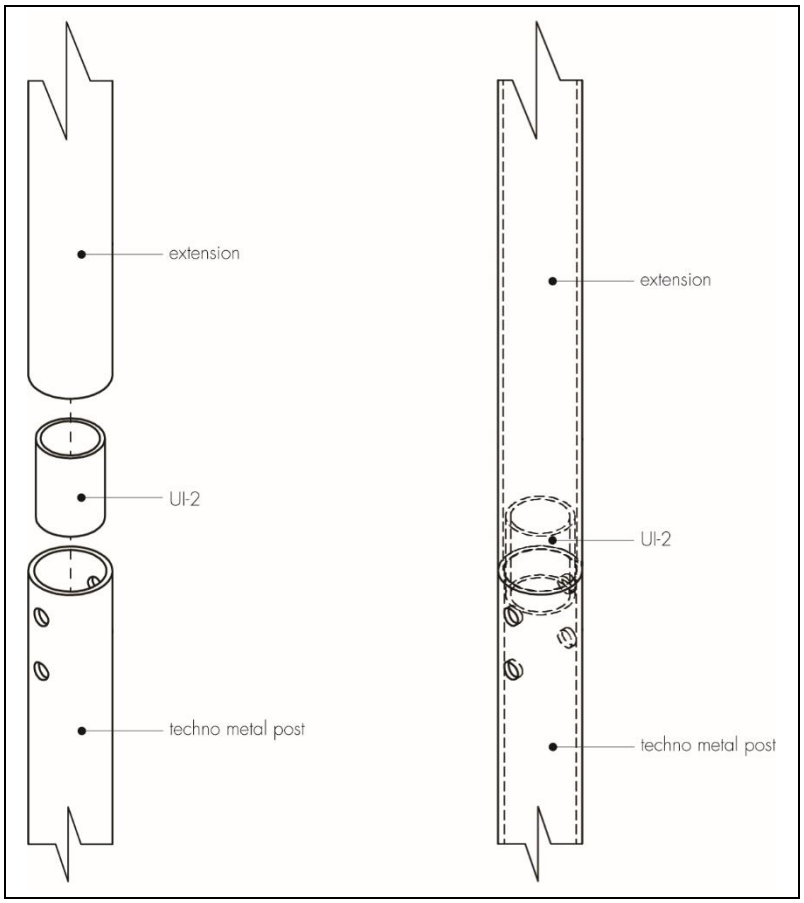


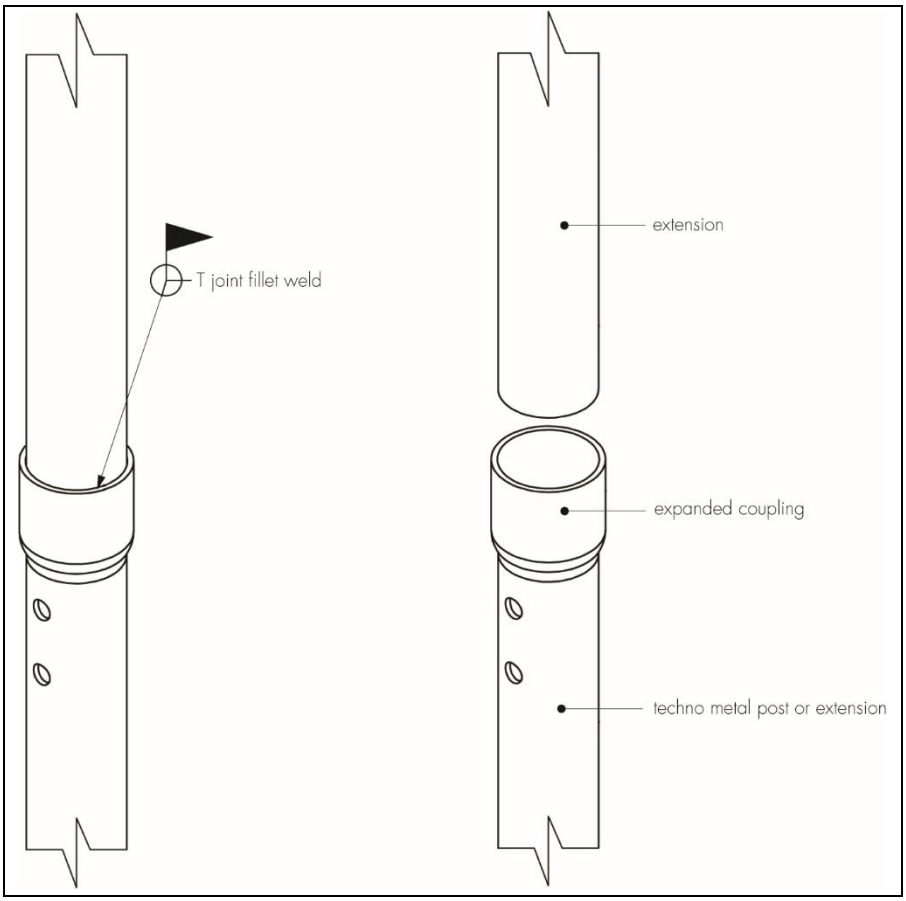
Figure 3b Shaft coupling: UI-2



Welded connectors: expanded shaft welded couplings (ESWC)

- can be used as an alternative to UE and UI couplings, but for shaft types P3, P3-HD, P4 and P4-HD only
- the shaft's top end is positioned in an expander device at the factory. The diameter of the shaft is increased to the required diameter to receive the external shaft diameter of the joining shaft, forming a coupling
- shaft extensions will be welded all around the expanded coupling on site, during the installation of the pile
- the expanded shaft welded coupling technique can transfer torsional, axial torsional, compression, tensile and bending actions between the shafts, in accordance with BS EN 1090-1 : 2009 (see Figure 4, below).

