SCI Assessment of the Chance Helical Piling System

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EXECUTIVE SUMMARY

Sub-Surface Technologies Ltd (SST) is the exclusive importer of Chance™ Helical Piling Systems into the UK civil construction market.

SST approached the Steel Construction Institute (SCI) to obtain an independent third party assessment of the Chance™ Helical Piling System, which they distribute. The primary reason for wanting the assessment was to satisfy the request of NHBC.

Based on information provided by SST, publicly available information and information belonging to SCI, a comprehensive assessment has been performed considering design, installation and testing of the Chance helical pile systems.

Taking into account a holistic approach, the review has established that for all the aspects reviewed, comprehensive data and procedures are in place to design and install an efficient and safe foundation system using Chance helical steel piles. Each of the aspects considered have been reviewed and where applicable helpful information and/or advice has been added.

As a result of the assessment the Chance Technical Design Manual for helical piling may display the “SCI Assessed” logo.

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1 Introduction

1.1 Background

Sub-Surface Technologies Ltd (SST) is the exclusive importer of Chance™ Helical Piling Systems into the UK civil construction market.

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1.2 Objectives

Following a meeting between SST, NHBC and SCI, the objectives and the technical issues to be assessed were agreed (see below). The assessment has been carried out under the "SCI Assessed" scheme.

SCI has assessed the contents of the Chance technical information to ensure that the following topics are adequately covered to enable the safe design and installation of the Chance™ Helical piles.

1. Geotechnical parameters and geotechnical design considerations

   Assessment of information to ensure installation and design of piles in different ground conditions is adequately covered.

2. Design procedures

   Assessment of design procedures to ensure that they accurately declare the performance of the product in the ground conditions in which the product is recommended for use.

3. Durability

   Assessment of the durability of the product from the information provided, to ensure that a minimum design life of 60 years can be obtained in all ground conditions for which the product is recommended.

4. Testing criteria

   Assessment and recommendation of project specific testing necessary for the confirmation of the performance of the product.

5. Construction details at pile head/cap

   Assessment of the pile head/cap details presented in the Chance information for their suitability to transmit loads from the foundations to the pile.

6. Compliance with the Building Regulations

   Assessment of the products ability to satisfy building regulation requirements i.e. load capacity and durability.

7. Contractor appraisal system

   Assessment of the Chance contractor appraisal process for adequate robustness and suitability.

1.3 Assessment procedure

The assessment procedure used by SCI is based on; information provided by SST, publicly available information and information belonging to SCI. The information provided by SST includes the following documents:

1. Chance Civil Construction Technical Design Manual
2. Chance Civil Construction CC Catalogue 2007
3. Submittal to Road and Bridge Technical Institute – Poland
4. CCMC 131936-R Evaluation Report
5. Evaluation of SS175 Chance Helical Screw Foundation System – Prof M.Hesham El Naggar Ph.D P.Eng
6. Introduction to Corrosion and Galvanizing of Helical Foundations – Howard A. Perko, Ph.D P.E
7. Corrosion of Steel Piling in Soils – Melvin Romanoff
8. Acceptance criteria for Helical Foundations Systems and Devices – ICC Evaluation Services, Inc

2 Chance Helical Piling Systems

A helical pile is a segmented deep foundation system with helical bearing plates welded to a central steel shaft. Load is transferred from the shaft through the helical bearing plates to the soil stratum in bearing. The pile is installed by a hydraulic torque head fitted to mobile equipment ranging in size from lightweight units to heavier units depending on the load requirements. As rotation and downward force is applied by the machine the pile penetrates the soil. The installation torque required to progress the pile is monitored throughout the process and gives an indication of the soil strength of the founding strata. Once at a soil depth with sufficient strength to support the load requirement, the pile can be loaded immediately.

