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### 3 GEOTECHNICAL SPECIFICATIONS

#### 3.1 ADDITIONAL GEOTECHNICAL INVESTIGATIONS

##### 3.1.1 Field of application

- 1 This section refers to all works related to the execution of the additional geotechnical investigation (AGI) and the instrumentation monitoring, to be executed by the Contractor.
- 2 The purpose of QCS is to provide as a general technical guide for acceptable construction work practices in the State of Qatar, considering this, any technology or material or specification or standard that is not mentioned in this section, modification shall be subject to approval in the light of the introduction of QCS (00-02).

##### 3.1.2 References

- 1 The following standards are approved and/ or referred to in this Section:
  - ASTM C114.....Standard Test Methods for Chemical Analysis of Hydraulic Cement
  - ASTM D1411.....Standard Test Methods for Water-Soluble Chlorides Present as Admixtures in Graded Aggregate Road Mixes
  - ASTM D4373.....Standard Test Method for Rapid Determination of Carbonate Content of Soils
  - BS 1377 .....Methods of test for soils for civil engineering purposes
  - BS 10175 .....Investigation of potentially contaminated sites. Code of practice - Code of practice
  - BS 5930 .....Code of practice for ground investigations
  

  - EN 1536 .....Execution of special geotechnical work - Bored piles
  - EN 1537 .....Execution of special geotechnical works - Ground anchors
  - EN 1538 .....Execution of special geotechnical work - Diaphragm walls
  - EN 1992 .....Eurocode 2: Design of concrete structures
  - EN 1997 .....Eurocode 7 - Geotechnical design:
  - EN 1997-1 .....Eurocode 7: Geotechnical design - Part 1: General rules
  - EN 1997-2 .....Eurocode 7 - Geotechnical design - Part 2: Ground investigation and testing
  - EN 10025 .....Hot rolled products of structural steels

  

  - ISO 710 .....Graphical symbols for use on detailed maps, plans and geological cross-sections:
  - ISO 14688 .....Geotechnical investigation and testing — Identification and classification of soil
  - ISO 14688-1 .....Geotechnical investigation and testing — Identification and classification of soil — Part 1: Identification and description
  - ISO 14688-2 .....Geotechnical investigation and testing — Identification and classification of soil — Part 2: Principles for a classification
  - ISO 14689 .....Geotechnical investigation and testing — Identification, description and classification of rock
  - ISO 22475 .....Geotechnical investigation and testing — Sampling methods and groundwater measurements

ISO 22475-1 .....Geotechnical investigation and testing — Sampling methods and groundwater measurements — Part 1: Technical principles for the sampling of soil, rock and groundwater

ISO 22476 .....Geotechnical investigation and testing — Field testing

ISO 22476-3 .....Geotechnical investigation and testing — Field testing — Part 3: Standard penetration test

ISO/IEC 17025 .....General requirements for the competence of testing and calibration laboratories

Standard Methods for the Examination of Water and Wastewater, produced by the American Public Health Association (APHA)

### 3.1.3 General

- 1 The Contractor shall carry out Additional Geotechnical Investigations (AGI) in order to examine the geological, hydrogeological and geotechnical conditions (including but not limited to the existence of karstic voids and earth gas) and determine the design geotechnical parameters, as required.
- 2 The Contractor shall submit his AGI programme in advance of undertaking any investigations for a SONO (Statement of No Objection) from the Engineer.
- 3 All AGI works and investigations shall be in accordance with latest version of, in order of priority:
  - (a) Qatar Construction Specifications: 'Ground Investigation' Section 3;
  - (b) EN 1997 – 2: 'Eurocode 7, Geotechnical Design, Part 2: Ground investigation and testing';
  - (c) BS 5930: 'Code of Practice for Site Investigations'.

### 3.1.4 Regulatory Reference Documents and Terminology

- 1 All Works shall be executed according to the relevant specifications included in the QCS, Section 3 (which shall have priority) and as indicated, but not limited to the following:
  - (a) EN 1997, Eurocode 7, Geotechnical Design
  - (b) ISO 14688, Geotechnical investigation and testing - Identification and classification of soil
  - (c) ISO 14689, Geotechnical investigation and testing - Identification and classification of rock
  - (d) ISO 17025, General requirements for the competence of testing and calibration laboratories
  - (e) ISO 22475-1, Geotechnical investigation and testing - Sampling methods and groundwater measurements
  - (f) ISO 22476-3, Geotechnical investigation and testing - Field testing
  - (g) ISO 710, Graphical symbols for use on detailed maps, plans and geological cross-sections
  - (h) BS 5930:1999 + A2:2010 Code of practice for site investigations
  - (i) BS 1377 Methods of test for soils for civil engineering purposes.
  - (j) BS 10175:2001 Investigation of potentially contaminated sites. Code of practice

### 3.1.5 Terminology

- 1 The terminology used in this specification comes from EN 1997-1 and 2, ISO 14688-1 and 2, ISO 14689 and ISO 22475-1.