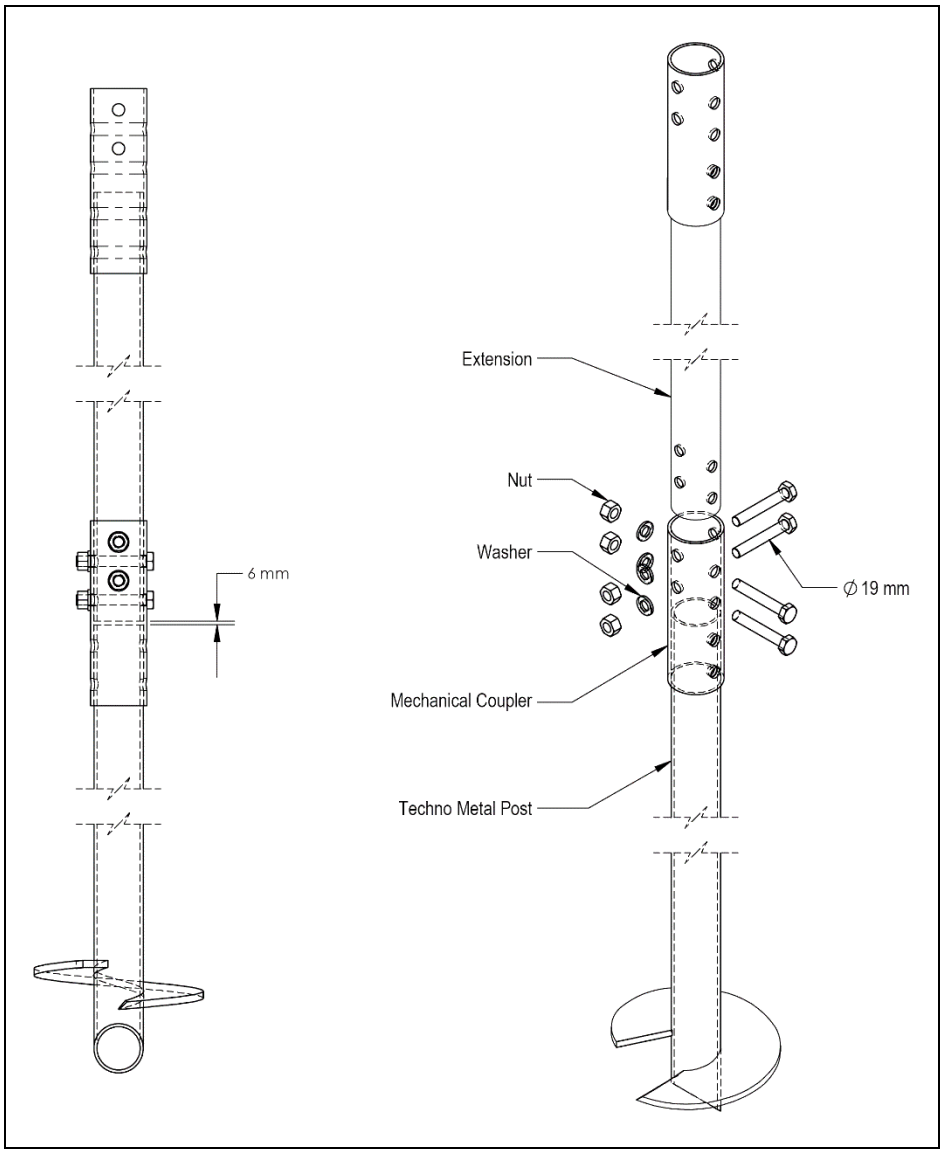
Figure 4 Shaft coupling: ESWC



Mechanical bolted connections

- extension of piles is achieved by using steel bolts, washers and nuts. A shaft mechanical coupler made of steel grade S355NH must be used for extensions
- the mechanical coupler is pre-welded to the initial pile during the manufacturing process at the Certificate holder's manufacturing plant
- holes are drilled at the factory in the shaft, coupler and extensions by plasma cutting. The shaft is extended on site by passing bolts through the shaft and coupler (see Figure 5)
- the bolt has a 19 mm diameter, with the length according to the diameter of the shaft of the pile
- before assembly, all tubes with pre-drilled holes, and holes drilled in situ, must be checked by the certified installer to make sure the material, surfaces, connections and accessories of the Techno Metal Post are free of dust, moisture, deformations, burrs, metal waste or other corrosion