Central steel shafts are available in either Type SS (Square shaft) series or Type RS (Round shaft) series. The Type SS series are available in 1.25 inch to 2.25 inch square cross sections (up to torque rating of 31.2 kNm). The Type RS series are available in 2.875 inch to 4.5 inch diameter sizes (up to torque rating of 31.2 kNm). Type SS-RS combinations are also available for both tension and compression applications where dense/hard soils have to be penetrated with softer/loose soils above the bearing strata.

Chance Helical Pulldown™ Micropiles in addition to the helical steel pile system are constructed with a grout column surrounding the upper part of the steel shaft. The grouted pile is therefore a stiffer pile (i.e. less deflection) and is more resistant to potential buckling of top of the pile when positioned in weak soils overlying the bearing strata.

The helical pile comprises of a lead section which contains the helical plates (one to four plates). The helices are arranged on the shaft such that their diameters decrease as they get farther down from the top of the lead section. Pile extensions which may also contain larger diameter helices are added until the lead section penetrates into the bearing strata. Segments or sections are joined with bolted couplings.

A helical bearing plate or helix is one pitch of a screw thread and being a true helix shape, the helices do not auger into the soil but rather cut into it with minimal soil disturbance. Helical plates are spaced at distances of three diameters of the preceding helix which is far enough apart that they function independently as individual bearing elements; consequently, the capacity of a particular helix on a helical pile is not influenced by the helix above or below it.

Each bearing plate is located at a depth whereby full capacity of the plate-to-soil interaction can take place (defined commonly as a ‘deep’ foundation where the top most plate is at least five helix diameters vertically below the ground surface or competent strata).

The interface connection connects the structure to the top of the helical pile shaft and enables the load to be transferred down the shaft. To evenly distribute the loading from the superstructure the connection may be a manufactured bracket (used for remedial

repairs) or a project specific attachment detail produced as prescribed by the structural design. Structural aspects dictate the connection configuration as a function of its application and may range from a simple threaded bar to a complex fitting.

3 Technical Assessment

The assessment is undertaken as described in Section 1.2.

3.1 Geotechnical parameters

An assessment of how the geotechnical parameters are obtained and used in the design of the helical piles has been based on a review of document “Chance Civil Construction Technical Design Manual” as supplied by SST.

The technical manual states that the fundamental requirement for a robust foundation design is an initial geotechnical investigation of the site, to identify the key soil parameters for the design of the helical pile systems. The manual states that the geotechnical investigation must obtain the following information:

- Location of the depth and thickness of the soil stratum suitable for seating the helical plates of the pile and to determine the necessary soil strength parameters of the stratum
- Establishment of weak zones (e.g. peat type soils), in which column stability of the pile for compression loading situations may require investigation
- Location of the groundwater table (GWT)
- Determination of any barriers to installing the piles (e.g. rubble fill, boulders or zones of cemented fills etc) which may require pre-drilling or relocation
- Preliminary evaluation of the corrosion potential of the foundation soils as related to the performance life of the steel pile. In the case of NHBC, a minimum required design life of 60 years must be assumed.

Site investigation will therefore typically comprise of exploratory borings, test pits or helical trial probe piles together with a few classification tests on representative soil samples.

However, if for whatever reasons the site investigation is limited, then other forms of information can be used to provide added verification. This additional information can take the form of pile load testing and/or additional site investigation in parallel with installation.

Pile load testing to failure provides a useful means of obtaining the pile performance on site and will reveal critical considerations in the design of the helical pile system. The pile load tests will therefore enable the design methodology to be refined and at the same time offer increased confidence in design.

For certain projects (e.g. small projects) pile load testing will not be appropriate because of the cost considerations or inconvenience. In these cases standard practice will be to use higher factors of safety, however, it has to be recognised that the factor of

safety cannot be defined in isolation from the parameters used in the foundation design e.g. deflection requirements at working load (serviceability conditions).