### 3.1.6 Worksite Organisation

- 1 Mechanical Equipment
- (a) An adequate number and type of drilling rigs in order to carry out the Works and in accordance with the AGI programme shall be provided.
- 2 Safety
- (a) Existence of Utilities, Pre-excavation pits
    - (i) Permits from relevant Authorities shall be obtained prior to the commencement of any Work.
- 3 Communication with Land Owners
- (a) Having obtained the required permit and prior to the commencement of the Works, the Contractor shall contact and co-operate with land owners, neighbours, shop owners or any other parties, whose activities may be adversely affected by the execution of the drilling, by informing them of the purpose of the Works, the time period required for its execution and assuring them that he shall ensure that disturbance due to the Works shall be limited to the minimum possible extent.
  - (b) The area shall be fully reinstated following the completion of works.

### 3.1.7 Principles for Depth Definition of Boreholes

- 1 The borehole depths shall be defined as the greatest of the following criteria:
- (a) The boreholes shall be constructed to a depth at least 10 m from the deepest level of the relevant structures general excavation works.
  - (b) In the case of boreholes intended for the investigation of the conditions related to foundations or piles, and for diaphragm walls, the borehole depth shall be 5 m deeper than the estimated depth that the piles or the diaphragm walls are planned to be constructed.
  - (c) For boreholes intended for the investigation related to surface foundations, the borehole depth shall be 15 m (and at least 2B, where B is the foundation width), in case of soil foundation conditions, or 5.0 m, in case of rock foundation conditions. Where rock foundation conditions are covered by weathered mantle, the minimum borehole depth shall be equal to the thickness of the weathered mantle in addition to 5m inside the rock substratum.
  - (d) The depth of the boreholes shall be minimum 2D (D=Diameter of the tunnel), or 10m below the foundation level for other structures

### 3.1.8 Principles on the definition of minimum number of coring boreholes

- 1 Notwithstanding that the entire geotechnical risk lies with the contractor the main principles of the AGI to be followed by the Contractor are:
- (a) A minimum of one (1) borehole for every 100m of alignment.
  - (b) A minimum of six (6) boreholes at each Metro Station and switchbox.
  - (c) A minimum of one (1) borehole at each Shaft shall be drilled.
  - (d) A minimum of one (1) borehole, for bridges having span dimension  $6.0\text{m} \leq S \leq 8.0\text{ m}$ .

- (e) A minimum of one (1) borehole at every piers location, for bridges having span dimension S>8.0 m.

## **3.2 BOREHOLE, SAMPLING AND GROUNDWATER MEASUREMENTS SPECIFICATIONS**

### **3.2.1 General Requirements**

- 1 The works shall be performed in accordance with ISO 22475-1 and in accordance with the following paragraphs.
- 2 All AGI boreholes shall be of continuous sampling except for the pressure meter boreholes.
- 3 The sampling category of soils and rocks and quality class of soil samples shall be the minimum required, depending on the laboratory test which is planned for each sample contained in table 3.1 (for soil samples) and Para. 3.4 and Para 3.5 (for soil and rock samples, respectively) of EN 1997-2.

### **3.2.2 Selection of Sampling Method**

- 1 The selection of sampling method shall be made as per Para. 5 of ISO 22475-1.

### **3.2.3 Pre-excavation Pits**

#### **1 Pit Excavation and Restoration**

- (a) All pre-excavation pits shall be excavated by hand or by very light mechanical means.
- (b) All pits shall be immediately restored to their previous condition upon completion of work according with the requirements of Para. 5.5 of ISO 22475-1 and if pits are to remain open after the day of excavation, the Contractor shall provide adequate fencing or covering, signalling and/or lighting to ensure the safety of the public and workers.

### **3.2.4 Trial Pits**

- 1 The excavation of any trial pits to investigate soil conditions, sample recovery or execution of field tests shall follow the same procedures as for pre-excavation pits.

### **3.2.5 Soil Sampling Methods**

#### **1 General**

- (a) Soil sampling shall be based on the provisions of Para. 6 of ISO 22475-1.