- once the bolts are inserted, the certified installer must use a calibrated torque wrench to tighten the bolts – for each bolt, the final torque must be 325 N.m
- the mechanical bolted connection can transfer torsional, compressive and tensile action between sections of the shaft, and should be carried out in accordance with BS EN 1090-2 : 2018.

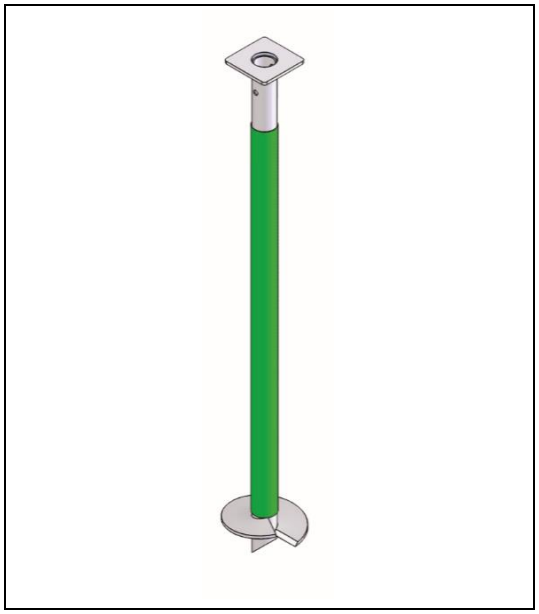
Figure 5 Shaft coupling: mechanical bolted connections



- **Techno protective sleeve**

- polyethylene protective sleeve (see Figure 6), used to ensure the shaft is not in contact with the soil
- generally used on the shaft located in the superficial (0 to 2 m) layers of soil, which may be affected by ground movements (due to, for example, freeze/thaw groundwater movements, clay swelling and shrinking) or any negative friction condition.