Commonly, site conditions which suit helical pile solutions are not suitable for detailed site investigations (e.g. small and/or inaccessible sites). The SPT N values for the founding strata are directly used in the desk studies to determine an estimate of the bearing capacity of the helical bearing plates of the pile.

It is understood that the N values obtained from the SPT method to be the most widely available and most robust soil parameter which forms the basis for the design of helical steel piles.

3.2 Design procedures

The design of the Chance helical steel pile systems is comprehensively covered in the Technical manual. Specific design approaches are provided in the section 'Design Methodology'.

The technical manual states that the steel helical pile has to have sufficient structural strength to be able to resist forces from:

- The torque applied during installation, and
- Loading during the design life of the pile.

The capacity of the pile system during installation, whilst it undergoes torque forces, is based on the torsional resistance of the steel shaft. Torque ratings for the range of helical piles that are manufactured by Chance are provided in product data sheets.

The geotechnical design approach for the pile is primarily to provide:

- Adequate pile resistance to static vertical axial loading.

However, in some cases the pile system will be required to provide:

- Adequate resistance of the pile to static lateral loading.

This review is primarily concerned with review of axial load resistance. However, a cursory review has been given to lateral loading resistance.

3.2.1 Resistance to static axial loading

Vertical static axial loading from the superstructure is assumed to be transferred to the founding soil by bearing between the soil directly below/above the helical plates.

The design approach used for determining the static axial load resistance of the helical pile is based on the universally known Terzaghi's general bearing capacity equation. Installation of the helical plates is chosen to be into firm bearing strata and at a depth sufficiently below the ground surface such that 'deep' foundations conditions are assumed to act. The vertical spacing of the helix plates in the piles are also

manufactured such that each plate can act independently of any adjacent helix plate, thereby allowing the maximum bearing capacity of the pile to be achieved. Minimum helical pile horizontal spacing is also recommended such that no reduction of pile capacity occurs due to too close spacing (group effects) of the plates.

Geotechnical parameters used in Terzaghi's equation are based on the determination of SPT N values which can be used for cohesive or cohesionless soils. In addition, where necessary (i.e. where a lack of information about the soil exists) reference is made to standard geotechnical text books which provide empirical relations for typical soil parameters (e.g. relationships for determining the angle of internal friction of the soil). Caution should be used where these types of assumptions are made and where applicable, higher factors of safety should be used for design.

Any uncertainty regarding the composition of the soil strata (where the soil strata may comprise both cohesive and cohensionless soils) is taken into account by determining the more conservative bearing capacity based on considering each soil type individually.

Selection of the appropriate helical pile system is based on; the vertical loads that will be acting, the theoretical ultimate bearing capacity of the helical plates and an appropriate factor of safety for design. An estimated installation torque that will be required to provide the necessary bearing capacity is calculated and a check is performed to assess the adequacy of torque rating (capacity) for the chosen helical pile system.

The design of helical piles accommodates both axial compressive and tensile loads. In compression the piles are governed by the capacity of the steel shaft, including potential buckling behaviour if the top soil strata are unsupportive, and the capacity of the helical plates in bearing. In the case of tensile axial loads similar consideration is given to design as for the compression case. However, where tensile forces are acting, consideration is also given to the capacity of the couplings which connect each pile segment to form the overall pile shaft.

The comprehensiveness of the design process presented in the technical manual is further substantiated by the inclusion of relevant design worked examples.

It should be noted that in the UK steelwork is designed to *BS 5950 Structural use of steelwork in building - Code of practice for design - Rolled and welded sections*.

Pile buckling due to compression loading

Buckling of slender foundation elements is most likely to occur in soils with poor strength properties such as peat, very loose sands and soft clays. The Technical manual acknowledges this potential problem and points out that this is a complex problem to analyze and numerical methods are required to determine performance of the pile. Chance points out that they have developed a design tool integrated with a finite element program called ANSYS to determine load response and buckling of helical steel piles. The technical manual includes a number of worked examples for

review, however, this aspect of design will have to be considered on an individual basis and in this report no further comment or assessment can be made.