#### **2 Sampling Categories**

- (a) The acceptable sampling categories according to EN1997-2 standard and ISO 22475-1 standard for the Works are A and B and shall be applied.
- (b) The appropriate method for sampling to ensure minimal disturbance of samples shall be selected. The quality of the samples shall be adequate to execute the required laboratory tests and to make the appropriate engineering geological description.

#### **3 Continuous Sampling during Drilling**

- (a) Samples shall be recovered by rotary core drilling with a double or triple tube core barrel as per Para. 6.3.2.2 of ISO 22475-1. Additionally, the inner sleeve shall be divisible in two (2), along the axis (split inner tube). In the event that the Contractor wishes to use another method of continuous sampling, he shall submit the relevant justification to the Engineer for a SONO, within the AGI program.
- (b) The use of single tube core barrel shall only be allowed in cases of cleaning of the borehole, or in cases of loose gravel that can be sampled by no other method.

- (c) Clean water shall be used for flushing.
- (d) Water supply during the drilling-sampling shall be continuous in order to achieve the optimum sampling.

4      Block Sampling from Trial Pits

- (a) Block sampling is executed based on the provisions of Para. 6.5 of ISO 22475-1.

**3.2.6 Rock Sampling Methods**

1      General

- (a) Rock sampling shall be executed on the basis of Para. 7 of ISO 22475-1.

2      Sampling Categories

- (a) The appropriate method for sampling to ensure minimal disturbance of samples shall be selected. The quality of the samples shall be adequate to execute the required laboratory tests and to make the appropriate engineering geological description.

3      Sampling by Drilling

- (a) Samples shall be recovered by rotary core drilling, with a double or triple tube core barrel as per Para. 7.3.3 of ISO 22475-1. Additionally, the inner sleeve shall be divisible in two (2) along the axis (split inner tube).
- (b) The use of single tube core barrel shall be only allowed in cases of cleaning of the borehole.
- (c) Clean water shall be used for flushing.
- (d) Water supply during the drilling-sampling shall be continuous in order to achieve the optimum sampling.

**3.2.7 Groundwater Sampling Methods**

1      Groundwater sampling shall follow the provisions of Para. 8 of ISO 22475-1.

2      Samples of groundwater shall be taken from each open standpipe piezometer following its cleaning and its air-lift development.

3      At boreholes where more than one aquifer has been detected, separate samples shall be taken for each aquifer.

**3.2.8 Handling, Transport and Storage of Samples**

1      General

- (a) Handling, transportation and storage of samples shall be carried out in compliance with the guidelines of chapter 11 of ISO 22475-1 and the requirements below.

2      Core Boxes

- (a) Core boxes shall be made in compliance with Para. 11.6 of ISO 22475-1.

3      Description of Borehole Cores, Core Boxes Photographing and Selection of Samples

- (a) The selection of samples shall be made in accordance with the Proposed Laboratory Test Program. After sample selection, the samples shall be packed according to the terms in Para. 11.3 of ISO 22475-1.

- (b) The packed samples shall then be transported to the laboratory of the Contractor, in accordance with the requirements of Para. 11.5 of ISO 22475-1.

4      Preservation and Disposal of Laboratory Samples

- (a) All samples delivered to the Contractor's laboratory shall be kept for a period of one (1) month after the Engineer has given its SONO to the Geotechnical Factual Report.

5 Transport and Storage of Core Boxes

- (a) The Contractor shall provide an adequate storage facility for the core boxes at all times. The Employer shall have custody of the core boxes, at the storage facility. The Contractor shall fully cooperate with the Employer to allow the Employer to maintain the security of the core boxes.
- (b) Following the engineering geological description and the selection of the samples for the execution of laboratory tests, the core boxes shall be carefully transported and delivered to the storage facility provided by the Contractor and shall be available for inspection by the Engineer at all times.
- (c) All core boxes shall be protected at all times during handling, transportation and storage against precipitation, sunlight, vibrations and drying.

**3.2.9 Backfilling and Site Abandonment**

- 1 Upon completion of each borehole, following the measurement of a final water level, boreholes shall be backfilled immediately in accordance with one of the following methods:
- (a) Installation of piezometers; or
- (b) In the event no piezometer is installed, the borehole shall be sealed with grout from the bottom to the surface, with specified cement grout (with a water/cement ratio 0.6 by weight) or any other method in compliance with Para. 5.5 of ISO 22475-1.
- 2 When artesian conditions are encountered such that water flows from the borehole to the surface, the Contractor shall immediately notify the Engineer and shall grout the borehole in order to prevent water flow, after the completion of the borehole to the required depth and the installation of the required instrumentation.