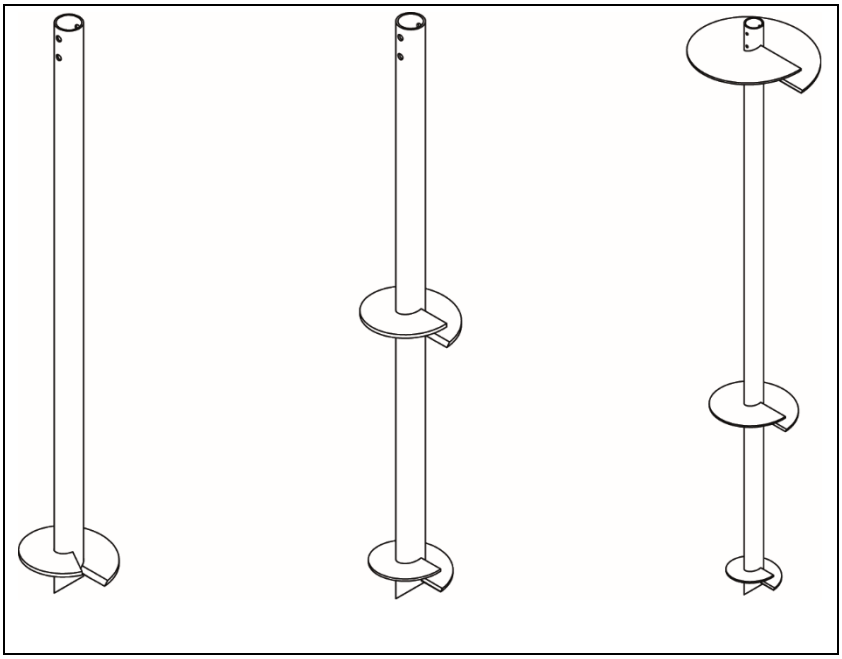
Figure 6 Protective sleeve



- **Helices**

- helical blades of steel grade S275, manufactured in accordance with BS EN 10025-3 : 2019 and factory welded to the shaft in accordance with BS EN ISO 3834-3 : 2005
- the helices are available in 152, 203, 254, 305, 356, 406, 457, 508 or 610 mm diameters, with 9 mm thick blades for shaft types P1 and P2, and 12.5 mm thick blades for the other shaft types (see Table 1 of this Certificate). The pitch of the helix is 76 mm.
- each shaft is generally supplied with one helix, at its base. For specific ground conditions or applications (see section 6.4), the system can be supplied with two or more helices, distributed along the shaft (see Figure 7). The number and diameter of the helices required depend on the design load and nature of the soil in which the helix is embedded.

Figure 7 Examples of helix configurations



1.3 The characteristics of the installation equipment developed by the Certificate holder, which must be used to install the piles (outside the scope of this Certificate), are given in Table 2. The track pressure for the machinery should be checked in accordance with BRE BR 470, prior to commencing the installation.

Table 2 Installation equipment developed by Techno Pieux Inc

Characteristic		Machinery		
	R2D	EM-1	EM-2	ET-1
Dimensions (all in mm)	2500, 760, 1500	2362, 1219, 1676	2640, 1230, 1710	4267, 1727, 2133
Mass (kg)	750	2025	2675	4037
Maximum mast height (mm)	3400	3683	4535	4572
Minimum required lateral clearance for installation (mm)	178	203	203	229
Maximum service bearing capacity under compression per pile installed (kN)	115	150	150	225
Ultimate bearing capacity under compression per pile installed (kN)	161	210	210	315

1.4 R2D, EM-1, EM-2 and ET-1 installation equipment, shown in Figure 8, is CE marked in accordance with Machinery Directive 2006-42-EC. The method used for calibration of the torque measurement devices has been evaluated by the BBA. The calibration procedure involves installing a certified torque monitor on the driving head of the installation equipment and inserting it onto a dynamic brake anchored to a rigid support. The screwing function is activated and the braking force is adjusted on the dynamic brake in order to obtain a specific pressure on the manometer. At each of the specified pressures, the screwing torque is measured.

Figure 8 Machines for the installation of the Techno Metal Post (outside the scope of this Certificate)

2 Manufacture

2.1 Raw materials used in the manufacture of the system are obtained from the Certificate holder's approved suppliers, to an agreed specification and in accordance with the company's documented quality control procedures.

2.2 The shaft and helices are assembled by welding at the factory. When requested, the shafts, helices and couplers are hot dip galvanized with a minimum coating of 530g/m².