Factors of safety

In the Technical Manual Chance Civil Construction recommends a minimum factor of safety (working load to Ultimate bearing capacity) of 2.0 for permanent conditions and 1.5 for temporary conditions. This is consistent with advice given in the UK in BS 8004: 1986 Clause 7.38 in which “appropriate factor of safety for a single pile would be between two and three”. However, it should be pointed out that a factor of safety towards the higher end should be considered if:

- Soil properties / ground conditions lack confidence
- Soil properties may deteriorate with time
- Uncertainty in the magnitude of ultimate capacity determined
- Differential settlement considerations potentially exist at working load
- Cyclic loads are expected
- Pile group effects.

Use of a higher factor of safety may also need to be considered for helical piles in tension as is usually the case in normal practice.

Consideration should also be given to helical pile systems used in temporary conditions as the factor of safety of 1.5 may be considered to be too low. A factor of at least 2.0 is recommended.

Considering the introduction of Eurocodes, awareness is made of Eurocode 7 regarding partial factors of safety specific for soils, and Eurocode 3 Parts 1 and 5, which are relevant to partial factors relating to steel materials used in piling.

Based on a review of current practice in the UK with respect to helical/screw piles, it is commonly found that a factor of safety of 3.0 is used when designing to resistant static axial load.

Relationship between pile axial capacity and installation torque

Chance Civil Construction has researched the relationship between installation torque and load bearing capacity of helical piles. A direct relationship between the two has been postulated and is included in the technical manual. The relationship is based on the calibration of test data for a number of sites which is related to undisturbed ground conditions and installation procedures. This relationship has been interpreted to be linear in nature in which a factor Kt is defined. Factor Kt is given a unique value for a particular type and range of size of helical pile system assuming the most conservative value when used to estimate soil bearing capacity. Different values are presented for the pile in compression and in tension.

Having this torque-capacity relationship provides a useful check of the site ground investigation thereby helping to verifying that the pile is being installed through

anticipated ground conditions. It can be used as a check on the calculated capacity of the pile.

Care must be taken that there is not over reliance of this equation; particularly if confirmation of soil strength is only undertaken by torque measurement. Although, this relationship may not be rigorous, the approach does provide a qualitative assessment of the soils being penetrated.

SCI has reviewed the following report “Evaluation of SS175 Chance Helical Screw Foundation System” – by Prof M.Hesham El Naggar Ph.D P.Eng. The report, which was conducted by the University of Western Ontario, evaluated the structural and geotechnical capacity of a representative Chance helical pile system under compression and tension applications. The pile system was tested at two test sites under the supervision of a professional engineer where eleven compression tests and thirteen tension test were successfully performed in clayey silt, silty clay and sand soils.

These test results were interpreted leading to the relationships which are presented in the Technical manual for use in design for the full range of helical pile systems under compression and tension loading. Validity of results obtained in this report is enhanced by similar consistent values being reported by independent test programmes.

If the helical pile system is to be installed in disturbed or sensitive soils, e.g uncontrolled fill, the relationship between the applied torque and pile axial capacity may in some cases not be as predictable. Therefore, if helical piles are to be installed in such soils, it may be advisable in certain specific situations, for the axial pile capacities to be confirmed by on-site load tests. This is more likely for large projects where high magnitude loads are to be supported, rather than for typical house/building underpinning projects that are commonly undertaken.

It is important to be aware that helical piles perform well in fill, when compared to other piling techniques.

If on-site tests are deemed to be necessary then the tests will need to be conducted by a professional geotechnical engineer.

3.2.2 Resistance to static lateral loading

In some situations helical pile systems will require to resist horizontal or lateral loads. These include forces due to wind pressure, live loads, water pressure, or seismic events.