**3.2.10 Topographical 'As Built' Survey**

- 1 A topographically survey of all boreholes, trial pits and other investigations at their final locations shall be conducted. Drawings showing the location of the 'as-built' borehole or trial pit with the location marked by the measured distance from fixed objects shown on the drawings shall be prepared.

**3.3 IN SITU TESTS SPECIFICATIONS**

**3.3.1 Test Standards**

- 1 In situ tests shall be carried out in accordance with the provisions of Chapter 4 of EN 1997-2.

**3.3.2 Standard Penetration Test (SPT)**

- 1 This test shall be carried out in accordance with ISO 22476-3.

**3.3.3 Pressure meter Test**

- 1 Pressure meter tests shall be carried out in accordance with Para. 4.4 of EN1997-2.

**3.3.4 Water Permeability Tests**

1 General

- (a) The Contractor shall execute variable head tests, constant head tests and packer tests in accordance with Earth Manual E-18 and the requirements below.

2 Water Permeability Test Program

- (a) The execution of water permeability tests shall cover the total geological formations encountered at each borehole.
- (b) Water permeability tests shall be conducted, for each borehole, as follows:
  - (i) In situ water permeability tests shall generally be carried out every six (6) drilling meters. Where there is high water permeability, the test shall be executed upon each cycle of sampling sequence.
  - (ii) The maximum length of the tested section is 3 m, except where there is low permeability.
  - (iii) Permeability tests shall commence at the ground water table or at a depth of 3 m from ground surface (whichever is shallower).
  - (iv) In tunnel areas, at least two (2) water permeability tests shall be carried out at the tunnel face depth.
  - (v) In tunnel areas, water permeability tests shall be conducted at the 6-metre zone above the crown (at least two (2) tests) and at the 3-metre zone below the invert (at least one (1) test).

### **3.3.5 Measurements of Volatile Organics**

- 1 All AGI boreholes shall be checked for potentially contaminated soil which shall include taking field measurements indicative of volatile organic compounds (VOC).

## **3.4 LABORATORY TEST SPECIFICATIONS**

### **3.4.1 Laboratory Test Program**

- 1 The minimum requirements with regard to the program and the number of the laboratory tests are presented below.

### **3.4.2 Soil samples**

- 1 Physical properties tests
  - (a) Determination of specific gravity and unit weight, water content, Atterberg limits and particle size analysis: One (1) test per formation, one additional test if the formation is thicker than 2 metres and, subsequently, one (1) additional test every 3 metres. Hydrometer tests shall be executed, when following particle size analysis with sieves the fine fraction is higher than 5%.
  - (b) Organic substances tests shall be executed on organic soil materials.
- 2 Engineering properties tests
  - (a) Unconfined compression test: One (1) test per formation, one additional test if the formation is thicker than 2 metres and, subsequently, one additional test every 3 metres.
  - (b) One dimensional consolidation tests, triaxial tests, shear tests, residual shear strength and swelling test: These tests shall be executed, taking into account the homogeneity of the soil and the type of the structure.

### **3.4.3 Rock samples**

- 1 The tests shall be performed, taking into account the homogeneity of the soil and the type of the structure.
- 2 Physical properties tests
  - (a) Water content, porosity and density: one test per formation, one additional test if the formation is thicker than four metres and subsequently an additional test every 5 metres.

- 3 Engineering properties tests
- (a) A uniaxial compression test with elasticity modulus and Poisson ratio determination and two point load tests, axial and diameter, every 3 m.
  - (b) CHERCHAR abrasiveness test every 5 m.