2.3 As part of the assessment and ongoing surveillance of product quality, the BBA has:

- agreed with the manufacturer the quality control procedures and product testing to be undertaken
- assessed and agreed the quality control operated over batches of incoming materials
- monitored the production process and verified that it is in accordance with the documented process
- evaluated the process for management of nonconformities
- checked that equipment has been properly tested and calibrated
- undertaken to carry out the above measures on a regular basis through a surveillance process, to verify that the specifications and quality control operated by the manufacturer are being maintained.

2.4 The management system of the manufacturer has been assessed and registered as meeting the requirements of EN ISO 9001 : 2015 by National Quality Assurance (Certificate 17081).

3 Delivery and site handling

3.1 The system components are delivered to site by the Certificate holder's operatives and/or by fully trained transport sub-contractors in accordance with the Certificate holder's instructions.

3.2 The shafts are crated in steel racking systems.

3.3 The weight of the shafts may be in excess of 180 kg: care must be taken while handling the system.

Assessment and Technical Investigations

The following is a summary of the assessment and technical investigations carried out on the Techno Metal Post.

Design Considerations

4 Use

4.1 The Techno Metal Post is satisfactory for use as a piled foundation, by screwing the system to the desired depth, provided that the design for each project is verified by the Certificate holder and the system is installed by qualified installers. The system is designed to resist static or dynamic axial (compressive and/or tensile), bending moments and shear actions.

4.2 The system components are for use as a complete foundation system, or as part of a foundation system incorporating pile caps or ground beams, the design of which is outside the scope of this Certificate.

4.3 The system, when correctly installed and designed, is capable of transmitting structural loading safely to the loadbearing soil.

4.4 The system is installed to the required depth or design torque using specific installation equipment developed by the Certificate holder. Assessment of the suitability of the system for use in any particular ground conditions should be based on the results of an adequate site investigation. Full consideration must be given to various factors which can affect the assumed performance. The limitations for use of the piles are set out within this Certificate and the user should be aware of these limitations.

4.5 The overall length of pile is dependent on soil conditions, permanent and imposed actions, working conditions and limiting criteria specified by the overall design.

4.6 Information provided in respect of ground conditions can vary on a project-specific basis; the system must be designed by an appropriately qualified pile design engineer on behalf of the Certificate holder with reference to BS EN 1997-1 : 2004 and its UK National Annex.

4.7 The pile layout and design should be in accordance with the requirements of Eurocode 7 (BS EN 1997-1 : 2004 and its UK National Annex), using the safe working loads provided by the Certificate holder. The Certificate holder's *Installation Manual* gives further guidance on the extent of site investigation required and the pile testing regime to be adopted. Site investigations should follow the recommendations given in BS 5930 : 2015. Information about structural design and geotechnical performance of the system is provided in sections 6.10 to 6.14 of this Certificate. Site investigations must:

- confirm the depth to each soil stratum, water table and their variation
- indicate the presence of caves, buried works, boulders, rocks and stones larger than 50 mm
- characterise homogeneity or heterogeneity and the mechanical properties of the soil to and beyond the stratum with adequate bearing capacity
- identify any layers of soil with shrinkage, heave or liquefaction potential, hardened sediments, aggressiveness.

4.8 Full consideration must be given to the requirements of pile design defined in BS EN 1993-1-1 : 2005, BS EN 1993-5 : 2007 and BS EN 1997-1 : 2004 and their UK National Annexes.

4.9 The general principles recommended in BS EN 12699 : 2015 must be considered for the execution of screw piles.

4.10 Full consideration must be given to the particular ground conditions when assessing the suitability of the system. The following factors apply:

- made-ground containing obstructions — where encountered, obstructions should be removed prior to piling or alternative pile positions determined.
- where large boulders or artificial hard obstructions (eg concrete) are present that may cause lateral displacement of the lower part of the pile during installation, they should be removed prior to piling or alternative pile positions must be identified. Where this is not possible, an alternative pile system should be considered.
- where steeply sloping hard strata exist that may cause lateral displacement of the lower part of the pile resulting in pile failure, an alternative pile system should be considered.
- ground containing voids — where voids are encountered, the piles should be relocated if possible, or an alternative pile system adopted

4.11 The minimum spacing between the piles should be three times the diameter of the largest helix.

5 Practicability of installation

The system must be installed by competent and certified trained installers, experienced and qualified with this type of system, using the specific installation equipment designed by the Certificate holder. The Certificate holder provides a specific training course for installers.