The analysis of deep foundations under lateral loading is complicated. Hence, this type of soil-structure interaction problem is best suited to be analysed using numerical methods on a computer. Methods commonly used to analyse piles subject to lateral loads are by finite differences (e.g. LPILE). These methods are in theory applicable to helical steel piles. However, care in their use is required in order to accurately model the coupling connections between the pile sections.

Commonly for a situation where vertical and horizontal loads are present a helical pile foundation arrangement will be designed to resist vertical axial loads by use of vertical piles, whilst the lateral loads will be designed by using raked piles.

3.2.3 Steel material specification

As the helical steel pile systems are manufactured in the USA, material specifications conform to current ASTM (American Society for testing and materials) standards. A listing of all the referenced codes and standards and products and materials specifications is presented in the Technical Manual in Appendix C Specifications in the Model Specification Chance Civil Construction Helical Piles for Structural Support.

In order that the material properties and strengths can be reviewed comprehensively by the engineer involved in the design, checking or approval of helical pile systems in the UK, it will be necessary to provide substantiating information including material test data/certificates showing composition and strength properties of each of the materials.

Steel materials specified to American standards are known to engineers in Europe to a greater or lesser extent, however, it will be necessary to have available direct comparisons between the American Standards and equivalent British Standards. A cursory review of the list of American codes and standards and the product and materials information used for the helical pile systems, indicates that there should be no major problem in their general acceptance for use in the UK.

An important aspect of the performance of the helical pile in the ground is the avoidance of brittle fracture of steel at the lowest service temperature which is expected to occur within the intended life of the structure. In the UK the lowest service temperature in an external environment stated in BS 5950-1 is -15 □C. Whereas, BS 8004 assumes that frozen ground conditions can occur to a maximum depth of 450 mm below the ground surface and should be considered in foundation design. Lower than 450 mm below ground level, soil temperature may be assumed to be above 0□. Therefore, the fracture toughness of any steel components situated 450 mm below ground level or higher must be specified to reflect the potential low temperatures.

The issue of brittle fracture generally becomes more significant with the following:

- Lower service temperatures
- Higher material thickness
- Higher steel grades
- Higher tensile stress levels
- Higher strain rates
- Details that cause stress concentrations.

Where the situations listed above occur in combination, there should be particular attention to material specification to avoid brittle fracture.

3.3 Durability

Helical steel piles, as for other buried steel foundation elements, must be designed to have sufficient corrosion resistance to maintain structural integrity throughout the design life of the structure. For housing, NHBC states that the design life of the structure (including foundations) is to be sixty years, whereas for the Highways Agency, highway structures and their foundations have a required design life of 120 years.

Corrosion protection requirements for the helical pile system will therefore be specific to the functionality of the structure that the foundation is to support and be dependent on the soil type/properties and conditions that will act at the specific site.

In the documents supplied by Chance relating to protection of steel from potential corrosion, both active and passive control methods are described. In this review consideration is given to passive control only as in most cases it is this type of corrosion control that is adopted for steel piling. Active control solutions are best considered by approaching manufacturers who are experienced in this form of specialised corrosion protection.

In the Technical Manual Appendix A Corrosion – An Overview, information and data is presented which enables prediction of corrosion loss in bare steel to be determined based on soil type, its resistivity and its pH value. The information provided is comprehensive and is supported by documented test data undertaken by the National Bureau of Standards (NBS) in the USA. In addition, the Federal Highway Administration has also proposed a nomograph for estimating corrosion rate of anchor/pile shafts which is also included in this appendix.

Chance recommends providing passive corrosion protection for helical pile systems particularly in disturbed soils (generally soils located in the vicinity of the ground surface). Hot dip galvanizing is recommended using a typical zinc thickness of 5 mils (equivalent to approx 127 µm or 898 g/m^2) which is based on results from studies conducted by the National Bureau of Standards in the USA. Conclusions from the study based on 5 mils galvanized coating state that the coating thickness is adequate for more than 10 years corrosion protection for both inorganic oxidizing soils and inorganic reducing soils. In addition, a relationship is given to estimate the corrosion rate (weight loss) for the 5 mils thick galvanised zinc coating based on the resistivity of the soil.