#### **3.4.4 Aggressiveness of soil and groundwater**

- 1 For the determination of basic design parameters, regarding the permanent underground works from reinforced concrete, sampling and testing according to ASTM D4373, ASTM C114, ASTM D1411, APHA 4500-H and the relevant articles of QSC, Section 5, shall be conducted.
- 2 The following sampling and tests shall be conducted, at a minimum:
- (a) For stations: at four (4) locations (e.g. two (2) each along the long sides - towards the corners) at two (2) depths per location (e.g. -10 and -20 m).
  - (b) For tunnels: at two (2) locations per tunnel, at two (2) depths per location (e.g. at the middle of the tunnel overburden and at the middle of the tunnel face).
  - (c) If defective values and/or unusual deviations of the values are identified, per area, additional sampling and checking is required (including doubling the locations and the samples).
  - (d) Aggressivity parameters that shall be checked at minimum are:
  - (e) Soil:
  - (f) Acidity degree as per Baumann – Gully.
    - (i) Sulphurous, as sulphur ions  $\text{SO}_{2-4}$  (mg/kg).
  - (g) Groundwater:
    - (i) Sulphurs  $\text{SO}_{2-4}$  (mg/l).
    - (ii) pH.
    - (iii)  $\text{CO}_2$  (mg/l).
    - (iv) Cations  $\text{NH}_4^+$  (mg/l).
    - (v) Cations  $\text{Mg}^{2+}$  (mg/l).
    - (vi) Chlorides  $\text{Cl}^-$  (mg/l).

#### **3.4.5 Geochemical Detection of Hydrocarbons Pollution**

- 1 At boreholes in the vicinity of petrol stations or where there is suspicion or evidence of pollution relative to the measurements with PID, soil and water samples shall be taken for TPH tests, according to method EPA8015b or APHA 5520-C or other equivalent method approved by EPA.
- 2 Especially for boreholes in the vicinity of petrol stations, regardless of evidence of pollution, at least four (4) soil samples, appropriately distributed, shall be obtained for the above-mentioned tests.

### **3.5 GEOTECHNICAL REPORTS**

#### **3.5.1 General**

- 1 The Contractor shall submit, for obtaining Engineer's SONO reports, in the following order:
- (a) Geotechnical Appraisal Report (GAR) including the Additional Geotechnical Investigations programme.

- (b) Geotechnical Factual Report (GFR) including the results of the Additional Geotechnical Investigations (AGI).
- (c) Geotechnical Interpretive Report (GIR) for each station, shaft and tunnel between stations.

2      Design geotechnical parameters

- (a) The design values of the geotechnical parameters shall be estimated on the basis of the procedure described in paragraphs 2.4.5.2 and 2.4.6.2 of Eurocode 7, using the characteristic values of geotechnical parameters.
- (b) The types and the selected values of the design and geotechnical parameters shall include proposals about the design soil parameters, for the various depths under the surface of the ground, according to the geological formations and the proposed stratigraphy of the soil in the area where the works are to be performed. They shall take into consideration the type, extent and geometry of the underground and other structures, the construction methods and the requirements of the proposed analysis method, and any other relevant factors.
- (c) In the GIR, the design assumptions of the geotechnical conditions shall correspond to the actual:
  - (i) Types of soil and their natural properties (specific weight, density, particle size, Atterberg limits, natural water content, and any other relevant properties).
  - (ii) Variation of soil properties.
  - (iii) Succession and layers of thickness, presence of discontinuities.
  - (iv) Ground water level and hydrogeological conditions, piezometric pressures that shall be used in the temporary retaining systems and long term conditions, permeability.
  - (v) Loading rate and analysis method (total or active pressures).
  - (vi) Shear strength parameters in terms of total and active stresses.
  - (vii) Soil pressure coefficients (active, at-rest, passive) and any proposed modifications of the theoretical values.
  - (viii) Strength and compressibility parameters, including consolidation properties, compression module when loading and unloading, Poisson ratio, non-linear stress and deformation parameters (if applicable), dynamic shear module and any other relevant properties.
  - (ix) If anchoring is to be used, values of ultimate bond strength and working bond strength between anchor or anchoring and environmental medium (soil or rock).
- (d) To calculate the regime of the initial geostatic stress field (coefficient of earth pressure K), a typical range of its values shall be proposed to be used in a sensitivity analysis during the design, as well as design values for each section or sub-section or structure.
- (e) These values shall be based on:
  - (i) Appropriate laboratory strength tests (e.g. triaxial tests and other relevant types of testing) as well as on in-situ tests (e.g. pressure meters and other relevant types of testing); and
  - (ii) Well documented empirical correlations taken from relevant available sources according to the local conditions, including the soil type and loading history (e.g. pre-consolidation stress, over consolidation ratio, and other relevant factors).
- (f) A sensitivity analysis of the geotechnical parameter values shall be included as a part of the GIR.