6 Structural performance

General

6.1 The system has adequate strength and stiffness to sustain the loads to which it will be subjected during normal handling, transportation and installation. The BBA have analysed a range of typical designs and confirmed that the design methodology is appropriate, the section properties and resistance have been accurately determined in accordance with BS EN 1993-1-1 : 2005, BS EN 1993-5 : 2007, BS EN 1997-1 : 2004, BS EN 1998-1 : 2004 and BS EN 1998-5 : 2004 and their UK National Annexes, and that an adequate range of loading cases, together with relevant load and material factors, have been considered.

6.2 The system can withstand the dynamic loadings likely to occur during installation.

6.3 The piles must be designed by a chartered civil or structural engineer on behalf of the Certificate holder. When installed to the required depth and designed screwing torque, the pile itself is capable of carrying the working loads specified by the design engineer. In the event that the agreed installation torque is achieved before the design depth, the design must be reviewed by the pile design engineer to establish acceptability of the installation depth.

6.4 The system can be considered as an end bearing element and the skin friction of the shaft is negligible. The load bearing capacity of the system is principally provided by the helix, in reaction to both compressive and tensile loads. Under tensile loads, the helix anchors the pile in the overburden soil stratum. In order to increase the load bearing capacity with low-bearing-resistance soil conditions to enable the use of comparatively smaller helices, or to reduce the settlement of the system, it is possible to use multiple helices on one shaft. This will distribute the loads transferred to the soil at multiple depths. The distance between the helices must be at least 3 times the largest diameter helix in order to allow the load bearing distribution with minimum stress overlap. However, the overall capacity cannot exceed the structural strength of the pile to pure compressive or tensile loads as given in Table 1, taking into consideration the reduction of the cross-section due to corrosion to BS EN 1993-5 : 2007 and its UK National Annex.

6.5 The installation equipment continuously records the installation torque required for screwing the piles. This depends on the soil type and strength at the helix depth, and the geometrical specifications of the helix. The torque is directly proportional to the axial load bearing capacity of the pile. The correlation factor for axial load bearing capacity of the pile to the screwing torque is empirically developed by tests performed by the Certificate holder, and formulas based on test reports publicly available via the Certificate holder's website. In case the soil condition doesn't comply with the range of soils tested previously or for sensitive installations requiring determination of precise load bearing capacity, a site-specific correlation factor between the installation torque and the load bearing capacity must be developed through testing.

6.6 When required, static load testing using anchoring piles must be used to validate the bearing capacity of the piles. The responsibility for the number of piles to be tested, correlation factors and the factor of safety to be applied lies with the qualified pile design engineer on behalf of the Certificate holder, with reference to the Tables A.NA.9, A.NA.10, A.NA.11 and A.NA.6 of the UK National Annex to BS EN 1997-1 : 2004, and the NHBC Design Guide NF 21, *Efficient Design of Piled Foundations for Low Rise Housing.*

6.7 There is no established relation between the lateral load capacity of the piles and the screwing torque. If lateral load bearing capacity is a design requirement, a site-specific test must be carried out to establish that the pile can resist the design loads.

6.8 If the structure and foundation are to be designed for seismic actions, the piles must be designed to BS EN 1998-1 : 2004 and BS EN 1998-5 : 2004, and their UK National Annexes.

6.9 The system, when correctly installed, will withstand the effects of design actions without undue deterioration in strength or stiffness for the life of a structure, when designed in accordance with BS EN 1993-1-1 : 2005, BS EN 1993-5 : 2007 and their UK National Annexes.

Structural design

6.10 Based on the aggressiveness of the soil and the corrosion-protection method used, a thickness reduction of the shaft wall due to corrosion during the lifetime of the pile is calculated. The cross sectional properties of the shaft are calculated based on the reduced cross section (considering the reduced thickness of the shaft). The classification of the cross section based on section 5.5 of BS EN 1993-1-1 : 2005 and the partial factors based on section 5.1.1 of BS EN 1993-5 : 2007 is calculated.

6.11 Structural resistance of the system to axial actions, shear and bending moments and their combined effects are calculated based on section 6.2 of BS EN 1993-1-1 : 2005.