In the UK information on the corrosion of steel piles in the ground was primarily presented by steel piling manufacturers. Reference was made to the Corus Piling Handbook. BS EN 1993-5 Eurocode 3 Design of steel structures Part 5 Piling, includes a section on durability of steel piles and presents data to be used for assessing steel thickness loss of bare steel piles due to corrosion in soils.

With regards to providing corrosion protection to steel by hot dip galvanising, BS EN ISO 14713 Protection against corrosion of iron and steel in structures - Zinc and

aluminium coatings — Guidelines, Section 6.2 states that “the factors influencing corrosion in soil make it impracticable to include simple guidance”.

Based on the review of all the documentation supplied by Chance regarding corrosion protection of steel piling and the review of the current British Standards that are available for assessing corrosion loss and protection, it is recommended that for bare steel helical steel piles reference should also be made to the requirements stated in BS EN 1993-5 as the information presented is specific to soil types and conditions found in the UK. It will be necessary to satisfy structural integrity throughout the design life of the foundation taking into account the loss of steel thickness as given in Table in 4.1.

With regards to providing additional corrosion protection to bare steel helical piles by hot dip galvanizing, it is felt that following the review of the information presented by Chance Civil Construction, this method should be endorsed as being an acceptable method of providing additional corrosion protection. However, it will be necessary to assess compatibility between the American standards relating to hot dip galvanising (ASTM A123 and A153) and the British Standard BS EN ISO 1461 Hot dip galvanized coatings on fabricated iron and steel articles-Specifications and test methods (ISO 1461:2009) and BS EN ISO 14713. It is suggested that contact is made with the Galvanizers Association in the UK to clarify compatibility of the codes and standards.

3.4 Testing criteria

Testing requirements for pre-production and production helical pile systems are comprehensively presented in Appendix B Load Tests of the Technical Manual. Chance recommend the “Quick load test method for individual piles” as specified in ASTM D-1143-81 Standard test method for pile under static axial compressive load and/or ASTM D3689 Standard test method for pile under static axial tension load. These test methods presented are considered by Chance to meet the minimum requirements for load testing and do not preclude codes or standards which may require the use of other testing methods.

In the UK, pile testing practice is specified in publication ICE specification for piling and embedded retaining walls for which specialist consultant and contractors refer to regarding all types of testing including static load testing. Also load testing requirements are presented in Section 7 of BS 8004 Code of practice for Foundations. However, no specific test procedures are provided for helical steel pile systems, consideration being given to bearing piles only. In the near future BS EN ISO 22477 Ground Investigation and Testing – Geotechnical Structure tests will be introduced, however, it is not known whether helical steel pile testing procedures will be included.

Acceptance of the load test results is generally governed by the building code for that jurisdiction and is subject to review by the structural engineer. The structural engineer determines the maximum deflection the structure can withstand without due loss of function or distress.

Load testing requirements can be defined before the commencement of the project by the writing of a comprehensive specification for the procurement and execution of the works. The model specification presented by Chance in the Technical Manual provides relevant guidance.

Specification of helical pile systems

The Chance Technical manual includes a Model Specification for helical piles. This is a comprehensive document which covers all the aspects of writing a specification for helical steel pile systems, providing a template for creating the specification and including guidance as to how the specification should be developed.

In the UK the ICE Specification for Piling and Embedded walls is the most referenced document to be used by specialist consultants and contractors to providing a standard agreed way of procuring and executing piling contracts. However, as of the 2nd Edition of this document, no specifications for helical pile systems are included. With the increased use of helical piling systems in the UK, it is envisaged that the ICE Piling Specification may be updated to include helical pile systems, thereby accommodating normal piling tolerances and standard load test procedures.