### **3.5.2 Photographic Archive**

- 1 General
  - (a) The Contractor shall perform detailed photographing of the works. Digital pictures shall be taken from the borehole worksites, the pre-excavation pits and trial pits (four sides and floor), the core boxes and the samples for testing.
- 2 Borehole Cores' Photographs
  - (a) The Contractor shall take photographs to provide a fully detailed record of all borehole cores. Colour and length scales shall be included in each photo. The cores shall be photographed twice.
- 3 Samples' Photographs
  - (a) The Contractor shall take sets of photographs of all samples (before and after the tests), to create a fully detailed archive. Rock samples are cleaned and lightly sprayed with water prior to photographing to reveal structure and bedding.

## **3.6 PILING AND DIAPHRAGM WALLING**

### **3.6.1 Piling**

- 1 This section specifies the materials and workmanship required for bored piles and bored pile walls. The design and installation shall be in accordance with EN 1997-1 and EN 1536.
- 2 Particular attention shall be paid to all safety aspects of the work, employing barriers and covers as necessary.
- 3 Compliance with all applicable environmental laws has to be achieved. Relevant permits and licenses shall be acquired by the Contractor.

### **3.6.2 Diaphragm Walling**

- 1 This Section specifies the materials and workmanship required for diaphragm wall construction.
- 2 EN 1997-1 and EN 1538 shall be strictly followed in relation to diaphragm wall construction, except where higher standards are required in this specification.

## **3.7 PILING – EXECUTION**

### **3.7.1 General**

- 1 All related works shall be according to QCS - Section 4 Piling, EN 1536 and EN 1997-1.

### **3.7.2 Boring**

- 1 In the event of rapid loss of drilling fluid from a pile excavation, the bore shall be backfilled immediately.
- 2 All reasonable steps shall be taken to prevent the spillage of drilling fluid on the Site, or in areas outside the immediate vicinity of boring.
- 3 For a pile constructed in a stable cohesive soil, without the use of temporary casing or drilling fluid, the pile shall be bored and concrete shall be placed as soon as practical.

### **3.7.3 Tolerances**

- 1 Tolerances shall be as per EN 1997-1 and EN 1536.
- 2 Records of the installation of each pile shall be kept. Any unusual or difficult driving or boring operation shall be noted in these records.

### **3.7.4 As-built Details**

- 1 Records of as-built details of the piling works, including soil conditions encountered during boring shall be kept and delivered to the Employer as part of the O&M documentation.

### **3.7.5 Placing Concrete**

- 1 The method of placing and the workability of the concrete shall be such that a continuous monolithic concrete shaft of full cross section is formed.

### **3.7.6 Pile Tests**

- 1 Pile tests shall be performed according to EN 1997-1 and EN 1536.

### **3.7.7 Protection of Piling from Chemical Attack**

- 1 Piles shall be protected against aggressive soil and ground water conditions, both during and after installation. The Contractor shall demonstrate that he has considered the protection required to the steel reinforcement cage and the concrete.

## **3.8 DIAPHRAGM WALLING – EXECUTION**

### **3.8.1 General**

- 1 Execution shall be carried out in accordance with EN 1997-1 and EN 1538.

### **3.8.2 Cleaning**

- 1 The exposed surface of the diaphragm wall shall be thoroughly cleaned to ensure bonding of any subsequent material placed on the wall.

## **3.9 ANCHORING, BRACINGS, NAILS AND BOLTS**

### **3.9.1 General**

- 1 This section specifies materials and workmanship requirements for pre-stressed anchoring, bracings, nails and bolts. The design and installation shall be in accordance with EN 1997- 1 and EN 1537.

### **3.9.2 Anchoring**

- 1 Temporary anchors shall have a design life of a minimum of 10 years.

### **3.9.3 Bracing**

- 1 All steel components for bracings shall be in accordance with EN 10025.
- 2 All concrete components for bracings shall be in accordance with EN 1992.

### **3.9.4 Nails and bolts**

- 1 All metal components of the bolts/nails shall conform to the standard specification EN 10025.

## **3.10 ANCHORING EXECUTION**

### **3.10.1 General**

- 1 Anchoring shall avoid damage to all existing buildings, structures and utilities.
- 2 In the event temporary anchors are required to be placed in adjacent properties, the approval of owners of adjacent properties shall be obtained.

### **3.10.2 Testing**

- 1 The Contractor shall test all anchors according to EN 1537.

### **3.10.3 Corrosion protection of anchors**

- 1 Anchors shall be protected against corrosion during service life according to EN 1537.

### **3.10.4 Tolerances**

- 1 The tolerances for anchoring shall be in accordance with EN 1537.

## **3.11 BRACING EXECUTION**

### **3.11.1 General**

- 1 Bracings shall be installed so that the waterproofing will not be damaged.

END OF PART