6.12 Checking against buckling is essential for 'slender piles passing through water or thick deposit of extremely low strength fine soil', taken from Note 4 in section 7.8 of BS EN 1997-1: 2005. Note 5 in the same section explains that 'normally a check for buckling is not required when the piles are contained with a characteristic shear strength (C_u) that exceeds 10 kPa'. Therefore, if required, a stability check under ultimate limit state must be done in accordance with section 6.3 of BS EN 1993-1-1 : 2005. The buckling length is determined in accordance with section 5.3.3 of BS EN 1993-5 : 2007 for the zone of the pile not laterally supported by soil with characteristic shear strength that exceeds 10 kPa.

6.13 Vertical deflection, horizontal deflection and dynamic performance, in accordance with section 7.2 of BS EN 1993-1-1 : 2005, must be considered in order to check the serviceability limit state. The acceptance criteria must be determined based on the serviceability limitations of the supported structure.

6.14 To confirm that the design load capacity is developed when the design installation depth is reached, the driving torque is measured and, based on the correlation factor explained in section 6.5 of this Certificate, the developed axial load bearing capacity is calculated. If this capacity exceeds the design load, the installation is satisfactory.

7 Maintenance

Once the system is installed in accordance with this Certificate, maintenance is not required. However, it is important that the piles are checked for suitability prior to installation.

8 Durability

8.1 Resistance to the effects of corrosion is achieved through the specification of appropriate steel sections to ensure that the wall thickness remains adequate for the life of the structure. If additional protection is required, the steel may be hot dip galvanized or provided with cathodic protection.

8.2 For mechanical bolted connections, a painted bolt should not be used as it can create pitting corrosions and concentrated hot spot corrosion.

8.3 For mechanical shaft couple connections, if a hot-dipped galvanized shaft needs to be drilled on site above ground level then corrosion-protective paint (ZRC Galvilite or equivalent – outside the scope of this Certificate) must be applied on the steel around the drilled spot outside and inside the shaft, and to the edges of the drilled spot/hole. Further information can be requested from certificate holder.

8.4 For durability greater than or equal to 50 years, the Certificate holder systematically uses an electrochemical technique which is a cathodic protection principle adapted for the Techno Metal Post that may protect simple or more complex installations.

Installation

9 General

9.1 Following delivery, and prior to installation, the piles should be checked by the pile installers for any damage, in accordance with the Certificate holder's instructions.

9.2 Provided the ground conditions are suitable and as predicted from the site investigation, and the method of installation is as detailed in this Certificate, piles can be installed without undue difficulty.

9.3 The pile elements are only for installation by trained and approved installers using specific installation equipment designed by the Certificate holder in strict accordance with their *Installation Manual*, BS EN 1997-1 : 2004 and its UK National Annex, and this Certificate.

10 Procedure

Installation

10.1 The installation equipment is positioned where the pile is being installed.

10.2 The shaft with the helix is mounted on the installation equipment. The pile toe is located accurately by the certified installer, and the pile head is fixed into the driving head of the equipment. The installation equipment is precisely located such that the pile toe points to the correct installation location.

10.3 Torsion is applied to the pile to screw it into the ground. Once the first pile is screwed, the screwed shaft is dislodged from the driving head of the installation equipment. When the sleeve is required, it is installed on the shaft before it is lodged on the driving head and screwed.

Jointing

10.4 If the design length of the pile requires installation of multiple shafts, a shaft coupling is embedded into the first shaft and either welded or bolted. Another shaft element is connected to the driving head and lifted and carefully guided onto the shaft coupling, and welded or bolted.

10.5 If a pile is to be extended above ground, the shaft elements are connected by UE or UI shaft couplings.

10.6 For mechanical bolted connections, extension is possible with the help of a mechanical coupler and bolts.

10.7 Screwing of the shafts continues until the design installation depth is reached or the applied torque proves the design load capacity is reached.

10.8 The load bearing element (connection with the supported structure) is welded or bolted to the top end of the pile.

Technical Investigations

11 Investigations

11.1 The manufacturing process was evaluated, including the methods adopted for quality control, and details were obtained of the quality and composition of the materials used.