It is recommended that the Chance model specification document be used with possibly minor amendments to reflect UK practice, for the writing of specifications for the procurement and execution of helical pile systems in the UK.

3.5 Construction details at pile head/cap

Helical steel pile systems are used to provide foundations for new build structures and for the remedial repair of existing structures, where additional support in the form of underpinning is required.

In the supporting information provided by Chance Civil Construction, product sheets are provided for a variety of remedial repair brackets which are used with the helical piles to provide effective transfer of forces between the building structure and the helical pile system. For each bracket ultimate and working mechanical strength is quoted based on a recommended factor of safety of 2.0. However, these strength values are based on a particular configuration of bracket and helical pile, hence strength values can be higher or lower than the values quoted in the product sheets. Note that for each bracket the mechanical strengths have been based on satisfying design requirements to the various codes and standards (Uniform Building Code, BOCA National Code and SBCCI Standard Code) for which Legacy Reports are presented in the Chance Technical Manual.

For new build construction projects a steel pile cap component is specified and is presented in the product data sheets. This particular pile cap is recommended to be used for reinforced concrete footings/beams. Working load capacities are presented for the steel pile components, however no further information is provided.

Design for the transfer of loads between the top of the helical pile system, through the steel pile cap into the reinforced concrete footings or beams is not included because the design of the connection will be project specific. Connection design will consider the transfer of forces at the concrete-steel cap interface and also distribution of forces in the concrete beam to the reinforcement steelwork.

Installation tolerances

A review of the information provided by Chance Civil Construction indicates that minimal information is presented regarding tolerances requirements during pile installation.

Typically in the UK, site tolerances are defined and agreed with the engineer and the design of the pile and pile cap will need to accommodate the agreed tolerances. Suggested minimum tolerance requirements commonly used for the installation of steel bearing piles in the UK are listed below, however, it should be emphasised that tighter tolerances can be readily achieved during installation.

- Maximum permitted deviation of the finished pile from the vertical at any level is 1 in 75.
- The maximum permitted deviation of any part of the finished pile from the specified rake is 1 in 25 for piles raking up to 1 in 6 and 1 in 15 for piles raking more than 1 in 6.
- The maximum deviation of the pile centre from the centre point shown in the setting out drawings is 75mm in any direction at commencing surface level (ICE Piling Specification – Clauses 1.8.2 to 1.8.4).
- The top elevation should be within 25mm of the design vertical elevation.

3.6 Compliance with Building Regulations

The part of the UK Building Regulation 2000 which relates to the structure and foundations is Part A Structures. Part A is divided into three requirements.

- Requirement A1 Loading
- Requirement A2 Ground movement.
- Requirement A3 Disproportionate collapse

In order for the Chance helical pile system to be compliant with the Building Regulations, Requirements A1, A2 and A3 must be satisfied. A1 and A2 are achieved by providing foundations of adequate strength.

Requirement A2 relating to ground movements is most applicable for foundations and in this case for helical pile systems. Requirement A2 states that:

The building shall be constructed so that ground movement caused by:-

(a) Swelling, shrinkage or freezing of the subsoil; or

(b) Land-slip or subsidence (other than subsidence arising from shrinkage, in so far as the risk can be reasonably foreseen; will not impair the stability of any part of the building.

In addition Requirement A2b states that:

There may be known or recorded conditions of ground instability, such as that arising from landslides, disused mines or unstable strata which, if ignored, can have a devastating effect on the safety of a building and its environs. Such conditions should be taken into account in the design of the building and the foundations.

Approved Documents are intended to provide guidance for some of the more common building situations. However, there may well be alternative ways of achieving compliance with the requirements. Approved Document A1 refers to BS 8004: 1986 Code of practice for foundations, however, in the case of helical pile systems compliance to the Building Regulations can be met using the Chance Civil Construction Technical Manual and the supporting design and installation and testing procedures contained within.

3.7 Contractor appraisal system

The following statement regarding the qualifications of the helical pile contractor is given in the Technical Manual in Appendix C Specifications in the Model Specification Chance Civil Construction Helical Piles for Structural Support.

The helical pile Contractor shall be experienced in performing design and construction of helical piles and shall furnish all materials, labour and supervision to perform the work. The Contractor shall be trained and certified by Chance Civil Construction in the proper methods of design and installation of the piles. The Contractor shall provide names of on-site personnel materially involved with the work including those who carry documented certification from Chance Civil Construction. At a minimum, one member of the installation team needs to be certified.

The helical pile Contractor shall not sublet the whole or part of the contract without the express written permission of the Owner.

In addition to the statement above SCI has been informed that Sub-Surface Technologies Limited arranges for Chance authorised certification courses to be run. These courses are conducted by an engineer duly authorised by the AB Chance Company. At the end of the course each attendee undergoes an examination to ensure that they have appropriately assimilated the principles outlined in the course. Successful attendees are awarded a certificate which is valid for two years and only so long as the attendee remains an employee of the company sponsoring his training. At the end of two years or immediately if the individual changes company the validity of the certificate expires and the individual is required to sit the course again.

It is SCI's opinion that based on the information provided by SSI the Contractor appraisal system is satisfactory for installation of Chance helical pile systems by their certified installers.

4 Conclusions

4.1 Areas of technical assessment

Geotechnical parameters

The Chance Technical Design Manual provides guidance for the installation and design of Chance helical piles in a wide range of ground conditions. Suitable site investigation requirements are presented along with how the site investigation information is used in design.

Further information is provided in Section 3.1.

Design procedures

The Chance Technical Design Manual provides comprehensive guidance on the design of Chance helical piles. The relationship between pile axial capacity and installation torque is substantiated with test evidence and includes a factor of safety of at least 2.0 for permanent works.

Further information is provided in Section 3.2.

Durability

The Chance Technical Design Manual provides information on providing corrosion protect to Chance helical piles. A combination of galvanising and providing sacrificial steel thickness can be used to provide the required design life.

Further information is provided in Section 3.3.

Testing criteria

The Chance Technical Design Manual, Appendix B, provides guidance on testing requirements of Chance helical piles. Load testing criteria for specific projects should be defined before commencement of the piling operation. It is recommended that the Chance model specification from the technical manual be used.

Further information is provided in Section 3.4.

Construction details at pile head/cap

Various construction details at the pile head/cap are presented in the Chance Technical Design Manual. These have been assessed in principle and are considered appropriate for their intended use. Numerical capacities quoted in the manual have not been assessed.

Further information is provided in Section 3.5.

Compliance with Building Regulations

Chance helical piles designed and installed in accordance with the Chance Technical Design Manual are capable of meeting, or contributing to the building meeting, the

requirements of building regulations in terms of structural capacity, ground movement and durability.

Further information is provided in Section 3.6.

Contractor appraisal system

It is SCI's opinion that based on the information provided by SSI the Contractor appraisal system is satisfactory for installation of Chance helical pile systems by their certified installers.

Further information is provided in Section 3.7.

4.2 Overall Conclusions

Based on information provided by SST, publicly available information and information belonging to SCI information supplied by SST Ltd, a comprehensive assessment has been performed considering design, installation and testing of the Chance helical pile systems.

Taking into account a holistic approach, the review has established that for all the aspects reviewed, comprehensive data and procedures are in place to design and install an efficient and safe foundation system using Chance helical steel piles. Each of the aspects considered have been reviewed and where applicable helpful information and/or advice has been added.

As a result of the assessment by SCI, the Chance Technical Design Manual for helical piling may display the "SCI Assessed" logo. A certificate of the successful completion of the "SCI Assessed" process will be issued and a record of the assessment will be listed on the "SCI Assessed" website.