11.2 An examination was made of technical data relating to:

- the effects of corrosion on the steel sections
- existing data relating to the durability of the system when used within the scope of this Certificate.

11.3 A site visit was carried out to assess the practicability of installation.

11.4 An examination was made of the Certificate holder's *Installation Manual*.

11.5 An examination was made of pile penetration log data relating to sites where piles have been successfully installed and tested by static or dynamic pile testing techniques.

11.6 The assessment of the system was made in relation to BS EN 1997-1 : 2004 and BS EN 1993-1-1 : 2004.

11.7 An assessment of axial load test reports was carried out on the system as follows:

- test piles installed in different types of soil tested and subjected to working loads. Deflections were measured and the correlation between deflection and load bearing capacity were approved
- test piles installed in different types of soil tested and subjected to ultimate loads. Deflections were measured and the correlation between deflection and load bearing capacity were approved
- helix capacity tests performed on 9 helices of 3 different diameters, and the mode of failure was either weld shear or local buckling of the shaft. No failure of the helix was recorded
- shear/torsional tests to validate the shear resistance of mechanical bolted connections under maximum torque to be applied by installation equipment and the effect of torque on the drilled holes.

Bibliography

BRE Report BR 470 : 2004 *Working platforms for tracked plant — good practice guide to the design, installation, maintenance and repair of ground-supported working platforms*

BS 5930 : 2015 *Code of practice for ground investigations*

BS EN 1090-1 : 2009 + A1 : 2011 *Execution of steel structures and aluminium structures. — Requirements for conformity assessment of structural components*
BS EN 1090-2 : 2008 + A1 : 2011 *Execution of steel structures and aluminium structures — Technical requirements for steel structures*

BS EN 1993-1-1 : 2004 + A1 : 2014 *Eurocode 3 — Design of steel structures — General rules and rules for buildings*
NA + A1 : 2014 to BS EN 1993-1-1 : 2004 + A1 : 2014 UK National Annex to *Eurocode 3 — Design of steel structures — General rules and rules for buildings*
BS EN 1993-1-8 : 2005 *Eurocode 3 — Design of steel structures — Design of joints*
NA to BS EN 1993-1-8 : 2005 UK National Annex to *Eurocode 3 — Design of steel structures — Design of joints*
BS EN 1993-5 : 2007 *Eurocode 3 — Design of steel structures — Piling*
NA + A1 : 2012 to BS EN 1993-5 : 2007 UK National Annex to *Eurocode 3 — Design of steel structures — Piling*

BS EN 1997-1 : 2004 + A1 : 2013 *Eurocode 7 : Geotechnical design — General rules*
NA + A1 : 2014 to BS EN 1997-1 : 2004 + A1 : 2013 UK National Annex to *Eurocode 7 : Geotechnical design — General rules*

BS EN 1998-1 : 2004 + A1 : 2013 *Eurocode 8 — Design of structures for earthquake resistance — General rules, seismic actions and rules for buildings*
NA to BS EN 1998-1 : 2004 UK National Annex to *Eurocode 8 — Design of structures for earthquake resistance — General rules, seismic actions and rules for buildings*

BS EN 1998-5 : 2004 *Eurocode 8 — Design of structures for earthquake resistance — Foundations, retaining structures and geotechnical aspects*
NA to BS EN 1998-5 : 2004 UK National Annex to *Eurocode 8 — Design of structures for earthquake resistance — Foundations, retaining structures and geotechnical aspects*

BS EN 10025-3 : 2019 *Hot rolled products of structural steels — Technical delivery conditions for normalized/normalized rolled weldable fine grain structural steels*

BS EN 12699 : 2015 *Execution of special geotechnical work — Displacement piles*

BS EN ISO 3834-3 : 2005 *Quality requirements for fusion welding of metallic materials — Documents with which it is necessary to conform to claim conformity to the quality requirements of ISO 3834-2, ISO 3834-32 or ISO 3834-4*

EN 10219-1 : 2006 *Cold formed welded structural hollow sections of non-alloy and fine grain steels — Technical delivery requirements*

EN ISO 9001 : 2015 *Quality management systems — Requirements*

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- relates only to the product that is named and described on the front page
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